ATTACHMENT

CNC-1381.05-00-0017, "Class 1E Diesel Protective Relaying and Sequencer Undervoltage Relay Settings"

Form 101.1 (R02-12)

CERTIFICATION OF ENGINEERING CALCULATION

Station and Unit Number: Catawba Nuclear Station Unit 1 & 2 Revision No.: 17

Title of Calculation: Class 1E Diesel Protective Relaying and Sequencer Undervoltage Relay Settings

Calculation Number: CNC-1381.05-00-0017

ACTIVE: Yes ☒ No ☐ TYPE I: Yes ☐ No ☒ QA CONDITION of items covered: 1

Microfiche Attachment List: Yes ☐ No ☒ (See Form 101.4) DSD List: Yes ☐ No ☒ (See Form 101.7)

Calculation Body Pages (Vol.)			Supporting Documents (Vol.)			Volumes	
Revised	Deleted	Added	Revised	Deleted	Added	Deleted	Added
~~16~~ 907 4/24/14		16.1, 17.1, 18.1, 18a.1, 18b.1, 18c.1, 21.1					

The signatures below certify that this calculation has been originated, checked, inspected and approved in accordance with established procedures.

Originated By: Butch Finch B. Finch Date: 4/1/14

Checked By: Robert A. Dickard R A Dickard Date: 4/1/14

Verification Method: Method 1 ☒ Method 2 ☐ Method 3 ☐ Other ☐

Approved By: Paul McIntyre Paul McIntyre Date: 4-2-14

Issued to DCRM: B. Finch Date: 4/24/14 Received by DCRM: K L Lisk Date: 5-1-14

Complete the Spaces Below for Documentation of Multiple Originators (Orig.) or Checkers (Chk.)

Pages: _____ Orig.: _____ Date: _____

Verif. Method 1☐ 2☐ 3☐ Other☐ Chk.: _____ Date: _____

Pages: _____ Orig.: _____ Date: _____

Verif. Method 1☐ 2☐ 3☐ Other☐ Chk.: _____ Date: _____

Form 101.1 (R02-12)

CERTIFICATION OF ENGINEERING CALCULATION

Station and Unit Number: Catawba Nuclear Station Unit 1 & 2 Revision No.: 16

Title of Calculation: Class 1E Diesel Protective Relaying and Sequencer Undervoltage Relay Settings

Calculation Number: CNC-1381.05-00-0017

ACTIVE: Yes [X] No [ ] TYPE I: Yes [ ] No [X] QA CONDITION of items covered: 1

Microfiche Attachment List: Yes [ ] No [X] (See Form 101.4) DSD List: Yes [ ] No [X] (See Form 101.7)

Calculation Body Pages (Vol.)			Supporting Documents (Vol.)			Volumes	
Revised	Deleted	Added	Revised	Deleted	Added	Deleted	Added
21	16, 17,18	16, 17,18, 18a, 18b, 18c	-	-	-	-	-

The signatures below certify that this calculation has been originated, checked, inspected and approved in accordance with established procedures.

Originated By: Robert A Dickard Date: 6/16/12

Checked By: Butch Fink Date: 6/25/12

Verification Method: Method 1 [X] Method 2 [ ] Method 3 [ ] Other [ ]

Approved By: Paul M. Intzes Date: 6-25-12

Issued to DCRM: RA Dickard Date: 6/28/12 Received by DCRM: K L Link Date: 9-28-12

Complete the Spaces Below for Documentation of Multiple Originators (Orig.) or Checkers (Chk.)

Pages: _____ Orig.: _____ Date: _____

Verif. Method 1[ ] 2[ ] 3[ ] Other[ ] Chk.: _____ Date: _____

Pages: _____ Orig.: _____ Date: _____

Verif. Method 1[ ] 2[ ] 3[ ] Other[ ] Chk.: _____ Date: _____

FORM 101.3 (R08-04)

CERTIFICATION OF ENGINEERING CALCULATION - REVISION LOG

Station And Unit Number: Catawba Nuclear Station Unit 1 & 2

Title Of Calculation: Class 1E Diesel Protective Relaying and Sequencer Undervoltage Relay Settings

Calculation Number: CNC-1381.05-00-0017

Active Calculation/Analysis Yes ☒ No ☐

	Calculation Pages (Vol)			Supporting Documentation (Vol)			Volumes		Orig	Chkd	Verif. Meth.	Appr[1]	Issue Date
Rev. No.	Revised	Deleted	Added	Revised	Deleted	Added	Deleted	Added	Date	Date	1, 2, 3, "Other"	Date	Rec'd Date
15	P.19, 20, 21	—	-	-	-	—	—	-	09-17-08	09/17/2008	1	9-17-08	KLS 10/7-08 EST 11-13-08

Note 1: When approving a Calculation revision with multiple Originators or Checkers, the Approver need sign only one block.

Form 01077 (R3-94)

CERTIFICATION OF ENGINEERING CALCULATION

STATION AND UNIT NUMBER: *Catawba Nuclear Station Unit 1 & 2*

TITLE OF CALCULATION: *Class 1E Diesel Protective Relaying and Sequenceer Undervoltage Relay Settings*

CALCULATION NUMBER CNC-1381.05-00-0017

ORIGINALLY CONSISTING OF:

PAGES ii, iii, 1 THROUGH 20

TOTAL ATTACHMENTS _____ TOTAL MICROFICHE ATTACHMENTS 0

TOTAL VOLUMES 1 TYPE I CALCULATION/ANALYSIS ☐ Yes ☒ No

TYPE I REVIEW FREQUENCY N/A

THESE ENGINEERING CALCULATIONS COVER QA CONDITION 1 ITEMS. IN ACCORDANCE WITH ESTABLISHED PROCEDURES, THE QUALITY HAS BEEN ASSURED AND I CERTIFY THAT THE ABOVE CALCULATION HAS BEEN ORIGINATED, CHECKED OR APPROVED AS NOTED BELOW:

ORIGINATED BY See Original Cover Sheet DATE _____

CHECKED BY See Original Cover Sheet DATE _____

APPROVED BY See Original Cover Sheet DATE _____

ISSUED TO DOCUMENT MANAGEMENT N/A DATE _____

RECEIVED BY DOCUMENT MANAGEMENT N/A DATE _____

MICROFICHE ATTACHMENT LIST: ☐ Yes ☒ No SEE FORM 101.4

REV	CALCULATION PAGES (VOL)			ATTACHMENTS (VOL)			VOLUMES		ORIG	CHKD	APPR	ISSUE DATE
NO	REVISED	DELETED	ADDED	REVISED	DELETED	ADDED	DELETED	ADDED	DATE	DATE	DATE	REC'D DATE
14	None	None	None						[signature] 4/22/98	[signature] 4/22/98	[signature] 4-22-98	[signature] 4/22/98 [signature] 4-30-98
15	P19, 20, 21	–	–	–	–	–			[signature] 9/17/08			

Form 01077 (R3-94)

CERTIFICATION OF ENGINEERING CALCULATION

STATION AND UNIT NUMBER: *Catawba Nuclear Station Unit 1 & 2*

TITLE OF CALCULATION: *Class 1E Diesel Protective Relaying and Sequencer Undervoltage Relay Settings*

CALCULATION NUMBER CNC-1381.05-00-0017

ORIGINALLY CONSISTING OF:

PAGES ii, iii, 1 THROUGH 20

TOTAL ATTACHMENTS _____ TOTAL MICROFICHE ATTACHMENTS 0

TOTAL VOLUMES 1 TYPE I CALCULATION/ANALYSIS ☒ Yes ☐ No

TYPE I REVIEW FREQUENCY 1 year

THESE ENGINEERING CALCULATIONS COVER QA CONDITION 1 ITEMS. IN ACCORDANCE WITH ESTABLISHED PROCEDURES, THE QUALITY HAS BEEN ASSURED AND I CERTIFY THAT THE ABOVE CALCULATION HAS BEEN ORIGINATED, CHECKED OR APPROVED AS NOTED BELOW:

ORIGINATED BY J.E. Herrington DATE 11-17-78

CHECKED BY R.M. Hartley DATE 11-20-78

APPROVED BY W.J. Foley DATE 12-06-78

ISSUED TO DOCUMENT MANAGEMENT N/A DATE _____

RECEIVED BY DOCUMENT MANAGEMENT N/A DATE _____

MICROFICHE ATTACHMENT LIST: ☐ Yes ☒ No SEE FORM 101.4

REV	CALCULATION PAGES (VOL)			ATTACHMENTS (VOL)			VOLUMES		ORIG	CHKD	APPR	ISSUE DATE
NO	REVISED	DELETED	ADDED	REVISED	DELETED	ADDED	DELETED	ADDED	DATE	DATE	DATE	REC'D DATE
12	* 1-20, ia, iii * Retype performed (now pgs. 1-21)	None	None	-	-	-	-	-	W.O. [signature] 10/2/95	[signature] 12/6/95	[signature] 12/12/95	KLS 12-23-95 bg2 1-11-96
13	None	None	None						W.O. [signature] 8/13/97	[signature] 8/13/97	[signature] 8/26/97	[signature] 9/3/97 bg2 9-29-97

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0000 4397 0723

Form 01077 (R3-88)

FORM 101.1	REVISION 11

CERTIFICATION OF ENGINEERING CALCULATION

STATION AND UNIT NUMBER Catawba Nuclear Station Units 1 & 2

TITLE OF CALCULATION Class 1E Diesel Protective Relaying and Sequencer Undervoltage Relay Settings

CALCULATION NUMBER CNC-1381.05-00-0017

ORIGINALLY CONSISTING OF:

PAGES ii, iii, 1 THROUGH 20

TOTAL ATTACHMENTS _____ TOTAL MICROFICHE ATTACHMENTS 0

TOTAL VOLUMES 1

TYPE 1 CALCULATION/ANALYSIS YES ☒ NO ☐
TYPE 1 REVIEW FREQUENCY 1 YEAR

REV. 08 [illegible] 7/2/90

THESE ENGINEERING CALCULATIONS COVER QA CONDITION 1 ITEMS. IN ACCORDANCE WITH ESTABLISHED PROCEDURES, THE QUALITY HAS BEEN ASSURED AND I CERTIFY THAT THE ABOVE CALCULATION HAS BEEN ORIGINATED, CHECKED OR APPROVED AS NOTED BELOW:

ORIGINATED BY J.E. Herrington DATE 11-17-78

CHECKED BY R.M. Hartley DATE 11-20-78

APPROVED BY W.J. Foley, Jr. DATE 12-06-78

ISSUED TO GENERAL SERVICES DIVISION N/A DATE

RECEIVED BY GENERAL SERVICES DIVISION N/A DATE

MICROFICHE ATTACHMENT LIST: ☐ Yes ☒ No SEE BACK OF FORM

REV. NO.	CALCULATION PAGES (VOL)			ATTACHMENTS (VOL)			VOLUMES		ORIG	CHKD	APPR	ISSUE DATE
	REVISED	DELETED	ADDED	REVISED	DELETED	ADDED	DELETED	ADDED	DATE	DATE	DATE	REC'D DATE
06	None	None	None	-	-	-	-	-	[illegible] 7-13-88	[illegible] 7-15-88	RG Dickard 7-15-88	[illegible] 7-18-88 [illegible] 7/18/88
07	NONE	NONE	NONE	—	—	—	—	—	[illegible] 6-26-89	FTS 6/30/89	RG Dickard 7/3/89	[illegible] 7/5/89 [illegible] 7-11-89
08	1,6,i	NONE	NONE	—	—	—	—	—	[illegible] 7-2-90	[illegible] 7/5/90	RG Dickard 7/11/90	[illegible] 7-24-90 [illegible] 7-27-90
09	i	NONE	NONE	—	—	—	—	—	[illegible] 5-6-91	[illegible] 5-13-91	RG Dickard 5-[illegible]-91	[illegible] 6-11-91 [illegible] 6-19-91
10	i,6,9,20	NONE	NONE	—	—	—	—	—	[illegible] 6-11-92	[illegible] 6/23/92	RG Dickard 6-23-92	[illegible] 6-25-92 [illegible] 6-29-92
11	1, 19, 20	NONE	ia, 17B	—	—	—	—	—	[illegible] 5-12-94	[illegible] 5/12/94	[illegible] 5/17/94	[illegible] 7/21/94 [illegible] 8-3-94

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CERTIFICATION OF ENGINEERING CALCULATION

Station and Unit Number Catawba Nuclear Station Units 1 & 2

Title of Calculation Class 1E Diesel Protective Relaying and Sequencer Undervoltage Relay Settings

Calculation Number CN-1381.05-17

These Engineering calculations cover items relating to nuclear safety. In accordance with established procedures, the quality has been assured and I certify that the above calculation has been performed, checked or approved as noted below:

Performed by J. E. Herrington J E Herrington Date 11-17-78

Checked by R M Hartley KRC Date 11-20-78

Approved by DMC W J Foley Jr Date 12-6-78

Revision/Addenda Log:

No.	Pages Revised	Pages Deleted	Pages Added	Performed By / Date	Checked By / Date	Approved By / Date	Date Issued / Date Received
01	17,20	NONE	NONE	J E Herrington 9/17/80	R.M. Hartley 9/18/80	W J Foley 9/19/80	N/A N/A
02	2,3,13,14,15, 17,18,20	NONE	NONE	J E Herrington 11-5-82	WB Barfield 11-15-82	D M Clark 11-19-82	11-18-82 PD 12-15-82
03	1, 19	NONE	NONE	L S Wright 1-3-84	R.M. Hartley 1-3-84	D M Clark 1-6-84	1-9-84 2-8-84
04	20	17, 18	17a, 18a	L. S. Wright 2-13-85	A. Benz 2-13-85	D M Clark 2-15-85	2-18-85 HDN 2-8-85
05	14,20	NONE	NONE	L S Wright 9/3/85	A Benz 9/4/85	D M Clark 9/4/85	

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File/Calculation No. CNC-1381.05-00-0017

REVISION DOCUMENTATION SHEET

Revision Number	Revision Description
15	Revised to include ABB Relay Model 411R0175 on P.19, 20 & 21 per Mod CE101444
16	Revised Section 7 on Loss of Voltage relays per PIP C11-8526. Inappropriate error values had been used in previous analysis.
17	Revised Section 7 for Loss of Voltage Nominal and Allowable Values to support LAR Submittal per PIP C12-5680. These Changes Become Effective When the LAR Is Approved.

Form 101.2 Revision 1
26164 (R9-89)

File/Calculation No. CNC-1381.05-00-0017

REVISION DOCUMENTATION SHEET

Revision Number	Review Frequency Changed Yes/No	Revision Description
11 JCH 5-12-94	No	REVISED TO INCLUDE LVR TECHNICAL SPECIFICATION ALLOWABLE VALUE (REFERENCE SITA 91-01 (CN) & PIP 0-C91-0028) AND ASSUMPTION DETERMINING LVR SETPOINT. ENGINEERING CALCULATION PERIODIC REVIEW PER PROJECTS MANUAL DOC. 803-00.
12 WOG 10/2/95	No	ENGINEERING CALCULATION PERIODIC REVIEW PER EDM 101. RETYPE OF CALCULATION PERFORMED.
13 WOG 8/13/97	No	ENGINEERING CALCULATION PERIODIC REVIEW PER EDM 101. NO CHANGES REQUIRED.
14 WOG 9/22/98	Yes	Engineering calculation Periodic review per EDM 101. Changed from Type I calculation to Type II per requirements of EDM 101.
15 Anib-Parsche		Revised to include ABB Relay Model 411R0175 on p. 19, 20 & 21 per Mod CE101444

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Form 101.2 Revision 0
26164 (12-82)

Calculation No. CN-1381.05-17

JH 11/10/86

REVISION DOCUMENTATION SHEET

REVISION NUMBER	REVIEW FREQUENCY CHANGED YES/NO	JH 7/20/90 REVISION DESCRIPTION
03		The 50 DGT Relay is to be set at 110% of the two-hour rating of the diesel generator (121% of the full-load rating) in accordance with Rev. 2 of Engineering Criteria RE-3.01, Section 5.4.5.
04		Added a time delay setting for the diesel load sequencer undervoltage relays (27D's) to prevent false diesel starts due to system transients.
05		40 DGT setting changed to assure proper protection for a short-circuited field when the diesel generator is fully loaded.
06		"Analytical Model Review Control" per D.E.D. II.4.12. No changes required.
07 JH 6/26/89		"ANALYTICAL MODEL REVIEW CONTROL" PER DED. II.4.12. NO CHANGES REQUIRED.
08 JH 7/2/90	No	ENGINEERING CALCULATION PERIODIC REVIEW PER DE PROJECTS MANUAL, DOC. 803-00. EDITORIAL REVISIONS ONLY.
09 JH 5/6/91	No	ENGINEERING CALCULATION PERIODIC REVIEW PER DE PROJECTS MANUAL, DOC. 803-00. NO REVISIONS NECESSARY.
10 JH 6/12/92	No	REVISED 32DGT TIME DELAY PER CE-3592, IMPL 6/2/92 & JH. CE-3593, IMP 6/2/92, REVISE D/G GROUNDING EQUIPMENT DATA/REFERENCE TO REFLECT AS-INSTALLED INFORMATION AND ENGINEERING CALCULATION REVIEW PER PROJECTS MANUAL DOC. 803-00

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JTH 11/17/78

A. PROBLEM: Determine the settings for all essential diesel generator and sequencer relays.

B. RELATIONSHIP TO NUCLEAR SAFETY: The relays are a portion of the Essential Power Distribution System for Catawba Nuclear Station.

C. DESIGN METHODS: Set the relays to protect the Diesel Generator whenever it is operating and the sequencer undervoltage relays to initiate sequencer operation.

JH 11/17/78

D. APPLICABLE CODES AND STANDARDS (Name, Number, Date, Revision):

None

E. OTHER DESIGN CRITERIA:

1) RE-3.01 -- Relaying - Auxiliary Systems - Equipment Protection Settings

F. RELATED SAR CRITERIA (PSAR or FSAR, Page, Amendment)

8.3.1.1.3.4 - Diesel Generator Protection Systems

G. CALCULATIONS:----------Page No. 1 - 189

H. ASSUMPTIONS:----------Page No. 20 ~~19~~

I. REFERENCES:----------Page No. 20 ~~19~~

J. CONCLUSION:----------Page No. 21 ~~20~~

REV. 12 GOL 10/2/95

1. **DIESEL GENERATOR BREAKER (1ETA18, 1ETB18, 2ETA18, & 2ETB18) INSTANTANEOUS OVERCURRENT RELAY TRIP (50DGT).**

Relay Type: ITE 50, 2-20 Amp tap range, Catalog # 218T0641, Reference Instruction Booklet IB-18.2.7-1 ISSUE G.

The 50DGT is utilized to protect the Emergency Diesel Generators from adverse overcurrent conditions during parallel operations by tripping its associated breaker and providing an alarm. When the D/G is running unparalleled (ex. during an emergency condition on an isolated bus), the 50DGT provides only an alarm to warn of an overcurrent condition. The relay is set at 121% of full load current (based on 7000 kW generator rating, instead of 5750 kW derated value) in order to prevent spurious trips during testing.

Current Transformer (CT) Ratio = $\frac{1200}{5} = 240$

D/G Full Load Current = $\frac{8750\ kVA}{\sqrt{3} \times 4.16\ kV} = 1214.4$ Amps

CT Secondary Current = $\frac{D/G\ FLA}{CT\ Ratio} = \frac{1214.4}{240} = 5.06$ Amps

Pickup Value = 1.21 x CT Secondary Current
= 1.21 x 5.06 Amps
= 6.12 Amps

PICKUP SETTING = 6.1 AMPS

2. DIESEL GENERATOR VOLTAGE CONTROLLED OVERCURRENT (51V) RELAY

Relay Type: Westinghouse COV-8, Range: 4-12 Amps, Catalog # 1876244, Reference Instruction Booklet I.L. 41-116E.

The Voltage Controlled Overcurrent (51V) relays are used in a two out of three logic scheme to isolate the generator from faults on the 4160 volt essential switchgear bus. These relays operate only when the voltage drops below a selected level (set at 80% of rated voltage). This allows the relays to operate on overcurrents caused by faults which cause large voltage drops, possibly resulting in generator damage. The overcurrent unit should be set at maximum permissible overload for the generator.

$$\text{CT Ratio} = \frac{1200}{5} = 240 \qquad \text{PT Ratio} = \frac{4200}{120} = 35$$

To determine Full Load Amps, use 7.5 MVA, 6.9/4.16 kV transformer rating.

$$\text{FLA} = \frac{7.5\ MVA \times 1000}{\sqrt{3} \times 4.16\ kV} = 1041 \text{ Amps}$$

$$\text{CT}_{\text{SECONDARY}}\ \text{I} = \frac{FLA}{CT\ RATIO} = \frac{1041\ Amps}{240} = 4.34 \text{ Amps}$$

Select Tap 5 Time Dial 5 2.05 sec@500%

Note: Even though the generator's rated full load current is 1214.4 Amps, the relay setting is based on the 7.5 MVA transformer rating. The Diesel Generator is provided as a backup to this transformer. In

addition, the Diesel Generator switchgear breaker is rated at 1200 Amps.

The attached thermal damage curve has been plotted as time vs. current, rather than time vs. P.U. rated KVA in order to permit plotting both the thermal damage and relay curves on one graph.
The following table gives the values for the thermal damage curve (S_B = 8750 KVA, V_B = 4.16 KV):

S_{PU}	S(KVA)	I(Amps)	Time(secs)
1.0	8750	1214.4	-
1.1	9625	1335.8	-
1.2	10,500	1457.3	930
1.3	11,375	1578.7	294
1.4	12,250	1700.1	126
1.45	12,687.5	1760.9	87
1.49	13,037.5	1809.4	66

Note: $S=S_{PU} \times S_B$; $I = \frac{S}{\sqrt{3}xV}$

51V Settings: Amp Tap = 5 Amps
Time Dial = 2.05 sec @ 500%
Voltage Tap = 96 Volts

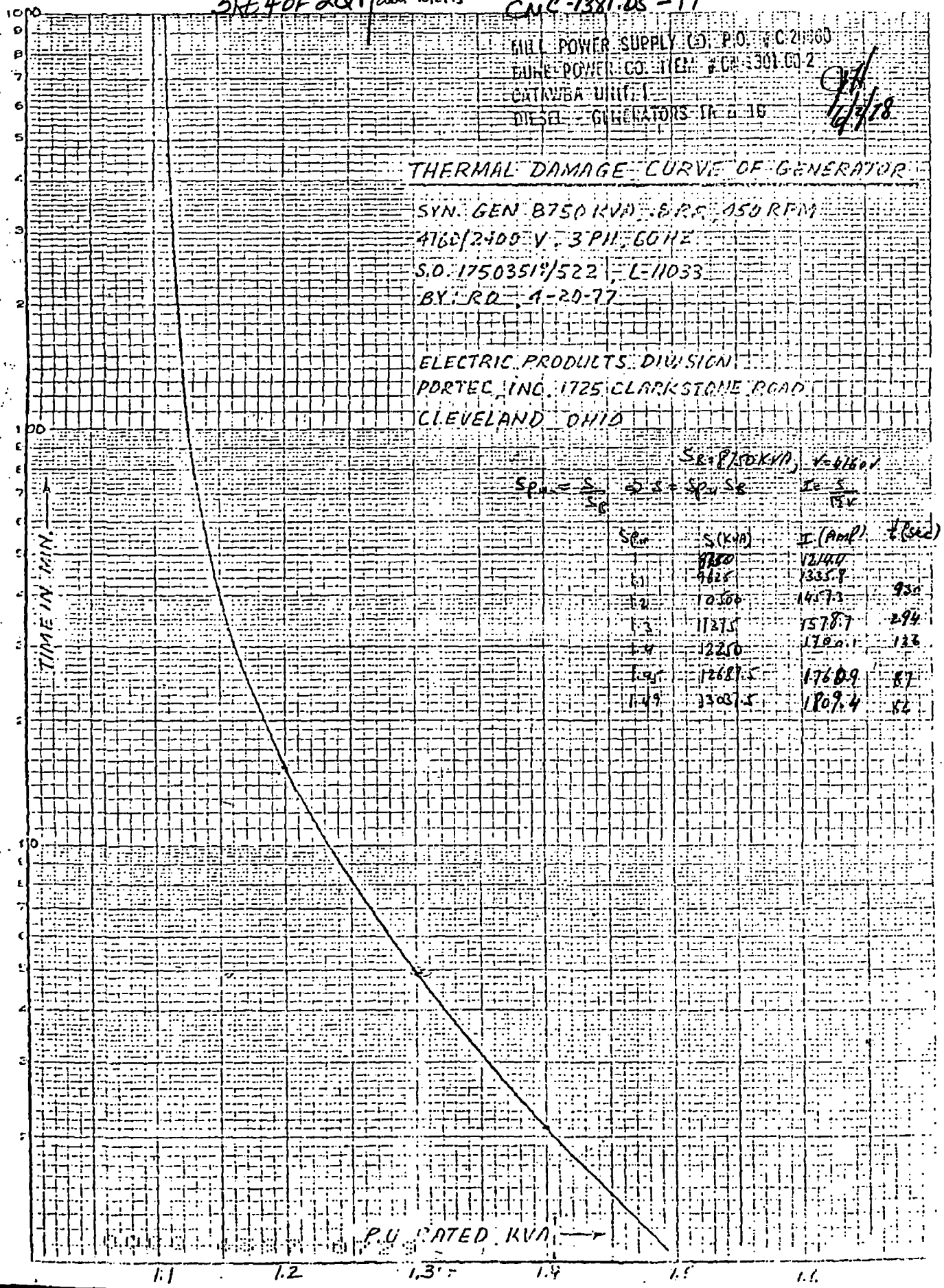
Since the relay trips the D/G Breaker via 2 out of 3 logic, it is desirable for it to trip before the incoming breaker (when paralleled) but after the feeder breakers have an opportunity to trip and clear the fault. Therefore, the time dial was chosen to coordinate with the incoming breaker relay (when the D/G is paralleled) and the worst case feeder breaker (4.16 KV Essential Feeder to the 4.16 Blackout Switchgear) relay.

SHT 4 OF 201 | REV. 12 | 10/2/95

CNC-1381.05-17

MILL POWER SUPPLY CO. P.O. # C-21060
DUKE POWER CO. ITEM # CN-1301.00-2
CATAWBA UNIT 1
DIESEL - GENERATORS 1A & 1B

6/3/78



$S_B = 8750$ KVA, $V = 4160$ V

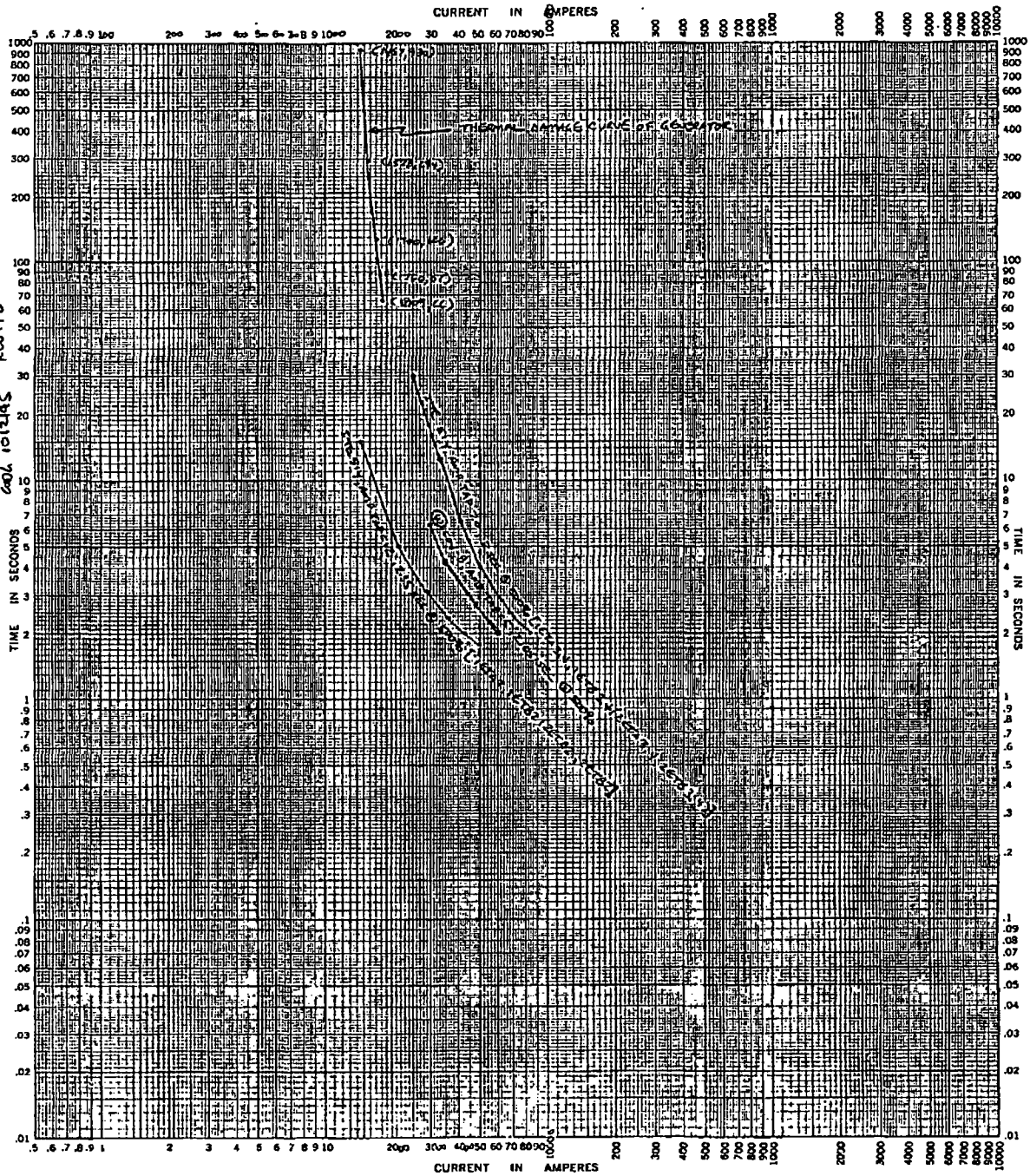
$S_{pu} = \frac{S}{S_B} \Rightarrow S = S_{pu} S_B$ $\quad I = \frac{S}{\sqrt{3}V}$

S_{pu}	S (KVA)	I (Amp)	t (sec)
1	8750	1214.4	
1.1	9625	1335.8	
1.2	10500	1457.3	930
1.3	11375	1578.7	294
1.4	12250	1700.1	126
1.45	12687.5	1760.9	87
1.49	13037.5	1809.4	82

EUGENE DIETZGEN CO. MADE IN U.S.A.
NO. 340R-L310 DIETZGEN GRAPH PAPER SEMI-LOGARITHMIC 3 CYCLES X 10 DIVISIONS PER INCH

CNC-1381.05-17

Sht. 5 of 21
Cadd 10/2/95 Rev. 12



D/G 51V COV-B Relay TIME-CURRENT CHARACTERISTIC CURVES	
For _____ Fuse Links. In _____	
BASIS FOR DATA Standards _____ Dated _____	
1. Tests made at _____ Volts a-c at _____ p-f., starting at 25C with no initial load _____	No. CNC-1381.05-17
2. Curves are plotted to _____ Test points so variations should be _____	Date 10/2/95

K+E TIME-CURRENT CHARACTERISTIC 48 5258
KEUFFEL & ESSER CO.

3. DIESEL GENERATOR NEUTRAL OVERVOLTAGE (59DGN) RELAY

Relay Type: ITE 59G; Tap Range: 3-18 V; Catalog # 211E1175; Reference Instruction Book IB-18.4.7-2, Issue C

The 59DGN Relay is used to initiate an alarm, and trip the D/G breaker (if the D/G is paralleled to the essential bus) when ground current appears in the generator neutral grounding transformer. The pickup voltage should be approximately 5% of the maximum ground fault voltage. The time dial setting should be a moderately inverse curve to give a slight time delay for minimum pickup voltages and a relatively fast pickup for ground voltages of approximately 15% or higher.

Grounding Transformer: 10 KVA, 4160/120 VAC

Grounding Resistor: 1.08 Ω, 600 Volts, 84 Amps (From Calculation CNC-1381.05-00-0009 and CNM-1301.00-0245, CE-3608)

Transformer Ratio = 4160/120 = 34.67 = N

Voltage across resistor during a line to ground fault is:

$$V_{SEC} = \frac{V}{\sqrt{3}N} = \frac{4160}{\sqrt{3}(34.67)} = 69.28 \text{ Volts}$$

Pickup Setting ≈ .05 x 69.28 V = 3.46 V

59 DGN Settings: 3 Volts
Time Dial 4; 2 secs @ 300 %

4. DIESEL GENERATOR CURRENT DIFFERENTIAL (87G) RELAY:

Relay Type: Westinghouse SA-1, 0.14 Amp Minimum Pickup, Catalog # 290B225A10, Reference Instruction Booklet I.L. 41-348.1F.

CT Ratio: 1200/5

This is an instantaneous relay and therefore requires no setting.

5. DIESEL GENERATOR REVERSE POWER (32DGT) RELAY:

Relay Type: CW Power Relay, Tap Range: 2-20 Watts, Catalog # 289B988A17, Reference Instruction Booklet I.L. 41-241.3J.

The 32DGT relay is used to protect the Diesel Generator from motoring should a loss of prime mover occur when the generator is paralleled with the essential bus. To determine the pickup power setting, determine the power consumption under motoring conditions, as specified by the generator manufacturer.

$$\text{CT Ratio} = \frac{1200}{5} = 240 \qquad \text{PT Ratio} = \frac{4200}{120} = 35$$

Motoring Levels of Diesel Generator (See attached Vendor Data):

a) Loss of Prime Mover (Fuel): I = 1000A, P.F. = 0.05

b) Diesel Generator at standstill when it is accidently tied to live bus: I = 9900 A, P.F. = 0.10

c) Diesel Generator operating in parallel with system and a loss of excitation occurs: I = 330 A, P.F. = 0.05

To determine the Power Tap Setting, calculate minimum power available from motoring levels of the Diesel Generator. (Note: the loss of excitation motoring level will not apply due to a 40DGT, Loss of excitation, relay being provided.)

The minimum power available during motoring will occur during the loss of prime mover.

V_{L-L} = PT Secondary Line to Line Voltage = 120 Volts

V_{L-N} = PT Secondary Line to Neutral Voltage = $\frac{120}{\sqrt{3}}$

$P_{1\varphi}$ = Power per phase on secondary = $I_2 \times V_{L-N} \times$ P.F.

I_1 = 1000 Amps I_2 = 1000/240 = 4.17 Amps

$P_{1\varphi} = 4.17 \times \frac{120}{\sqrt{3}} \times .05$

Watt Tap Setting = $\sqrt{3} \times 4.17 \times \frac{120}{\sqrt{3}} \times .05 = 25.02$ Watts

Select Watt Tap = 20 Watts
Time Delay Setting = 3 Secs @ 200 %
ICS Setting = 2.0 Amps
Time Dial Setting = 3

Note: 1 second delay at 200% should be sufficient to override any transient conditions. However, experience has shown that a 3 second delay should prevent the spurious trips detailed by minor mods CE-3592 and CE-3592.

REV. 12
WTH 10/2/95

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CNC-1381.05-17

JH
6/7/78

DELAVAL
ENGINE AND
COMPRESSOR DIVISION

P.O. BOX 2161
550 85th AVENUE
OAKLAND,
CALIFORNIA 94621

May 10, 1977

Duke Power Company
P. O. Box 2178
Charlotte, North Carolina 28242

Attention: Mr. R. H. Wright

Subject: Catawba Nuclear Station Units 1 and 2
Diesel Generators (CN1301.00)
Mill Power No. C-20660
De Laval S/N 75017/20

Gentlemen:

In reference to your letter of March 9, 1977 regarding generator motoring conditions, we are enclosing in the attached the currents and power factors under the conditions you mentioned. As stated in your letter the generator would be connected to a live 4160 volt bus, therefore, we expect this to be voltage under the conditions postulated.

A thermal damage curve for the subject generator is also enclosed.

Very truly yours,

DE LAVAL TURBINE INC.
Engine & Compressor Division

A. Rafalski

A. Rafalski
Project Engineer

AR:ljj

cc: C. A. Newell
C. H. Moeller

Enclosures

SHT 11 OF 201 | REV. 12
CNC-1381.05-17 | Aug 10/2/95

MILL POWER SUPPLY CO. P.O. #C-20660
DUKE POWER CO. ITEM #CN-1301.00-2
CATAWBA UNIT 1
DIESEL - GENERATORS 1A & 1B

S.O. 17503519/522

4/20/77

JEH 6/7/78

While generator is connected to an energized 4160 Volt bus. The current and power factor under the following conditions of metering will be as follows:

a) Loss of prime mover - When full load field current was being applied I_L = 1000 Amps, P.F. = .05

b) Diesel engine at standstill when generator is accidentally tied to live bus (neglecting the effect of diesel engine coupled to generator, the generator will start as motor.

Locked rotor current = 9900 Amps
Locked rotor P.F. = .10

c) Diesel generator operating in parallel with system - a loss of excitation occurs.

Diesel generator running at synchronous speed will draw magnetization current from the bus.

I_L = 330 Amps, P.F. = .05

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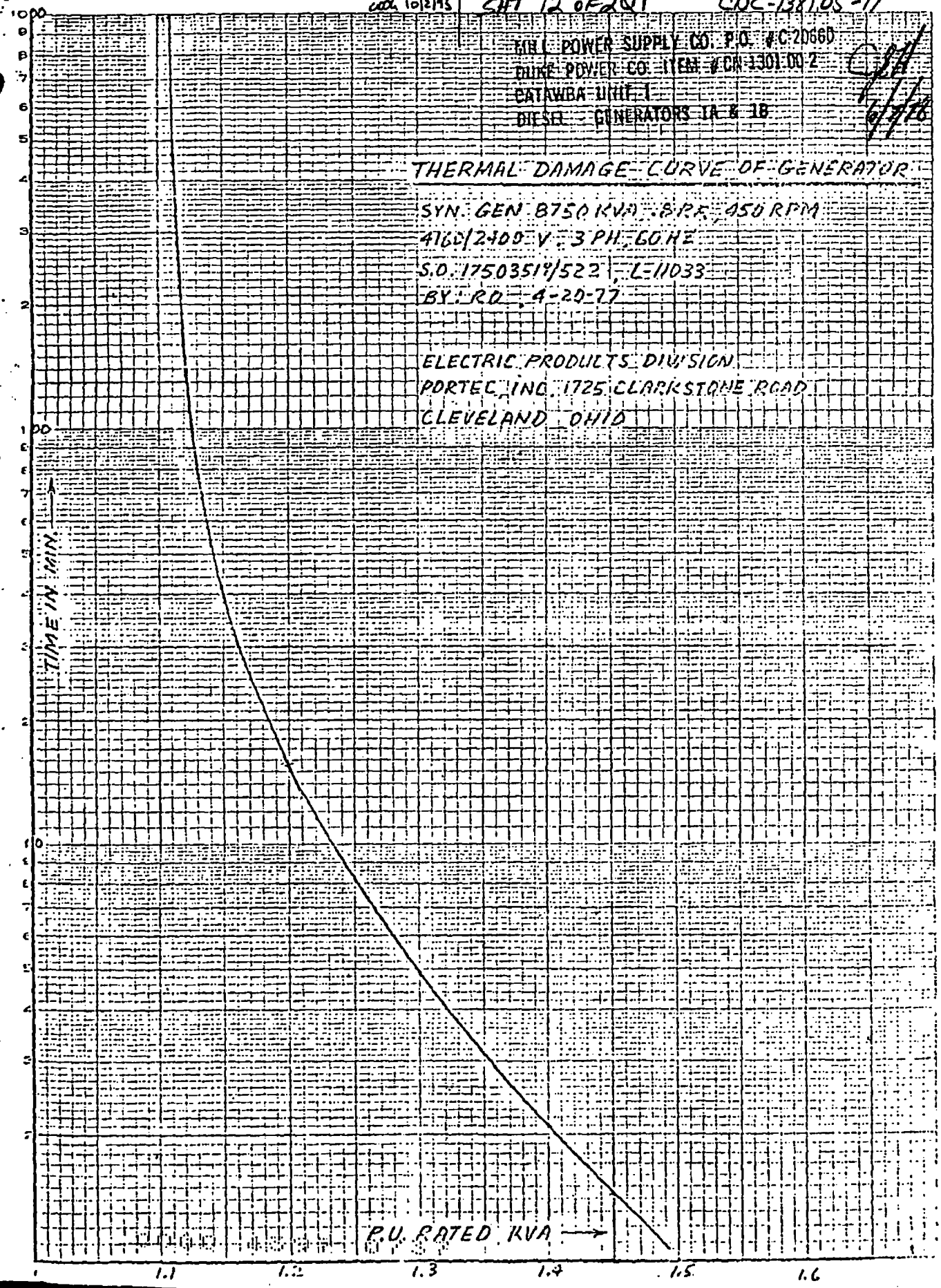
CURVE NO 2134
CNC-1381.05-17



EUGENE DIETZGEN CO.
MADE IN U. S. A.
NO. 340R-L310 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
3 CYCLES X 10 DIVISIONS PER INCH

6. DIESEL GENERATOR LOSS OF EXCITATION (40DGT) RELAY:

Relay Type: GE CEH Loss of Excitation Relay, Tap Range: Offset 0-4 ohms, Characteristic circle diameter: 5-50 ohms, Single mho unit, catalog # 12CEH51A4A, Reference Instruction Booklet GEK-27887C (Taps 0,0.5,1.0,2.5,4.0)

The 40DGT Relay is used to protect the diesel generator from damage should a loss of excitation occur. The relay is used to initiate an alarm, and trip the D/G breaker (if the D/G is paralleled to the essential bus).

There are two settings that must be made on the CEH 51A relay. They are the Offset Tap Setting and the Circle Diameter Restraint Tap Setting. Per Instruction Booklet GEK-27887C, the following Offset and Diameter settings are recommended:

Offset = One half of the transient reactance = $X'_d/2$

Diameter = Synchronous reactance = X_d

The following information is required to make settings:

Transient reactance = $X'_d = 0.170$ pu
Synchronous reactance = $X_d = 1.030$ pu
Base MVA = Generator rating = 8.750 MVA
Base KV = Generator rating = 4.16 KV
CT Ratio = 1200/5 = 240
PT Ratio = 4200/120 = 35

$$Z_{BASE}\,(\text{sec}) = \frac{(KV_{BASE})^2}{MVA_{BASE}} \times \frac{CT\ Ratio}{PT\ Ratio} = \frac{(4.16\,kV)^2}{8.75\,MVA} \times \frac{240}{35}$$

$$= 13.56\ \Omega_{SECONDARY}$$

$X'_d(sec) = (Z_{BASE}) \times (X'_d\ pu) = 13.56 \times 0.170 = 2.31\ \Omega_{SECONDARY}$

$X_d(sec) = (Z_{BASE}) \times (X_d\ pu) = 13.56 \times 1.030 = 13.97\ \Omega_{SECONDARY}$

12CEH51A4A is a 5-50 ohm relay with a 0.5-4.0 ohm offset.

A) Offset Tap (Offset setting is the difference between the two offset taps used):

$$\frac{X_d'}{2} = \frac{2.31}{2} = 1.15\ \Omega$$

Use the next higher setting: 1.5 Ω

∴ Set "L" lead on 1.0 and "H" lead on 2.5

B) Set Restraint Tap to value corresponding to actual synchronous reactance of machine in secondary ohms (X_d = 13.97 Ω).

$$\text{Restraint Tap Setting (\%)} = \frac{(\textit{Basic Minimum Diameter}) x 100}{(\textit{Desired Diameter in Secondary Ohms})}$$

$$= \frac{5 \times 100}{13.97} = 35.79\ \%$$

Use next lower tap: 35 %

Set upper number one lead on tap 5.
Set lower number one lead on tap 30.

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SERIAL NO.	DASH	A.C. SYNCHRONOUS GENERATOR DATA	SALES ORDER NO.	DATE
17503519/522	200		17503519/522	11/25/75

TYPE	KVA	VOLTS	AMPS	PHASE	HERTZ
L- 11033	8750	4160/2400	1214.4/2103.3	3(6 wire)	60
FRAME	**INSUL.CLASS**	**P.F.**	**POLES**	**DUTY**	**RPM**
190	F	.8	16	Cont.	450

GENERATOR:

1	Direct Axis Synchronous Reactance(Unsaturated)	Xd	1.030	P.U.
2	Quadrature Axis Synchronous Reactance (")	Xq	.531	P.U.
3	Direct Axis Transient Reactance (Rated Voltage)	X'd	.170	P.U.
4	Direct Axis Subtransient Reactance(" ")	X"d	*.129	P.U.
5	Quadrature Axis Subtransient Reactance(" ")	X"q	.109	P.U.
6	Zero Sequence Reactance (" ")	Xo	.075	P.U.
7	Negative Sequence Reactance (" ")	X2	*.119	P.U.
8	Direct Axis Transient Open Circuit Time Constant	T'do	4.626	Sec.
9	Short Circuit Transient Time Constant	T'd	.763	Sec.
10	Short Circuit Subtransient Time Constant	T"d	.04	Sec.
11	Synchronous Impedance Unit on Rated KVA Base		1.976	Ohms
12	Short Circuit Ratio	SCR	1.08	
13	Field Resistance at 25 Deg. C		.313	Ohms
14	Field Current at Full Load, Rated Voltage and Power Factor		250.7	Amps
15	Field Current at No Load, Rated Voltage		137.4	Amps
16	Field Current at No Load 60% Volts		75.7	Amps
17	Continuous Duty Field Voltage		104.2	Volts
18	Inherent Regulation		29	%
19	Recommended Field Discharge Resistor		50	Amps
20	Synchronizing Power Coefficient at No Load	PrNL	16480	KW/El.Rad
21	Synchronizing Power Coefficient at Full Load	PrFL	23200	KW/El.Rad
22	Unbalance Magnetic Pull at 1/32 Displacement	Pd(1/32)	17575	Lbs.
23	Magnetization Characteristics	Curve No.	2517	

RECEIVED JAN 9 1976 DUKE POWER COMPANY DESIGN ENGINEERING

*Revised-12/19/75

STATIC -EXCITATION

CNM 1301 00-50

SERIAL NO.	600	D.C. EXCITER DATA	TYPE L-

1	KW	VOLTS	AMP	RPM	INSUL. CLASS
2	Field Resistance at 25 Deg. C				Ohms
3	Recommended Rheostat:	Plate(s)	Ohms		Amps
4	Saturation Curve		Curve No.		

Form No: 2089

0000 4397 0740

7. DIESEL GENERATOR LOAD SEQUENCER UNDERVOLTAGE (27) RELAYS: 27XA, 27YA, 27ZA, 27XB, 27YB, 27ZB

Relay Type ITE 27D, Tap Range 60-110 Volts, Time Delay: 0.1-1.0 seconds, Catalog # 211R6175, Reference Instruction Booklet IB- 18.4.7-2 Issue E.

These devices are applied on the 4.16 kV essential switchgear and are located on the Diesel Generator Load Sequencer Panels 1DGLSA-1, 1DGLSB-1, 2DGLSA-1 and 2DGLSB-1. The relays use 2 out of 3 logic to detect loss of power on the respective essential bus.

The Diesel Generator Load Sequencer undervoltage relays are installed to initiate an Essential Diesel Generator Start signal for loss of voltage on the 4.16 kV Essential switchgear. Loss of voltage should be sensed as soon as practical to permit system separation and connection to the emergency Diesel Generators. The setpoint (drop out) for loss of voltage (LOV) is assumed to be above the 80% rated starting voltage capabilities of the 4.16 kV essential motors. (80% of 4 kV = 3200 volts). The 100 volt tap was selected since it equates to 3500 volts (84.1% of 4.16 kV nominal system voltage) when referred to the primary of the 4200/120 volt potential transformers (PT ratio = 4200/120 = 35/1).

A time delay is employed to prevent unnecessary diesel starting during system transients. Since experience indicates that system transients typically are shorter than 10 cycles, the time delay should be set to:

Td = 10 cycles/60Hz = 0.167 seconds

SITA 91-01(CN) identified no evidence was found that all possible errors (calculation, calibration, PT's, relay), as well as drift, were included in determining the minimum acceptable value or relay drop out setpoint. PIP 0-C91-0028 (PIR 0-C91-0381) addressed the degraded voltage relay (DGVR) setpoint calculations in detail but the LOV setpoint and allowable Technical Specification value were only briefly mentioned.

The Channel Uncertainty (CU) analysis below is performed with the square root sum of the squares methodology per typical fleet practice and review of Reference 2. The scope section of EDM 102, Rev 3 (Instrument Setpoint/Uncertainty Calculations) states that EDM 102 is not specifically applicable to protective relaying.

NOTE: Pages 16.1, 17.1, 18.1, 18a.1, 18b.1, 18c.1 and 21.1 become the effective pages for post LAR implementation for the LOV nominal and allowable value setpoint changes. Pages 16, 17, 18, 18a, 18b, 18c and 21 are pre-LAR implementation.

Rev. 17 B. Finch 4/1/14

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Rev. 17 B. Finch 4/1/14

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Td = 10 cycles/60Hz = 0.167 seconds

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The Channel Uncertainty (CU) analysis below is performed with the square root sum of the squares methodology per typical fleet practice and review of Reference 2. The scope section of

Channel Uncertainty (CU)

1) (VV) Voltage Variation - The 27D undervoltage relay has the following rating of variation in operating voltage for variation in control power voltage supplied to the relay: ±0.2V change in operating voltage for 10V variation in control power voltage (Reference 1). The worst case voltage drop for the Vital Instrumentation and Control Power System occurs with a concurrent safety injection actuation and a loss of offsite power. The bounding scenario being modeled for this relaying is a safety injection actuation with offsite power still available. When offsite power is still available the Vital Instrumentation and Control Power System battery chargers will limit the voltage drop magnitude and duration. This analysis is being performed for the worst case conditions so that it is a bounding analysis. The worst case voltage drop according to Reference 5, will be from 132 volts to 115 volts. 132 - 115 = 17 volts.

VV = 0.2V/10V X 17V = ±0.34V

2) (TV) Temperature Variation - The 27D undervoltage relay has the following rating for variation in temperature: ±0.5V over the temperature range of 20-40 degrees C (Reference 1). The expected temperature range for the Diesel Generator tunnel areas where these relays are located is 35 - 120 degrees F, per Reference 3. In the event of a LOCA or other accident requiring Safety Injection Actuation the Diesel Generator tunnel areas will not see any significant change in location temperature at the beginning of the event. Per Reference 2 it is only necessary to consider process and environmental conditions that occur during the postulated event. The Diesel Generator tunnel areas are not expected to exceed 40 degrees C (104 degrees F) during the time frame the 27D relays are required to operate. The typical temperature tolerance of ±0.5V for the temperature range of 20 - 40 degrees C will be used in this calculation.

TV = ±0.5V.

3) 27D relay accuracy - Operating voltage is adjusted as required at each test interval by accurate and proven digital test equipment. No separate uncertainty is assigned for error in sensing the correct magnitude of source voltage. Per discussion with ABB Technical Support personnel, only the VV and TV terms discussed above are applicable for a 27D relay tested and calibrated in this manner. Relay drift between test intervals is addressed separately below.

EDM 102, Rev 3 (Instrument Setpoint/Uncertainty Calculations) states that EDM 102 is not specifically applicable to protective relaying.

Channel Uncertainty (CU)

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4) Seismic - Since the ABB Type 27D relay is a solid state device and has no electro-mechanical parts, it is not expected to experience degradation of performance during a seismic event. This term is not applicable.

5) Radiation - The undervoltage relays are located in a Mild EQ environment per Reference 3. The low radiation dose rates are not expected to affect performance. Also, any potential cumulative effects are minimized by adjustments made during periodic calibrations. This term is not applicable.

6) (RD) Relay drift - Drift is a variation in instrument channel output that may occur between calibrations that cannot be related to changes in the process variable or environmental conditions. The best source data for relay drift is from detailed calibration records. Relay specific calibration records from the past 11 monthly calibrations were reviewed for use in updating this analysis. The data points that were reviewed were the AS LEFT dropout voltage for one month compared to the AS FOUND dropout voltage at the next monthly check. This review shows that the average drift between monthly calibrations is 0.1V. The maximum drift measured for the complete set of calibration data on all four trains was 0.7V. Based on this operating experience a relay drift value of 0.7V will be used in this analysis.

RD = +0.7V

7) (VT) Potential transformer accuracy - The potential transformer providing sensing voltage to the 27D relay has a rated accuracy of ±0.3% of the indicated voltage per Reference 4. For conservatism this uncertainty term will be calculated based on the Degraded Voltage Relay Allowable Value. Per Reference 7 this minimum value for operation of the Degraded Voltage Relays is 3738V or 106.8V on the potential transformer secondary.

VT = 106.8 X .003 = ±0.32V

8) (MTE) Measuring and Test Equipment - The controlling procedures for calibration of the 27D Loss of Voltage Relays (IP/1(2)/A/4971/010) require the relays be tested and calibrated with a Doble Model F6150 test set. The accuracy of the test set is ±0.5% of setting per Reference 6.

MTE = 100 X .005 = ±0.5V

All of the terms assigned values above are random independent variables, with the exception of relay drift which is treated as a bias.

4) Seismic - Since the ABB Type 27D relay is a solid state device and has no electro-mechanical parts, it is not expected to experience degradation of performance during a seismic event. This term is not applicable.

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MTE = 98.5 X .005 = ±0.493V

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All of the terms assigned values above are random independent variables, with the exception of relay drift which is treated as a bias.

$CU = \pm SQ\ RT\ (VV^2 + TV^2 + VT^2 + MTE^2) + RD$

$CU = \pm SQ\ RT\ (0.34^2 + 0.5^2 + 0.32^2 + 0.5^2) + 0.7$

$CU = \pm SQ\ RT\ (0.1156 + 0.25 + 0.1024 + 0.25) + 0.7$

$CU = \pm SQ\ RT\ (0.718) + 0.7$

$CU = \pm 0.847 + 0.7$

$CU = \mathbf{\pm 1.6V}$

The purpose of this calculation revision is to correct inappropriate input data for the uncertainty associated with the 27D Loss of Voltage Relay. The positive and negative uncertainty will be applied in reference to the Technical Specification Nominal Trip Setpoint value of 3500V. This revision does not involve any proposed change to the nominal trip setpoint.

NOTE: The term "pickup" for a 27D relay refers to the voltage where the relay will operate to indicate a loss of voltage. Per Reference 7 the nominal trip setpoint for the LOV relays is 3500V. The pickup setpoint must be converted to the equivalent 120V base relay setting across the VT ratio, 4200/120.

Actual setpoint = 3500 X 120/4200 = 100V

Therefore, due to CU, the setpoint could vary in the following range

Pickup + CU = 100 + 1.6 = 101.6V

Pickup - CU = 100 - 1.6 = 98.4V

Since the CU is calculated using square root sum of the squares method, there is the possibility that the actual error (and drift) could be more than calculated.

The difference between the LOV relay pickup and dropout, deadband, is approximately 3% or 3.0V (3% of 100 V setting) and is not adjustable (Reference 1). The reset point should be estimated by the following equation:

$CU = \pm SQ\,RT\,(VV^2 + TV^2 + VT^2 + MTE^2) + RD$

$CU = \pm SQ\,RT\,(0.34^2 + 0.5^2 + 0.32^2 + 0.493^2) + 0.7$

$CU = \pm SQ\,RT\,(0.1156 + 0.25 + 0.1024 + 0.243) + 0.7$

$CU = \pm SQ\,RT\,(0.711) + 0.7$

$CU = \pm 0.843 + 0.7$

$CU = \mathbf{\pm 1.54V}$

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The positive and negative uncertainty will be applied in reference to the Technical Specification Nominal Trip Setpoint value of 3450V.

* Rev. 17

NOTE: The term "pickup" for a 27D relay refers to the voltage where the relay will operate to indicate a loss of voltage. Per Reference 7 the nominal trip setpoint for the LOV relays is 3450V. The pickup setpoint must be converted to the equivalent 120V base relay setting across the VT ratio, 4200/120.

* Rev. 17

Actual setpoint = 3450 X 120/4200 = 98.5V

* Rev. 17

Therefore, due to CU, the setpoint could vary in the following range

Pickup + CU = 98.5 + 1.54 = 100.04V

Pickup - CU = 98.5 - 1.54 = 96.96V

* Rev. 17

The difference between the LOV relay pickup and dropout, deadband, is approximately 3% or 3.0V (3% of 98.5 V setting) and is not adjustable (Reference 1). The reset point should be estimated by the following equation:

* Rev. 17

Reset = pickup X percent deadband

Reset = 98.5 X 1.03 = 101.5V

* Rev. 17

Reset = pickup X percent deadband

Reset = 100 X 1.03 = 103V

Therefore, due to CU, the reset could vary in the following range:

Reset + CU = 103 + 1.6 = 104.6

Reset - CU = 103 - 1.6 = 101.4

The time delay should remain set to 10 cycles to prevent unnecessary diesel starting during brief system transients. An acceptable tolerance of ±1 cycle is provided based on the manufacturing accuracy of ±10%.

The relay shall be set as follows:

PICKUP TAP: 100V

PICKUP VOLTAGE: 100V ±0V

TIME DELAY: 10 Cycles, 0.167 sec.

The setting tolerance is ±0.0V so that the relays will be set to exactly the proper setpoint. However, when the setpoint is examined after setting the relay or for calibration check it may drift by the amount described below.

Drift associated with the relay

Drift = $\pm SQ\ RT\ (VV^2 + TV^2) + RD$

Drift = $\pm SQ\ RT\ (0.34^2 + 0.5^2) + 0.7$

Drift = ±1.3V

Therefore, the setpoint should remain within the range (setpoint ± drift).

Actual pickup setpoint + drift = 100 + 1.3 = 101.3

Actual pickup setpoint - drift = 100 - 1.3 = 98.7

Therefore, due to CU, the reset could vary in the following range:

* Rev. 17 B. Tuso 4/1/14

Reset + CU = 101.5 + 1.54 = 103V

Reset - CU = 101.5 - 1.54 = 100V

The time delay should remain set to 10 cycles to prevent unnecessary diesel starting during brief system transients. An acceptable tolerance of ±1 cycle is provided based on the manufacturing accuracy of ±10%.

The relay shall be set as follows:

PICKUP TAP: 100V

* Rev. 17

PICKUP VOLTAGE: 98.5V

TIME DELAY: 10 Cycles, 0.167 sec.

The setting tolerance is ±0.0V so that the relays will be set to exactly the proper setpoint. However, when the setpoint is examined after setting the relay or for calibration check it may drift by the amount described below.

Drift associated with the relay

Drift = $\pm SQ\ RT\ (VV^2 + TV^2) + RD$

Drift = $\pm SQ\ RT\ (0.34^2 + 0.5^2) + 0.7$

Drift = ±1.3V

Therefore, the setpoint should remain within the range (setpoint ± drift).

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Actual pickup setpoint + drift = 98.5 + 1.3 = 99.8

Actual pickup setpoint - drift = 98.5 - 1.3 = 97.2

Although the pickup setpoint has a ±0.0V setting tolerance, ±0.5V is an expected range for setpoint drift. If the relay setpoint drift is greater than 0.5V and less than 1.3V a calibration is required. If the relay were to drift more than 1.3V, Engineering should be notified and the relay re-calibrated.

References:

1. IB 18.4.7-2, Issue E, ABB Single Phase Voltage Relays Instructions
2. ANSI/ISA-67.04.01-2006 (Setpoints for Nuclear Safety-Related Instrumentation)
3. CNLT-1780-03.03, Rev. 30, Environmental Qualification Criteria Manual
4. CNM-1312.02-0054.001, Rev. D11, 4160V Switchgear Instruction Book
5. CNC-1381.05-00-0122, Rev. 5 (Station Blackout Battery Sizing Calculation for the 125 VDC Vital I&C Batteries)
6. DPC-1210.04-00-0005, Rev. 4 (Measuring and Test Equipment (M&TE) Uncertainties) Attachment 36
7. Technical Specification 3.3.5 (Loss of Power (LOP) Diesel Generator (DG) Start Instrumentation)

Although the pickup setpoint has a ±0.0V setting tolerance, ±0.5V is an expected range for setpoint drift. If the relay setpoint drift is greater than 0.5V and less than 1.3V a calibration is required. If the relay were to drift more than 1.3V, Engineering should be notified and the relay re-calibrated.

References:

1. IB 18.4.7-2, Issue E, ABB Single Phase Voltage Relays Instructions
2. ANSI/ISA-67.04.01-2006 (Setpoints for Nuclear Safety-Related Instrumentation)
3. CNLT-1780-03.03, Rev. 30, Environmental Qualification Criteria Manual
4. CNM-1312.02-0054.001, Rev. D11, 4160V Switchgear Instruction Book
5. CNC-1381.05-00-0122, Rev. 5 (Station Blackout Battery Sizing Calculation for the 125 VDC Vital I&C Batteries)
6. DPC-1210.04-00-0005, Rev. 4 (Measuring and Test Equipment (M&TE) Uncertainties) Attachment 36
7. Technical Specification 3.3.5 (Loss of Power (LOP) Diesel Generator (DG) Start Instrumentation) as amended by LAR from PIP C-12-5680.
8. Technical Specification 3.3.2, Table 3.3.2-1, Item 6.d (Auxiliary Feedwater Actuation on Loss of Offsite Power) as amended by LAR from PIP C-12-5680.
9. Historical PIPs: C-11-8526, C-11-8680, C-12-5423, C-12-5424, C-12-5680

Rev. 17
B. Fink
4/1/14

8. DIESEL GENERATOR LOAD SEQUENCER SPECIAL UNDERVOLTAGE (27) RELAYS: 27XA/SPL, 27XB/SPL

Relay Type: ITE 27H, Tap Range 60-110 Volts, Catalog #ABB L411R0175 or 211B0175D, Reference Instruction Booklet IB-18.4.7-2, Issue C. Rev. 15 Auto-Pasiche [initials] 9/13/98

These relays are applied on the 4.16 KV essential switchgear and are located in the Diesel Generator Load Sequencer Panels 1DGLSA-1, 1DGLSB-1, 2DGLSA-1, and 2DGLSB-1. The relays allow an accelerated sequence and take the sequencer out of test mode should a blackout occur.

The setting of these relays should be above that of the three sequencer 27D relays. They are set as follows:

PT Ratio = 4200/120 = 35

Choose Pickup = 110 Volts; This is equal to: 35 x 110 = 3850 Volts

3850/4160 = .925; This corresponds to 92.5 % of nominal voltage.

H. ASSUMPTIONS

4.16 KV Essential Switchgear bus voltage less than 3500 Volts (LVR Dropout Setpoint) is indicative of loss of bus voltage.

I. REFERENCES

1. 4.16 KV Essential Switchgear I/B, CNM-1312.02-00-0054
2. ITE Protective Relays I/B, IB-18.2.7-1, Issue G
3. Westinghouse Relay I/B, IL 41-116E
4. ITE Protective Relays I/B, IB-18.4.7-2, Issue C & D
5. Westinghouse Relay I/B, IL 41-348.1F
6. Westinghouse Relay I/B, IL 41-241.3J
7. GE Relay I/B, GEK-27887C
8. 230 KV Switchyard Protective Relay Calculation, CNC-1381.06-00-0037.
9. ABB Protective Relays IB 18.4.7-2, Issue E ~~CNM-1312.03-0108-001~~ Rev. 15
10. ABB Protective Relays Descriptive Bulletin 41-2315
11. Protective Relay I/B for DG & DG Load Seq. CNM1312.11-0001.001 9/12/08

J. CONCLUSIONS

CODE #	RELAY ANSI NO. & FUNCTION	MANUFACTURER, TYPE, CATALOG #, RANGE	SETTING
1	50 DGT, Diesel Generator Instantaneous Overcurrent	ITE Type 50, Catalog # 218T0641, 2-20 Amps	Tap: 6.1 Amps
2	51V, Diesel Generator Voltage Controlled Overcurrent	Westinghouse Type COV-8, Catalog # 1876244, 4-12 Amps, 80-100 Volts	Tap: 5 Amps Trip Time: 2.05 sec @ 500 % Voltage Tap: 96 Volts Target: 0.2 Amps
3	59 DGN, Diesel Generator Neutral Overvoltage	ITE Type 59G, Catalog # 211E1175, 3-18 Volts	Tap: 3 Volts 2 seconds @ 300 %
4	87G, Diesel Generator Current Differential	Westinghouse Type SA-1, Catalog # 290B225A10 (minimum pickup 0.14 amps)	N/A
5	32 DGT, Diesel Generator Reverse Power	Westinghouse Type CW, Catalog # 289B988A17, Range 20-120 Watts	Tap: 20 Watts Time: 3 secs @ 200 % ICS Setting: 2.0 Amps Time Dial Setting: 3
6	40 DGT, Diesel Generator Loss of Excitation	GE Type CEH, Catalog # 12CEH51A4A, Range: Offset: 0-4 Ω, Characteristic circle diameter: 5-50 Ω	"L" lead: 1.0 "H" lead: 2.5 Lower no. one tap: 30 Upper no. one tap: 5 Target: 0.2
7	27, Diesel Generator Load Sequencer Undervoltage (2 out of 3)	ITE Type 27D, Catalog # 211R6175, 60-110 Volts, 0.1-1.0 secs	Dropout: 100 Volts (84.1 %) Time Delay: 0.167 secs Tech Spec Allowable: ~~3242~~ 3444 Volts
8	27, Diesel Generator Load Sequencer "Special" Undervoltage	ITE Type 27H, Catalog # 211B0175D or 411R0175 (ABB) 60-110 Volts	Pickup: 110 Volts (92.5%)

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Station Catawba Nuclear Station Unit 1&2 Rev 17 Sheet 21.1 of 21
Subject Class 1E Diesel Protective Relaying and Sequencer Undervoltage Relay Settings
File No. CNC-1381.05-00-0017 Orig By B. Finl Date 4/1/14
Checked By RADickard Date 4/1/14

J. CONCLUSIONS

CODE #	RELAY ANSI NO. & FUNCTION	MANUFACTURER, TYPE, CATALOG #, RANGE	SETTING
1	50 DGT, Diesel Generator Instantaneous Overcurrent	ITE Type 50, Catalog # 218T0641, 2-20 Amps	Tap: 6.1 Amps
2	51V, Diesel Generator Voltage Controlled Overcurrent	Westinghouse Type COV-8, Catalog # 1876244, 4-12 Amps, 80-100 Volts	Tap: 5 Amps Trip Time: 2.05 sec @ 500 % Voltage Tap: 96 Volts Target: 0.2 Amps
3	59 DGN, Diesel Generator Neutral Overvoltage	ITE Type 59G, Catalog # 211E1175, 3-18 Volts	Tap: 3 Volts 2 seconds @ 300 %
4	87G, Diesel Generator Current Differential	Westinghouse Type SA-1, Catalog # 290B225A10 (minimum pickup 0.14 amps)	N/A
5	32 DGT, Diesel Generator Reverse Power	Westinghouse Type CW, Catalog # 289B988A17, Range 20-120 Watts	Tap: 20 Watts Time: 3 secs @ 200 % ICS Setting: 2.0 Amps Time Dial Setting: 3
6	40 DGT, Diesel Generator Loss of Excitation	GE Type CEH, Catalog # 12CEH51A4A, Range: Offset: 0-4 Ω, Characteristic circle diameter: 5-50 Ω	"L" lead: 1.0 "H" lead: 2.5 Lower no. one tap: 30 Upper no. one tap: 5 Target: 0.2
7	27, Diesel Generator Load Sequencer Undervoltage (2 out of 3)	ITE Type 27D, Catalog # 211R6175, 60-110 Volts, 0 1-1.0 secs	Dropout: 100 Volts (84.1 %) Time Delay: 0.167 secs Tech Spec Allowable: ~~3242~~ 3444 Volts
8	27, Diesel Generator Load Sequencer "Special" Undervoltage	ITE Type 27H, Catalog # 211B0175D or 211R0175 (ABB) 60-110 Volts	Pickup: 110 Volts (92.5%)

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* Rev. 17
B. Finl
3/27/14
Dropout: 98.5 Volts (82.9%)
Time Delay: 0.167 secs
Tech Spec Allowable: 3396 Volts