ENCLOSURE 5
WATTS BAR NUCLEAR PLANT (WBN)
CALCULATION WBPEVAR9001007
MEDIUM VOLTAGE APPENDIX R, AND
REGULATORY GUIDE 1.75 ASSOCIATED CIRCUIT ANALYSIS

9206260098 920615
PDR ADOCK 05000390
A PDR

EBASCO SERVICES INCORPORATED
DNE CALCULATIONS

Sheet ~~1a~~ 1 of RS 3/13/92

TITLE: MEDIUM VOLTAGE APPENDIX R AND REG. GUIDE 1.75 ASSOCIATED CIRCUITS ANALYSIS	Plant/Unit WBN/1, 2

PREPARING ORGANIZATION NE, Ebasco Services Inc.	KEY NOUNS (Consult RIMS DESCRIPTORS LIST) ELCTRICAL CALCS, ASSOCIATED CIRCUITS, MEDIUM VOLTAGE		
BRANCH/PROJECT IDENTIFIERS WBPEVAR9001007	Each time these calculations are issued, preparers must ensure that the original (RO) RIMS accession number is filled in.		
	Rev 2	(for RIMS' use)	RIMS accession number
	RO	900214B0005	B26 90 0202 408
APPLICABLE DESIGN DOCUMENT(S) WB-DC-30-13, R2	R2	MAR 1 7 1992 (69)	B18 '92 0312 334
	R__		
FSAR SECTION(S) 8.3.1.4 / UNID SYSTEM(S) N/A RS 3/12/92	R__		

Revision 0	R2	R3	R4	Safety-related? Yes [X] No [ ]
ECN NO.(or indicate Not Applicable) N/A	M-12651-C M-16432-A			Statement of Problem
Prepared P. D. Salmons*	P. Salmons 3/2/92 P. Salmons			PROTECTION OF MEDIUM VOLTAGE ASSOCIATED CIRCUITS REQUIRES DOCUMENTATION.
Checked/Verified G. C. Patel*	3/2/92			
Reviewed G. L. Nicely*	3-2-92			
Approved M. C. Brickey*	C.C. Lybe for MCB 03/11/92			
[redacted]-2-90				
USE FORM TVA 10534 IF MORE SPACE REQUIRED — List all pages added by this revision	SEE REV LOG			
List all pages deleted by this revision	SEE REV LOG			
List all pages changed by this revision	SEE REV LOG			

Abstract:

These calculations contain an unverified assumption(s) that must be verified later. Yes |__| No |X|

PSO Relay Setting Sheets were used for plotting protective device curves to show V5 circuit protection, and coordination of shutdown boards. See Sections 8.0 and 9.0 for results and conclusions.

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* Refer to RO for original signatures, RIMS #900214B0005

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A. L. Schildkraut, TR-E17 WBNP

0278x

TVA 10697 (DNE-6-86) **QA Record**

DNE CALCULATIONS

PAGE 1a

TITLE MEDIUM VOLTAGE APPENDIX R AND REG GUIDE 1.75 ASSOCIATED CIRCUITS ANALYSIS	PLANT/UNIT WBN / 1, 2
PREPARING ORGANIZATION NE-EE-WBEP	KEY NOUNS (Consult RIMS DESCRIPTORS LIST) Electrical Calcs, Associated circuits, Medium Voltage
BRANCH/PROJECT IDENTIFIERS WBPEVAR9001007	Each time these calculations are issued, preparers must ensure that the original (RO) RIMS accession number is filled in.
APPLICABLE DESIGN DOCUMENT(S) N/A	
SAR SECTION(S) 8.3.1.4 / UNID SYSTEM(S) N/A	

Rev	(for RIMS' use)	RIMS accession number
R0	900214B0005	B26 '90 0202 408
R 1	910920C0002	B26 '91 0827 400
R —		
R —		

56

	Revision 0	R1	R2	R3
ECN No. (or indicate Not Applicable)	N/A	N/A		
Prepared	P D Salmons			
Checked	G C Patel	E J Jackson		
Reviewed	G L Nuckles			
Approved				
Date	2-2-90	8-27-91		
List all pages added by this revision.		None		
List all pages deleted by this revision.		None		
List all pages changed by this revision.		See rev. log		

Use form 10534 if more space required.

Safety-related? Yes ☒ No ☐

Statement of Problem

Protection of medium voltage associated circuits requires documentation.

ORIGINAL

Abstract

These calculations contain an unverified assumption(s) that must be verified later. Yes ☐ No ☒

PSO Relay Setting Sheets were used for plotting protective device curves to show V5 circuit protection, and coordination of shutdown boards. See Sections 8.0 and 9.0 for results and conclusions. R1

FSAR Compliance Review _____ Date 2-2-90
YE ABC

~~Total Pages, RO: 56~~

EEB

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Microfilm and destroy. ☐ QAC-IC WBN

Address: ~~ISOB, WBN~~

cc: RIMS, SL 26 C-K

TVA

Title: MEDIUM VOLTAGE APPENDIX R AND REG GUIDE 1.75 ASSOCIATED CIRCUITS ANALYSIS

REVISION LOG

WBPEVAR9001007

Revision No.	DESCRIPTION OF REVISION	Date Approved
0	Initial Issue of Calculation. Total Pages R0 = 56. |R1	PDS 1-31-90 GCP 2-1-90
1	The purpose of this revision is to correct detail errors and to revise documentation as identified by NE's self-assessment program and subsequently documented by corrective action for WBP910055SCA. Revised conclusion to remove statement that #6 AWG cables are sized contrary to design criteria and added reference 3.11 (EX-WB-DC-30-5-14) which justifies these cables. Uniquely identified references 3.3, 3.5 and 3.7 by adding revision level, date, or RIMS number. Reference 3.3 was issued after R0 of this calculation, however, this calculation complies with the issued criteria WB-DC-30-13. Added page 3A. corrected procedural detail errors (line-throughs without initials and dates) on pages 18, 29-37. Revised pages 1, 2, 5, 8, 10, 11, 18, 29-37. Total pages R1 = 56. No FSAR sections are deemed relevant to this revision. R1 FSAR COMPLIANCE [signature] ABC/LE 8-27-91 DATE	See cover sheet for approval and date. GCP 8/23/91 EJJ 8/23/91
2	THE PURPOSE OF THIS REVISION IS TO EVALUATE THE CABLES SHOWN AS NOT PROTECTED IN THE REVISION 1. THE MODIFIED RESULTS ARE SHOWN IN TABLES 8·1 AND 8·2. PAGES ADDED 1a, 3B, 15, 15a, 17a, 17b, 37, 57, 58, ~~59~~ & 60 PAGES DELETED 15, 37 RS 2-14-92 PAGES REVISED 2, ~~4~~, 5, 7, 10, 11, 12, 14, 15, 15a 16, 17a, 17b, 17, 18, 21, 28, 33, 34, 35 36, 37, 38, 39, 42, 46, 47 & 49 PRK 2/19/92 TOTAL PAGES OF ENTIRE CALCULATION : ~~65~~ 66 RS 2-14-92 FSAR SECTION 8·3·1.4 WAS REVIEWED AND NO DISCREPANCIES WERE FOUND. REV 2 FSAR COMPLIANCE REVIEW _____ LE RS 2-14-92 PRK 2/26/92	SEE COVER SHEET. PRK 2/19/92

CALCULATION REVISION LOG

Sheet 2a

TITLE: Medium Voltage Appendix R and Reg. Guide 1.75 Associated Circuits Analysis	REVISION LOG WBPEVAR9001007

REVISION NUMBER	DESCRIPTION OF REVISION	DATE APPROVED
2	The purpose of this revision is to evaluate the cables shown as not protected in Revision 1. The modified results are shown in Tables 8.1 and 8.2. Pages added: 1a, 2a, 3b, 14, 15, 15a, 16, 16a, RS 17, 17a, 17b, 18, 37, ~~57, 58, 59~~, ~~3-13-92~~ LE ~~3/13/92 and 60~~, 17c, ATTACHS 2,3 & 4 J.J. 3-2-92 LE Pages deleted: 14, 15, 16, 17, 18, Pages revised: 2, 5, 7, 10, 11, 12, 21, 19, 28, 33, 34, 35, 36, 38, 39, 42, 46, 47, and 49 Total pages of entire calculation: ~~68~~ 69 PRK 3/2/92 FSAR Section 8.3.1.4 was reviewed and no discrepancies were found. J.J. 2-29-92 Rev. 2 FSAR Compliance Review C.C. Lyke for MCB ABC/LE DATE 03/11/92	See Cover Sheet

0649x

THIS SHEET ADDED BY REV 2

R2
RS
2-14-92

CALCULATION DESIGN VERIFICATION (INDEPENDENT REVIEW) FORM

WBPEVAR9001007
Calculation No.

0
Revision

Method of design verification (independent review) used (check method used):

1. Design Review ✓
2. Alternate Calculation
3. Qualification Test

Justification (explain below):

Method 1: In the design review method, justify the technical adequacy of the calculation and explain how the adequacy was verified (calculation is similar to another, based on accepted handbook methods, appropriate sensitivity studies included for confidence, etc.).

Method 2: In the alternate calculation method, identify the pages where the alternate calculation has been included in the calculation package and explain why this method is adequate.

Method 3: In the qualification test method, identify the QA documented source(s) where testing adequately demonstrates the adequacy of this calculation and explain.

PERFORMED DESIGN REVIEW IN ACCORDANCE WITH MEMO FROM W.S. RAUGHLEY TO A P CAPOZZI DATED DEC 22, 1987 (B43871222905). VERIFIED THAT THE INPUTS AND OUTPUTS ARE REASONABLE AND CONSISTENT BASED UPON EXPERIENCE, ENGINEERING JUDGEMENT, OR DETAILED CHECK OF SELECTED DATA. REVIEWED THE PURPOSE, ASSUMPTIONS, METHOD AND CONCLUSIONS TO VERIFY THE TECHNICAL ADEQUACY OF EACH.

GLWieck
Design Verifier
(Independent Reviewer)

2/1/90
Date

JUN 2 4 1990

CALCULATION DESIGN VERIFICATION (INDEPENDENT REVIEW) FORM

WBPEVAR9001007 — Calculation No.

R1 — Revision

Method of design verification (independent review) used (check method used):

1. Design Review ✓
2. Alternate Calculation
3. Qualification Test

Justification (explain below):

Method 1: In the design review method, justify the technical adequacy of the calculation and explain how the adequacy was verified (calculation is similar to another, based on accepted handbook methods, appropriate sensitivity studies included for confidence, etc.).

Method 2: In the alternate calculation method, identify the pages where the alternate calculation has been included in the calculation package and explain why this method is adequate.

Method 3: In the qualification test method, identify the QA documented source(s) where testing adequately demonstrates the adequacy of this calculation and explain.

Performed independent review of calculation for technical adequacy as addressed in NEP 3.1, Attachment 10.

Verified that the design inputs are appropriate, methodology is correct, and the results are reasonable.

E. J. Iglavas — Design Verifier (Independent Reviewer)

8/23/91 — Date

CALCULATION DESIGN VERIFICATION (INDEPENDENT REVIEW) FORM

WBPEVAR9001007	R2
Calculation No.	Revision

Method of design verification (independent review) used (check method used):

1.	Design Review	*
2.	Alternate Calculation	NR
3.	Qualification Test	NR

Justification (explain below):

Method 1: In the design review method, justify the technical adequacy of the calculation and explain how the adequacy was verified (calculation is similar to another, based on accepted handbook methods, appropriate sensitivity studies included for confidence, etc.).

Method 2: In the alternate calculation method, identify the pages where the alternate calculation has been included in the calculation package and explain why this method is adequate.

Method 3: In the qualification test method, identify the QA documented source(s) where testing adequately demonstrates the adequacy of this calculation and explain.

* Design verification has been performed by the design review method in accordance with the guidelines set forth by project procedure E-76-TVA.

Josef Barta — 2-28-92

Design Verifier (Independent Reviewer) — Date

THIS SHEET ADDED BY REV 2

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FSAR COMPLIANCE

R0: Section 8.3.1.4 of the FSAR was reviewed along with Appendix 8C, and 8E. No discrepancies were noted; however, updating Appendix 8C by referencing new calculations performed for RG 1.75 circuits may be desirable. The WBN Technical Specifications should include a list of medium voltage breakers which require periodic testing. | R1

R1: The purpose of this revision is to correct procedural detail errors. No FSAR sections are applicable. | R1

R2 SEE REV LOG PAGE 2 | R2 RS 2-14-92

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1. PURPOSE

The purpose of this calculation is to evaluate medium voltage associated circuits per Appendix R and Regulatory Guide 1.75. This calculation will document the adequacy of

- selective coordination for 6.9 KV Shutdown Boards and cable short circuit protection,
- cable short circuit protection for non-required circuits fed from 6.9 KV Shutdown Boards,
- cable short circuit protection for all V5 non-1E cables in Category I structures.

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2. ASSUMPTIONS

2.1 For a worst-case analysis, all circuits fed from the non-1E 6.9 KV Unit Boards and Common Boards are assumed to be routed in Category I structures, and these circuits are analyzed for cable protection. This assumption is conservative and does not require later verification.

2.2 ~~For the 6.9 KV Shutdown Board high impedance fault analysis, all loads on the board are assumed to be running at full load. The fault is assumed to occur on the circuit with the largest differential between full load current and breaker setting (whether the circuit is required for Appendix R or not). This differential is added to the total load current to get the maximum board loading for a high impedance fault.~~
~~This assumption is conservative and does not require later verification.~~

R2

RS 2-14-92

2-29-92

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3. REFERENCES

3.1 WBN FSAR Section 8.3.1.4

3.2 WB-DC-40-51, Fire Protection of Safe Shutdown Capability, B26 880718 013.

3.3 WB-DC-30-13, 10CFR50 Appendix R, Type I, II, and III Circuits, B26 900213 076. | R1

3.4 WB-DC-30-5, Power, Control, and Signal Cables for Use in Category I Structures, B26 880713 055.

3.5 WBN Computerized Cable Routing System (CCRS), System ID Y9894, Version 6, dated 8-~~28~~ 18-89. (W13 ~~89~~ 1002 302) | R1

3.6 PSO Relay Setting Sheet Manual —

Sheet Number			Sheet Number		
4624	85	2-13-85	3880	84	6-13-84
4625			3881	84	↓
4626			4345	84	11-5-84
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5696			4031	84	8-13-84
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5700			4666	85	2-22-85
5702			4135	84	9-11-84
5705			7782	88	11-28-88
5706			7783	88	↓
5709	↓	↓	4669	85	2-22-85
4667	85	2-22-85	3178	83	10-13-83
3175	83	10-13-83	3179	83	10-13-83
3176	83		3180	83	10-13-83
3177	83	↓	3882	84	6-13-84

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3.6 PSO Relay Setting Sheet Manual (cont.) –

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3883	84	6-13-84
4346	84	11-5-84
7208	79	6-11-79
4028	84	8-13-84
4032	84	↓
4318	84	10-17-84
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7786	88	11-28-88
7787	88	11-28-88
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3181	83	10-13-83
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3183	83	↓
3884	84	6-13-84
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4347	84	11-5-84
7211	79	6-11-79
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4033	84	↓
4319	84	10-17-84
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4137	84	9-11-84
7790	88	11-28-88
7791	88	11-28-88
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3186	83	↓
3886	84	6-13-84
3887	84	↓

Sheet Number		
4348	84	11-5-84
7213	79	6-11-79
4030	84	8-13-84
4034	84	↓
4320	84	10-17-84
4672	85	2-22-85
4138	84	9-11-84
7794	88	11-28-88
7795	88	↓
4674	85	2-27-85
8913	80	7-22-80
8964	80	8-13-80
8980	80	8-21-80
8953	80	8-14-80
8958	80	8-14-80
9887	81	5-11-81
3342	77	3-17-77
5733	78	9-5-78
7250	79	6-11-79
4433	84	12-14-84
4434	84	↓
4675	85	2-27-85
8912	80	7-22-80
8965	80	8-13-80
8981	80	8-21-80
8954	80	8-14-80
8959	80	8-14-80
8970	80	8-13-80
3341	77	3-17-77
5732	78	9-5-78
7251	79	6-11-79
8911	80	7-22-80

IVA 11030 (WM-7-75)

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3.6 PSO Relay Setting Sheet Manual (cont.) —

Sheet Number			Sheet Number		
8991	80	8-27-80	8992	80	8-27-80
3855	84	6-6-84	3858	84	6-6-84
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3805	84	↓	3808	84	↓
3829	84	↓	3833	84	↓
3861	84	6-6-84	3863	84	6-6-84
3856	84	6-6-84	3859	84	↓
3830	84	5-10-84	3834	84	5-10-84
3806	84	↓	3809	84	↓
3382	83	12-16-83	3384	83	12-16-83
3862	84	6-6-84	3864	84	6-6-84
3800	84	5-10-84	3803	84	5-10-84
3807	84	↓	3810	84	5-10-84
3831	84	↓	3835	84	5-10-84
3383	83	12-16-83	3385	83	12-16-83
8993	80	8-27-80	8994	80	8-27-80
3801	84	5-10-84	3804	84	5-10-84
3832	84	↓	3836	84	↓
3857	84	6-6-84	3860	84	6-6-84
3865	84	↓	3866	84	↓

3.7 DG-E12.6.2, Selection of Conductor Sizes Based on Fault-Current Criteria, Revision 0, dated 6-30-76. | R1

3.8 Calculation WBN EEB-MS-TI06-0002, Rev 18, Auxiliary Power System Analyses, ~~B26 891208 405~~. B26 911008 400 | R2

3.9 Calculation WBN EEB-MS-TI05-0001, Rev 15, Auxiliary Power System Database (TELAS), ~~B26 890626 424~~. B26 911031 400 | R5 2-14-92

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3.10 TVA Drawings —

15E500-1 R7	45N714 R2
15E500-2 R6	45W1720-1 R2
45N715 R14	45W2720-1 R2
45N720 R15	45W1724-2 R5
45N721-1 R10	45W2724-2 R5
45N721-2 R12	75N700 R9
45W724-1 R15	45W1720-1 R2
45W724-2 R15	45W2720-1 R2
45W724-3 R16	
45W724-4 R15	

3.11 Exception Request to Design Criteria EX-WB-DC-30-5-14 (B26 910517 076). R1

3.12 BRANCH INSTRUCTION AC LOADING EEB-TI-5 R0 PRK 2/19/92 R2

3.13 EQUIPMENT REQUIRED FOR SAFE SHUTDOWN PER 10 CFR 50 APPENDIX-R CALCULATION NO WBN-OSG4-031 REV 13. RS 2-14-92

3.14 DG-E2.4.1, Auxiliary Power System, Design Criteria and Procedures, Revision 1, dated 4-22-85. R2 PRK 2/25/92

3.15 WBPE 2009201003 R0, CABLE TEMPERATURE FOR CSST C AND D 69 KV FEEDERS TO SHUTDOWN BOARDS. 2-29-92

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CHECKED GCP DATE 2-1-90

4. DESIGN INPUT DATA

4.1 PSO Relay Setting Sheets were used to determine breaker protective relay settings and to plot curves. See References for list of sheets used.

4.2 Overcurrent relay and fuse characteristic curves (Attachment 1) were used to plot time-current curves.

4.3 ELMS-AC (Ref. 3.8) was used as the source for maximum fault current.

4.4 TVA single line drawings, connection drawings, and CCRS were used to determine cables within the scope of this study and to determine cable sizes.

4.5 Cable thermal damage curves were taken from DG-E 12.6.2.

4.6 Full load currents for shutdown board loads are taken from TELAS (Ref. 3.9).

4.7 ABB POWER T&D CO. TEST REPORT CSST-C & D SERIAL # MLM 5695~~4~~ PRK 3/9/92 ATTACHMENT-2. R2 RS 2-14-92

4.8 AMPACITY REQUIREMENTS FOR THE CSST-C & D CABLES TO THE 6.9KV SHUTDOWN BOARDS FROM REF 3.15 APPENDIX-A (SEE ATTACHMENT-4)

4.9 WB-DC-30-13 (Ref. 3.3) was used to determine and plot cable auto-ignition curves. R2 PRK 2/25/92 2-27-92

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5. Documentation of Assumptions

No unverified assumptions — see Section 2.

6.0 COMPUTATIONS AND ANALYSES

Time-current plots are included in Appendix A. To reduce the number of plots, identically set relays were combined to make generic plots when practical. The analyses of this calculation essentially consist of the plots documented in Appendix A.

Cable thermal damage and auto-ignition curves were developed by determining values for 10 and 0.01 seconds and plotting.

R2 PRK 2/26/92 f.j. 2/29/92

6.1 6.9KV Shutdown Boards Circuits

6.1.1 Selective Coordination of 6.9KV Shutdown Boards - Plot A.1

This plot is applicable to all four boards, showing the normal feeder and two alternate feeders. The load breaker curves shown are for the largest loads, and thus are the worst-case curves.

It was demonstrated a high impedance fault of 606 Amps will not trip the upstream breaker set at 800 Amps.

R2 PRK 2/26/92 f.j. 2/29/92

6.1.2 Cable Short Circuit Protection for Non-required Circuits Fed from 6.9KV Shutdown Boards. - Plot A.1

This plot is applicable to all four boards. All cables off the shutdown boards are size 2/0. Since the worst-case protective relay settings are shown, all circuits are shown to be sufficiently protected.

THIS SHEET ADDED BY REV 2

6.1.3 High Impedance Fault Analysis - Time Current Plot A.1

The methodology for the high impedance fault analysis conforms to Appendix R Type I circuits described in the Design Criteria WB-DC-30-13 (Ref. 3.3). The Design Criteria paragraph 3.1 specifies: that the total current carried by a board when one of its Non-Appendix R circuits is subjected to a high impedance fault shall not trip the upstream feeder breaker. The high impedance fault current (I_F) is calculated as follows:

I_F = Total current for all Appendix R Loads (I_R)
+ Total largest current for Non-Appendix R loads operating (I_{NR})
+ Differential between protective device setting and normal load current of largest Non Appendix R load operating (DI)

$I_F = I_R + I_{NR} + DI$

PRK 2/26/92

Table 6-1 is a load list of a 6.9KV Shutdown Board obtained from Reference 3.9. The trip settings are the same in Rev. 1 of the calculation and obtained from 6.9KV Switchgear Relay Setting Sheets. The Appendix R loads required were determined from calculation WBN-OSG4-031, (Ref. 3.13) Equipment Required for Safe Shutdown per 10CFR50 Appendix R. The full load currents of loads operating are shown under the column heading "APP.-R Load Amps" and the loads not required are shown as '0'. The total Unit 1 accident load was obtained from Attachment-4. This is shown under column heading Accident FLA.

R2
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[signature]
2/29/92

TABLE 6-1

6.9KV SHUTDOWN BOARD CONNECTED LOAD AND APPENDIX-R LOAD

LOAD	HORSE POWER HP or kVA	FLA AMPS (FLA)	BREAKER TRIP SET AMPS (TCA)	APP.-R LOAD AMPS	(TCA)-(FLA) AMPS	ACCIDENT FLA
CNTMT SPRAY PMP	700	52.58	64.0	0	11.4	52.6
RHR PUMP	400	30.00	37.5	0	7.5	30.0
SAFETY INJ PMP	400	31.00	37.5	0	6.5	31.0
ERCW PMP	800	63.00	72.0	0	9.0	63.0
ERCW PMP	800	63.00	72.0	63.0	9.0	0.0
AUX FEEDWTR PMP	600	49.50	60.0	49.5	10.5	49.5
CNTFGL CHRG PMP	600	45.00	54.0	45.0	9.0	45.0
6900/480 XFMR	2000	167.35	216.0	167.35	48.65	167.3
6900/480 XFMR	2000	167.35	216.0	167.35	48.65	167.3
PRZR HTR GP NON SAFETY	500	41.84	60.0	0	18.16	0
PRZR HTR GP SAFETY	500	41.84	60.0	41.84	18.16	0
	TOTAL	752.46		534.04		605.8

THIS SHEET ADDED BY REV 2

I_R = 534.04 Amps
Largest Non Appendix R load current I_{NR} = 63 Amps., DI = 9.0 Amps
$I_F = I_R + I_{NR}$ + DI Amps
I_F = 534.04 + 63.0 + (9.0) = 606.04 Amps

The largest Non-Appendix R load is actually the spare 6900/480V transformer on each 6.9kV Shutdown Board. Since the cables associated with the spare transformers are either routed in the same fire zones as the normal transformers cables or will be protectd from a fire, the next largest load on the 6.9kV Shutdown Board was used for determining the high impedance fault.

Power factor is chosen to be 1.0 for conservatism. A 1.0 power factor provides the largest possible current value. Time-Current plot A.1 shows that the upstream main feeder breakers of the 6.9kV Shutdown Boards will not trip at their present set point, due to a high impedance fault of 606 Amps above. A lower trip setting of 800 Amps for the above breakers will also be adequate to prevent tripping due to a high impedance fault. Also such a trip setting is satisfactory for a maximum load of 605.8 Amps when the Unit 1 is postulated to have an accident. It is recommended that the trip setting of the circuit breakers be lowered to 800 Amps for superior protection against overcurrent for 6.9kV Board Feeders. DCN M-12051-C shall include a statement that the CSST switchgear overcurrent relay trip settings will be lowered by Transmission and Customer Services Group (T & CS). R2

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6.1.4 480V Circuits Protected by 6.9KV Shutdown Board Breakers - Plots A.2, A.3

The secondaries of the 480V Shutdown Board transformers and Pressurizer Htr. transformers are protected by the primary side circuit breakers.

The plots show adequate cable protection for the 480V shutdown board cables. Plot A.2 shows that the cable thermal damage curve is below the protective relay curve (primary side of the transformer) for the time period 0.9 to 1.2 seconds (57,500 to 50,000 Amp approximate values). However the cable is adequately protected as the thermal damage curve is above the maximum short circuit current for the secondary side of the transformer.

$I_{sc} = I_{pu} \times I_B$
$I = V/Z$

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Transformer Rating From One-line Drawing: 2000 KVA, 0.07Z (Z=.07 pu)

$$I_{sc} = \frac{2000 \times 1.05}{\sqrt{3} \times 0.480 \times 0.07} = 36{,}084 \text{ amps}$$

(1.05 was adopted from Para. 2.1 on assumptions in Ref. 3.8)

Note: The above I_{sc} value of 36,084 Amps is an approximate value based on the transformer information obtained from one-line drawings. A detailed calculation using actual transformer tested ratings and exact motor load short-circuit contributions may ~~yeild~~ i.e. PRK 2/28/92 larger short-circuit values. These values will however still be below 50,000 Amps (1.2 seconds) which is the approximate val~~ie~~u PRK 2/28/92 at which point the cable thermal curve crosses below the relay curve on plot A.2. For conservatism, the auto-ignition temperature curve was not used even though the curve is always above the protective relay curve for all points between 0.01 and 10 seconds.

6.2 Cable Short Circuit Protection for All V5 Non-1E Cables in Category I Structures

6.2.1 Cables from 6.9KV Common Boards A and B - Plot A.4

All cables from the Common Boards are size 2/0. The 2/0 thermal damage curve is plotted against the Common Board breaker with the worst-case relay settings. All cables are protected.

6.2.2 480V Circuits Protected by 6.9KV Common Board Breakers - Plots A.5, A.6, A.11.

The secondaries of the 480V Aux. Bldg. Common Board transformers and Switchyard Distribution Cabinet transformers are protected by primary side breakers or fuses.

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The plots show adequate cable protection. Plot A.5 shows that the cable thermal damage curve for the 480V Aux. Bldg. Common Board feeder cables is below the protective relay curve (primary side of the transformer) for the time period 1.0 to 1.8 seconds (28,500 to 21,500 Amp approximate values). However the cable is adequately protected as the thermal damage curve is above the maximum short circuit current for the secondary side of the transformer.

$I_{sc} = I_{pu} \times I_B$
$I = V/Z$

Transformer Rating From One-line Drawing: 1000 KVA, 0.08Z (Z=0.8 pu)

$$I_{sc} = \frac{1000 \times 1.05}{\sqrt{3} \times 0.480 \times 0.08} = 15{,}787 \text{ Amps}$$

(1.05 was adopted from Para. 2.1 on assumption in Ref. 3.8)

Note: The above I_{sc} value of 15,787 Amps is an approximate value based on the transformer information obtained from one-line drawings. A detailed calculation using actual transformer tested ratings and exact motor load short-circuit contributions may ~~yeild~~ yield larger short-circuit values. These values will however still be below 21,500 Amps (1.8 seconds) which is the approximate value at which point the cable thermal curve crosses below the relay curve on plot A.5. For conservatism, the auto-ignition temperature curve was not used, even though the curve is always above the protective relay curve for all points between 0.01 and 10 seconds.

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6.2.3 Cables from 6.9KV Unit Boards 1A, 1B, 1C, 1D, 2A, 2B, 2C, 2D - Plots A.7, A.8

The cables routed into Category I structures from the Unit Boards consist of the normal shutdown Board feeders from Boards 1B, 1C, 2B, 2C. See A.7.

Since all circuits are assumed to be associated circuits, Plot A.8 is showing that all circuits from each 6.9KV Unit Board are adequately protected. Size 2/0 is the smallest cable feeding any Unit Board load.

6.2.4 Cables from CSST C and D Switchgear - Plot A.9

CSST's C and D provide alternate power supplies to the Shutdown Boards. Plot A.9 shows coordination between CSST switchgear breaker and shutdown board breaker. Feeder cables are adequately protected for thermal damage. The value of short circuit current calculated is 24062 which includes motor contribution from one shutdown board via the secondary windings (CSST-C) using the shortest cable lengths and including the cable impedance based on 25°C conductor temperature.

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The Plot A.9 shows the short circuit current coincides with the protection relay curve at approximately 1.4 seconds. The cable thermal curve is above the short-circuit/protection relay curve at this point.

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6.2.5 Short circuit calculation for cables connecting CSST-C and D to 6.9KV Shutdown Boards (Plot A.9)

CSST C No. MLM56954 with on load tap changers:

Z_{HX} = 4.98% @ 16.5 MVA 4.98 x 33/16.5 = 9.96% @ 33 MVA
Z_{HY} = 4.95% @ 16.5 MVA 4.95 x 33/16.5 = 9.90% @ 33 MVA
Z_{XY} = 9.29% @ 16.5 MVA 9.29 x 33/16.5 = 18.58% @ 33 MVA

Load Loss H-X = 37.451 KW @ 16.5 MVA
Load Loss H-Y = 37.282 KW @ 16.5 MVA
Load Loss X-Y = 90.896 KW @ 16.5 MVA

@ 33 MVA Base

$$R\ (PU) = \frac{I^2R\ Loss\ (KW)}{Rating\ (kVA)} \times \frac{MVA\ Base}{MVA\ Rating}\ PU$$

$$R_{HX} = \frac{37.451}{16.5\times10^3} \times \frac{33}{16.5} = 0.0045\ PU$$

$$R_{HY} = \frac{37.282}{16.5\times10^3} \times \frac{33}{16.5} = 0.0045\ PU$$

$$R_{XY} = \frac{90.896}{16.5\times10^3} \times \frac{33}{16.5} = 0.011\ PU$$

$Z_H = 1/2\ (Z_{HX} + Z_{HY} - Z_{XY})$
$= 1/2(9.96 + 9.90 - 18.58)$
$= 0.64$ PU @ 33 MVA

$Z_X = 1/2(Z_{HX}+Z_{XY} - Z_{HY})$@ 24 MVA
$= 1/2\ (9.96 + 18.58 - 9.90) \times 24/33$
$= 6.78$ PU @24MVA

$Z_Y = 1/2\ (Z_{HY} + Z_{XY} - Z_{HX})$@24 MVA
$= 1/2(9.90+18.58 - 9.96)\times24/33$
$= 6.73$ PU @24 MVA

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$X_{HX} = \sqrt{Z_{HX}^{\ 2} - R_{HX}^{\ 2}} = \sqrt{0.0996^2 - 0.0045^2} = 0.0995$ PU

$X_{HY} = \sqrt{0.099^2 - 0.0045^2} = 0.0989$ PU

$X_{XY} = \sqrt{0.1858^2 - 0.011^2} = 0.1855$ PU

$X_H = 1/2\ (0.0995 + 0.0989 - 0.1855) = 0.0065$ PU

$X_X = 1/2\ (0.0995 + 0.1855 - 0.0989) = 0.0931$ PU

$X_Y = 1/2\ (0.0989 + 0.1855 - 0.0995) = 0.0925$ PU

$R_H = 1/2\ (0.0045 + 0.0045 - 0.011) = -0.001$ PU

$R_X = 1/2\ (0.0045 + 0.011 - 0.0045) = 0.0055$ PU

$R_Y = 1/2\ (0.0045 + 0.011 - 0.0045) = 0.0055$ PU

$X_H/R_H = 0.0065/-0.001 = -6.50$

$X_X/R_X = 0.0931/0.0055 = 16.93$

$X_Y/R_Y = 0.0925/0.0055 = 16.82$

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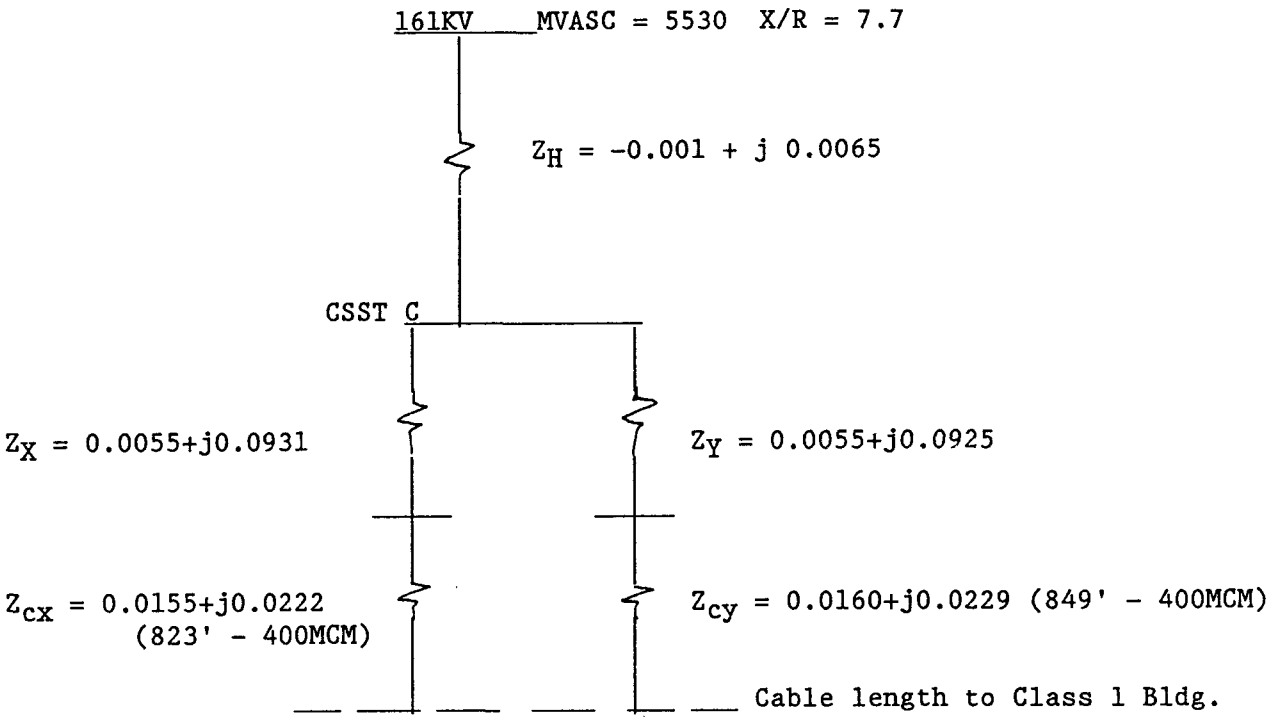

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$$Z_S \text{ @ 33 MVA Base} = \frac{33 \times 10}{5530 \times 10^6} \angle \tan^{-1} 7.7 = 0.00597 \angle \tan^{-1} 7.7$$

$$= 0.00597 \angle 82.6°$$

$$Z_S = 0.00077 + j0.005920 \text{ PU @ 33 MVA Base}$$

$$Z_H = 0.0010+j0.0065$$
$$Z_X = 0.0055+j0.0931$$
$$Z_{cx} = 0.0155+j0.0222$$

$$Z_{tot} = 0.02077+j0.1277 = 0.1294 \angle 80.7°$$

$$I_{sc} = \frac{33000 \times 1.05^*}{3 \quad 6.9 \times 0.1294} = 22406 \text{ Amps}$$

* 1.05 was adopted from Para. 2.1 on Assumptions in Ref. 3.8.

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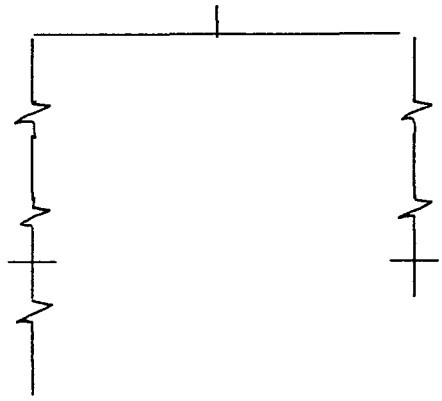
Motor contribution from one shutdown board via secondary windings (CSST - C)

33MVA Base

$Z_x = 0.0055 + j\ 0.0931$

$Z_{cx} = 0.0155 + j\ 0.0222$

$Z_m = 0 + j\ 1.52$



$Z_y = 0.055 + j\ 0.0925$

$Z_{cy} = 0.0160 + j\ 0.0229$

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Motor Load = Total connected load Table 6.1 - PRZR heater loads = 752.46-2(41.84)=668.78 Amps

Motor contribution from one 6.9KV shutdown BD:
6.25 times connected motor full load current = 668.78Ax6.25 = 4180 Amps = I_M
(6.25 times I_{FLA} used as symmetrical short circuit contribution for conservatism - Ref. 3.14)

Motor Reactance $X_m = \frac{4180\ \ 3 \times 6.9}{33000} = 1.52$ P.U.

$Z_m = 0 + j\ 1.52$

$Z_{cx} = 0.0155 + j\ 0.0222$

$Z_x = 0.0055 + j\ 0.0931$

$Z_y = 0.055 + j\ 0.0925$

$Z_{cy} = 0.0160 + j\ 0.0229$

$Z_{mc} = 0.0425 + j\ 1.7507 = 1.7512\ \underline{/88.6°}$

$I_{mc} = \frac{33 \times 10^6 \times 1.05}{3 \times 6900 \times 1.7512} = 1656$ Amps

$I_{tot} = I_{sc} + I_{mc} = 22406 + 1656 = 24062$ Amps

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6.3.4 Cables from RCP Boards 1A, 1B, 1C, 1D, 2A, 2B, 2C, 2D
Plot A.10

The cable from RCP Board to containment penetration and then to the RCP is 500MCM minimum, and is adequately protected as shown by Plot A.5. The 2/0 cable from the penetration to the RCP PT fuse is inadequately protected by the RCP Board breaker, both against thermal damage and auto-ignition. A minimum cable size of 300MCM is necessary to be protected for the cable thermal damage temperature limit of 250°C, in the 0.01 to 10 second range. PRK 2/28/92

R2 PRK 2/26/92

J.J. 2-29-92

7.0 SUPPORTING GRAPHICS

See Appendix A for Time-Current plots.

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8. SUMMARY OF RESULTS

Selective coordination of 6.9 KV Shutdown Boards is shown by Plot A.1. Table 8-1 lists non-1E circuits which are part of this analysis and notes whether or not the protective device is sufficient.

TABLE 8-1

* INDICATES CABLES ARE PROTECTED AGAINST REACHING AUTO IGNITION TEMP OF 530°C AND NO * INDICATES PROTECTED AGAINST INSULATION DAMAGE TEMP 250°C.

BOARD	BREAKER	LOAD	CABLE/SIZE	CABLE PROTECTED?
6.9KV SHTDN BD 1A-A	21	PRZR HTR D	1PP860/2/0	YES/A.1
1B-B	21	PRZR HTR C	1PP840/2/0	YES/A.1
2A-A	21	PRZR HTR D	2PP860/2/0	YES/A.1
2B-B	21	PRZR HTR C	2PP840/2/0	YES/A.1
6.9KV COMMON BD. A	11	AUX BLDG LTG	PP75/2/0 PP76/2/0 PP77/2/0 PP78/2/0	YES/A.4
	15	DSL AUX BD G-S	PP1625/2/0	YES/A.4
	3	AB CHILLER A	PP130/2/0	YES/A.4
	6	AB COM. BD A	PP70/2/0	YES/A.4
	9	IPS BD.	PP87/2/0	YES/A.4

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TABLE 8-1 (CONT.)

BOARD	BREAKER	LOAD	CABLE/SIZE	CABLE PROTECTED
6.9KV COMMON BD. B	11	AUX BLDG LTG	PP81/2/0 PP82/2/0 PP83/2/0 PP84/2/0	YES/A.4
	3	AB CHILLER B	PP132/2/0	YES/A.4
	6	AB COM BD B	PP71/2/0	YES/A.4
	9	IPS BD.	PP88/2/0	YES/A.4
6.9KV UNIT BD 1B	8	SHTDN BD 1A-A	1PP105R/400MCM 1PP106R/400MCM 1PP107R/400MCM	YES/A.7
6.9KV UNIT BD 1C	10	SHTDN BD 1B-B	1PP110P/400MCM 1PP111P/400MCM 1PP112P/400MCM	YES/A.7
6.9KV UNIT BD 2B	8	SHTDN BD 2A-A	2PP105R/400MCM 2PP106R/400MCM 2PP107R/400MCM	YES/A.7
6.9KV UNIT BD 2C	10	SHTDN BD 2B-B	2PP110P/400MCM 2PP111P/400MCM 2PP112P/400MCM	YES/A.7

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TABLE 8-1 (CONT.)

BOARD	BREAKER	LOAD	CABLE/SIZE	CABLE PROTECTED?
6.9 KV COM SWGR C (CSST C-X WDG)	B1 (1712)	SHTDN BD 1A-A	1PP100R / 400MCM 1PP101R / 400MCM 1PP102R / 400MCM	YES* ~~NO~~/A.9
	B1 (1712)	SHTDN BD 2A-A	2PP100R / 400MCM 2PP101R / 400MCM 2PP102R / 400MCM	YES* ~~NO~~/A.9
6.9 KV COM SWGR C (CSST C-Y WDG)	B2 (2714)	SHTDN BD 1B-B	1PP1095R / 400MCM 1PP1096R / 400MCM 1PP1097R / 400MCM	YES* ~~NO~~/A.9
	B2 (2714)	SHTDN BD 2B-B	2PP1095R / 400MCM 2PP1096R / 400MCM 2PP1097R / 400MCM	YES* ~~NO~~/A.9
6.9 KV COM SWGR D (CSST D-Y WDG)	A1 (1812)	SHTDN BD 1A-A	1PP1098P / 400MCM 1PP1099P / 400MCM 1PP1100P / 400MCM	YES* ~~NO~~/A.9
	A1 (1812)	SHTDN BD 2A-A	2PP1098P / 400MCM 2PP1099P / 400MCM 2PP1100P / 400MCM	YES* ~~NO~~/A.9
6.9 KV COM SWGR D (CSST D-X WDG)	A2 (2814)	SHTDN BD 1B-B	1PP115P / 400MCM 1PP116P / 400MCM 1PP117P / 400MCM	YES* ~~NO~~/A.9
	A2 (2814)	SHTDN BD 2B-B	2PP115P / 400MCM 2PP116P / 400MCM 2PP117P / 400MCM	YES* ~~NO~~/A.9

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R2

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TABLE 8-1 (CONT.)

BOARD	BREAKER	LOAD	CABLE/SIZE	CABLE PROTECTED?
6.9KV RCP BD 1A	1A	RC PUMP 1	1PP980/500MCM	YES/A.10
			1PP981/500MCM	
			1PP982/750MCM	
			1PP983/750MCM	
		RCP PT & RLY PNL	1PP1081/2/0	NO/A.10
			1PP1082/6	YES/A.10
6.9KV RCP BD 1B	1B	RC PUMP 2	1PP1000/500MCM	YES/A.10
			1PP1001/500MCM	
			1PP1002/750MCM	
			1PP1003/750MCM	
		RCP PT & RLY PNL	1PP1083/2/0	NO/A.10
			1PP1084/6	YES/A.10
6.9KV RCP BD 1C	1C	RC PUMP 3	1PP1020/500MCM	YES/A.10
			1PP1021/500MCM	
			1PP1022/750MCM	
			1PP1023/750MCM	
		RCP PT & RLY PNL	1PP1086/2/0	NO/A.10
			1PP1087/6	YES/A.10
6.9KV RCP BD 1D	1D	RC PUMP 4	1PP1040/500MCM	YES/A.10
			1PP1041/500MCM	
			1PP1042/750MCM	
			1PP1043/750MCM	
		RCP PT & RLY PNL	1PP1088/2/0	NO/A.10
			1PP1089/6	YES/A.10

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TABLE 8-1 (CONT.)

BOARD	BREAKER	LOAD	CABLE/SIZE	CABLE PROTECTED
6.9 KV RCP BD 2A	2A	RCPump 1	2PP980 / 500 MCM	YES/A.10
			2PP981 / 500 MCM	
			2PP982 / 750 MCM	
			2PP983 / 750 MCM	
		RCP PT & RLY PNL	2PP1081 / 2/0	NO/A.10
			2PP1082 / 6	YES/A.10
6.9 KV RCP BD 2B	2B	RC Pump 2	2PP1000 / 500 MCM	YES/A.10
			2PP1001 / 500 MCM	
			2PP1002 / 750 MCM	
			2PP1003 / 750 MCM	
		RCP PT & RLY PNL	2PP1083 / 2/0	NO/A.10
			2PP1084 / 6	YES/A.10
6.9 KV RCP BD 2C	2C	RC Pump 3	2PP1020 / 500 MCM	YES/A.10
			2PP1021 / 500 MCM	
			2PP1022 / 750 MCM	
			2PP1023 / 750 MCM	
		RCP PT & RLY PNL	2PP1086 / 2/0	NO/A.10
			2PP1087 / 6	YES/A.10
6.9 KV RCP BD 2D	2D	RC Pump 4	2PP1040 / 500 MCM	YES/A.10
			2PP1041 / 500 MCM	
			2PP1042 / 750 MCM	
			2PP1043 / 750 MCM	
		RCP PT & RLY PNL	2PP1088 / 2/0	NO/A.10
			2PP1089 / 6	YES/A.10

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TABLE 8-1 (CONT.)

BOARD	BREAKER	LOAD	CABLE/SIZE	CABLE PROTECTED?
6.9KV COMMON BD A	8	UNIT BD EM XFMR	PP112/2/0	YES/A.4
	10	TURB BLDG LTG	PP50/2/0 PP51/2/0 PP52/2/0 PP53/2/0	YES/A.4
	14	CCW PS BD	PP85/2/0	YES/A.4
	7	SB MAIN BD	PP62/2/0	YES/A.4
	5	TURB BLDG COM BD	PP66/2/0	YES/A.4
	4	SWYD CAB's.	PP101/2/0	YES/A.4
	16	ADD MWT BD	PP2080/2/0	YES/A.4
	16	HS/LAB XFMR	PP630/2/0	YES/A.4
6.9KV COMMON BD B	15	ENV. DATA STA.	PP19/2/0	YES/A.4
	14	CCW PS BD	PP86/2/0	YES/A.4
	10	TURB BLDG LTG	PP56/2/0 PP57/2/0 PP58/2/0 PP59/2/0	YES/A.4
	7	SB MAIN BD	PP62/2/0	YES/A.4
	5	TURB BLDG COM BD	PP66/2/0	YES/A.4

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TABLE 8-1 (CONT.)

BOARD	BREAKER	LOAD	CABLE /SIZE	CABLE PROTECTED?
6.9KV COMMON BD B	4	SWYD. CAB'S.	PP101 / 2/0	YES/A.4
↓	8	UNIT BD EM. XFMR	PP111 / 2/0	YES/A.4
6.9KV UNIT BD 1A	5	480V UNIT BD	1PP120 / 2/0	YES/A.8
↓	8	CB PUMP 1A	1PP250/2/0	YES/A.8
↓	9	CCWP 1A	1PP125/300MCM	YES/A.8
↓	7	HOTWELL PUMP 1A	1PP226/2/0	YES/A.8
↓	6	#3 HTR DR PMP 1A	1PP300/2/0	YES/A.8
6.9KV UNIT BD 1B	6	CB PUMP 1B	1PP264/2/0	YES/A.8
↓	5	CCWP 1B	1PP155/300MCM	YES/A.8
↓	4	#3 HTR DR PUMP 1B	1PP315/2/0	YES/A.8
↓	3	#7 HTR DR PUMP 1A	1PP350/2/0	YES/A.8
6.9KV UNIT BD 1C	8	CB PUMP 1C	1PP278/2/0	YES/A.8
↓	9	CCWP 1C	1PP185/300MCM	YES/A.8
↓	7	HOTWELL PUMP 1B	1PP233/2/0	YES/A.8
↓	5	#7 HTR DR PUMP 1B	1PP365/2/0	YES/A.8

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TABLE 8-1 (CONT.)

BOARD	BREAKER	LOAD	CABLE/SIZE	CABLE PROTECTED?
6.9KV UNIT BD 1D	3	480V UNIT BD	1PP122/2/0	YES/A.8
	5	CCWP 1D	1PP212/2/0	YES/A.8
	6	#3 HTR DR PUMP	1PP330/2/0	YES/A.8
	4	HOTWELL PUMP	1PP241/2/0	YES/A.8
	7	STBY. MN. FEED P.	1PP47/400MCM	YES/A.8
6.9KV UNIT BD 2A	5	480V UNIT BD	2PP120/2/0	YES/A.8
	8	CB PUMP 2A	2PP250/2/0	YES/A.8
	9	CCWP 2A	2PP125/2/0	YES/A.8
	7	HOTWELL PUMP 2A	2PP226/2/0	YES/A.8
	6	#3 HTR DR PUMP 2A	2PP300/2/0	YES/A.8
6.9KV UNIT BD 2B	6	CB PUMP 2B	2PP264/2/0	YES/A.8
	5	CCWP 2B	2PP155/2/0	YES/A.8
	4	#3 HTR DR PUMP 2B	2PP315/2/0	YES/A.8
	3	#3 HTR DR PUMP 2A	2PP350/2/0	YES/A.8

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TABLE 8-1 (CONT.)

BOARD	BREAKER	LOAD	CABLE/SIZE	CABLE PROTECTED?
6.9 KV UNIT BD2C	8	CD PUMP 2C	2PP278/2/0	YES/A.8
↓	9	CCWP 2C	2PP185/2/0	YES/A.8
↓	7	HOTWELL PUMP 1B	2PP233/2/0	YES/A.8
↓	5	#7 HTR DR PUMP 2B	2PP365/2/0	YES/A.8
6.9 KV UNIT BD 2D	3	480V UNIT BD	2PP122/2/0	YES/A.8
↓	5	CCWP 2D	2PP212/300MCM	YES/A.8
↓	6	#3 HTR DR PUMP	2PP330/2/0	YES/A.8
↓	4	HOTWELL PUMP	2PP241/2/0	YES/A.8
↓	7	STBY MN FD. PUMP	2PP47/400MCM	YES/A.8
6.9KV SHTDN BD1A-A	21	PRZR HTR XFMR SECONDARY	1PL4650/500MCM 1PL4651/500MCM 1PL4652/500MCM 1PL4653/500MCM	YES/A.3
6.9KV SHTDN BD1B-B	21	PRZR HTR XFMR SECONDARY	1PL4700/500MCM 1PL4701/500MCM	YES/A.3
6.9KV SHTDN BD2B-B	21	PRZR HTR XFMR SECONDARY	2PL4700/500MCM 2PL4701/500MCM	YES/A.3

COMPUTED PDS DATE 1-31-90
CHECKED GCP DATE 2-1-90

TABLE 8-1 (CONT.)

BOARD	BREAKER	LOAD	CABLE / SIZE	CABLE PROTECTED?
6.9KV SHTDN BD 2AA	21	PRZR HTR XFMR SECONDARY	2PL4650 / 500MCM 2PL4651 / 500MCM 2PL4652 / 500MCM 2PL4653 / 500MCM	YES/A.3
6.9KV COMMON BD A	6	AB COM BD XFMR SECONDARY	PL400 / 400 MCM PL401 / 400 MCM PL402 / 400MCM PL403 / 400MCM	YES ~~NO~~ / A.5
6.9KV COMMON BD B	6	AB COM BD XFMR SECONDARY	PL405 / 400MCM PL406 / 400MCM PL407 / 400MCM PL408 / 400MCM	YES ~~NO~~ / A.5
6.9KV COMMON BD A	4	SWYD DIST XFMR SECONDARY	PL3018 / 300MCM	YES/A.6
6.9KV COMMON BD B	4	SWYD DIST XFMR SECONDARY	PL3019 / 300MCM	YES/A.6

COMPUTED _____ DATE _____

CHECKED _____ DATE _____

TABLE 8-1 (CONT.)

BOARD	BREAKER	LOAD	CABLE/SIZE	CABLE PROTECTED
6.9KV COM BD A OR B	8	480V UNIT BDS EMERG XFMR SECONDARY	PL1625/750MCM	YES/A.11
			PL1626/	
			PL1627/	
			PL1628/	
			PL1631/750MCM	
			PL1632/	
			PL1633/	
			PL1634/	
			PL1637/750MCM	
			PL1638/	
			PL1639/	
			PL1640/	
			PL1643/750MCM	
			PL1644/	
			PL1645/	
			PL1646/	

COMPUTED DATE
CHECKED DATE

Table 8-2 lists 1E circuits which are part of this analysis and notes protection.

TABLE 8-2

BOARD	BREAKER	LOAD	CABLE/SIZE	CABLE PROTECTED
6.9KV SHTDN BD 1A-A	13	CS PUMP	1PP625A/2/0	YES/A.1
	4	SHTDN XFMR	1PP759A/2/0	
	5	SHTDN XFMR	1PP750A/2/0	
	14	RHR PUMP	1PP575A/2/0	
	15	SI PUMP	1PP600A/2/0	
	18	CNT CHRG PUMP	1PP550A/2/0	
	9	ERCW PUMP	1PP687A/2/0	
	8	ERCW PUMP	1PP675A/2/0	
	10	AFW PUMP	1PP650A/2/0	
	3	SHTDN XFMR	1PP756A/2/0	
	20	PRZR HTR	1PP800A/2/0	

TVA 11030 (WM-7-75)

COMPUTED DATE
CHECKED DATE

TABLE 8-2 (CONT.)

BOARD	BREAKER	LOAD	CABLE/SIZE	CABLE PROTECTED
6.9KV SHTDN BD1B-B	14	RHR PUMP	1PP587B/2/0	YES/A.1
	4	SHTDN XFMR	1PP765B/2/0	
	5	↓	1PP753B/2/0	
	15	SI PUMP	1PP612B/2/0	
	18	CENT CHRG PUMP	1PP562B/2/0	
	9	ERCW PUMP	1PP712B/2/0	
	8	ERCW PUMP	1PP700B/2/0	
	10	AFW PUMP	1PP662B/2/0	
	3	SHTDN XFMR	1PP762B/2/0	
	13	CS PUMP	1PP637B/2/0	
↓	20	PRZR HTRS	1PP820B/2/0	↓
6.9KV SHTDN BD2A-A	13	CS PUMP	2PP625A/2/0	YES/A.1
	4	SHTDN XFMR	2PP759A/2/0	
	5	SHTDN XFMR	2PP750A/2/0	
	14	RHR PUMP	2PP575A/2/0	
↓	15	SI PUMP	2PP600A/2/0	↓

VA 11030 (WM-7-75)

COMPUTED _____ DATE _____
CHECKED _____ DATE _____

TABLE 8-2 (CONT.)

BOARD	BREAKER	LOAD	CABLE/SIZE	CABLE PROTECTED
6.9KV SHTDN BD 2A-A	18	CENT CHRG PUMP	2PP550A/2/0	YES/A.1
	9	ERCW PUMP	2PP675A/2/0	
	8	ERCW PUMP	2PP687A/2/0	
	10	AFW PUMP	2PP650A/2/0	
	3	SHTDN XFMR	2PP756A/2/0	
	20	PRZR HTRS	2PP800A/2/0	
6.9KV SHTDN BD 2B-B	14	RHR PUMP	2PP587B/2/0	YES/A.1
	4	SHTDN XFMR	2PP765B/2/0	
	5	SHTDN XFMR	2PP753B/2/0	
	15	SI PUMP	2PP612B/2/0	
	18	CENT CHRG PUMP	2PP562B/2/0	
	9	ERCW PUMP	2PP700B/2/0	
	8	ERCW PUMP	2PP712B/2/0	
	10	AFW PUMP	2PP662B/2/0	
	3	SHTDN XFMR	2PP762B/2/0	
	13	CS PUMP	2PP637B/2/0	
	20	PRZR HTRS	2PP820B/2/0	

COMPUTED _____ DATE _____
CHECKED _____ DATE _____

TABLE 8-2 (CONT)

BOARD	BREAKER	LOAD	CABLE/SIZE	CABLE PROTECTED
6.9KV SHTDN BD 1A-A	3	SHTDN XFMR SECONDARY	1PL5040A/750MCM 1PL5041A/ 1PL5042A/ 1PL5043A/ 1PL5044A/	YES ~~NO~~ A.2 R2 PRK 2/25/92 RS 2/19/92 2-29-92
	4	SHTDN XFMR SECONDARY	1PL5050A/750MCM 1PL5051A/ 1PL5052A/ 1PL5053A/ 1PL5054A/	
	5	SHTDN XFMR SECONDARY	1PL5045A/750MCM 1PL5046A/ 1PL5047A/ 1PL5048A/ 1PL5049A/ 1PL5055A/ 1PL5056A/ 1PL5057A/ 1PL5058A/ 1PL5059A/	
	20	PRZR HTR XFMR SECONDARY	1PL4625A/500MCM 1PL4626A/500MCM	YES/A.3

COMPUTED _____ DATE _____

CHECKED _____ DATE _____

TABLE 8-2 (CONT)

BOARD	BREAKER	LOAD	CABLE/SIZE	CABLE PROTECTED
6.9 KV SHTDN BD 1B-B	3	SHTDN XFMR SECONDARY	1PL5060B/750MCM 1PL5061B/ 1PL5062B/ 1PL5063B/ 1PL5064B/	YES ~~NO~~/A.2 PRR 2/25/92 R2 RS 2-14-92 2-29-92
	4	SHTDN XFMR SECONDARY	1PL5070B/750MCM 1PL5071B/ 1PL5072B/ 1PL5073B/ 1PL5074B/	
	5	SHTDN XFMR SECONDARY	1PL5065B/750MCM 1PL5066B/ 1PL5067B/ 1PL5068B/ 1PL5069B/ 1PL5075B/ 1PL5076B/ 1PL5077B/ 1PL5078B/ 1PL5079B/	
	20	PRZR HTRXFMR SECONDARY	1PL4675B/500MCM 1PL4676B/500MCM	YES/A.3

VA 11030 (WM-7-75)

COMPUTED _____ DATE _____

CHECKED _____ DATE _____

TABLE 8-2 (CONT)

BOARD	BREAKER	LOAD	CABLE/SIZE	CABLE PROTECTED
6.9KV SHTDN BD2A-A	3	SHTDN XFMR SECONDARY	2PL5040A/750MCM 2PL5041A/ 2PL5042A/ 2PL5043A/ 2PL5044A/	YES ~~NO~~/A.2 PRK 2/25/92 R2 R3 2-14-92 2-29-92
	4	SHTDN XFMR SECONDARY	2PL5050A/750MCM 2PL5051A/ 2PL5052A/ 2PL5053A/ 2PL5054A/	
	5	SHTDN XFMR SECONDARY	2PL5045A/750MCM 2PL5046A/ 2PL5047A/ 2PL5048A/ 2PL5049A/ 2PL5055A/ 2PL5056A/ 2PL5057A/ 2PL5058A/ 2PL5059A/	
	20	PRZR HTR XFMR SECONDARY	2PL4625A/500MCM 2PL4626A/500MCM	YES/A.3

COMPUTED _____ DATE _____
CHECKED _____ DATE _____

TABLE 8-2 (CONT)

BOARD	BREAKER	LOAD	CABLE/SIZE	CABLE PROTECTED
6.9KV SHTDN BD 2B-B	3	SHTDN XFMR SECONDARY	2PL5060B/750MCM 2PL5061B/ 2PL5062B/ 2PL5063B/ 2PL5064B/	YES ~~NO~~/A.2 R2 RS 2-14-92
	4	SHTDN XFMR SECONDARY	2PL5070B/750MCM 2PL5071B/ 2PL5072B/ 2PL5073B/ 2PL5074B/	2-27-92
	5	SHTDN XFMR SECONDARY	2PL5065B/750MCM 2PL5066B/ 2PL5067B/ 2PL5068B/ 2PL5069B/ 2PL5075B/ 2PL5076B/ 2PL5077B/ 2PL5078B/ 2PL5079B/	
	20	PRZR HTR XFMR SECONDARY	2PL4675B/500MCM 2PL4676B/500MCM	YES/A.3

9. CONCLUSIONS

The results of this calculation are summarized in Section 8. All cables, except the 2/0 cables from the penetrations to the RCP PT fuses, are protected against reaching temperature for insulation damage or auto-ignition as indicated in Tables 8-1 and 8-2.

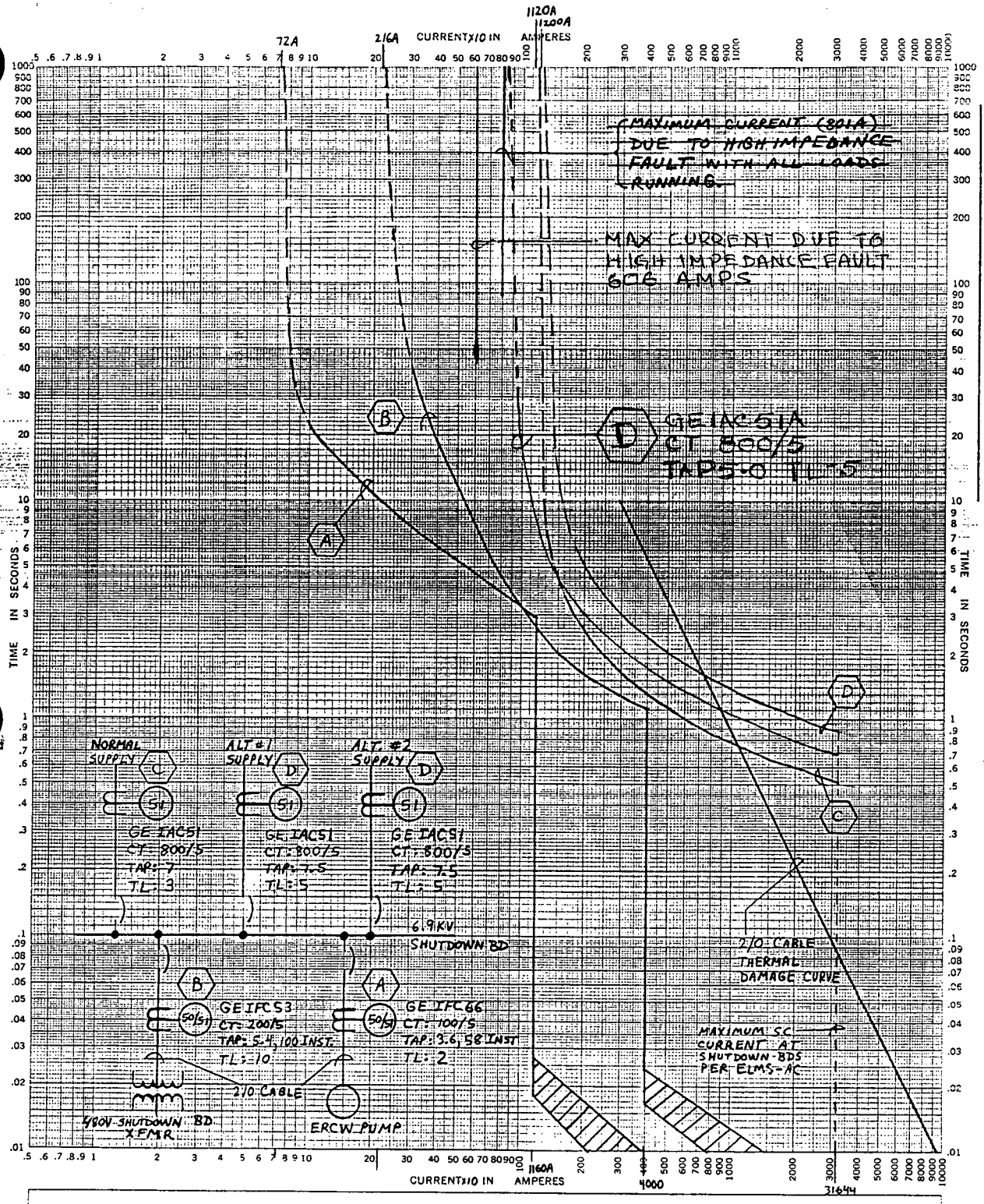
It is recommended that the IAC51 relays be reset at a lower value, at 800 Amp primary current as demonstrated in time current plot A.1 for the alternate supplies for 6.9kV Shutdown Boards and plot A.9 for the main feeder breakers on 6.9kV Shutdown Boards. Such a revised setting will provide superior protection against overcurrent for 6.9kV Shutdown Board feeders, which carry a maximum current of 605.8 Amps. R2

It is recommended that the 2/0 cables from the pentetration to the RCP PT fuse be upsized to a minimum size of 300MCM. 300MCM cables will be protected for thermal damage as shown on time-current plot A.10. DCN M-16432-A will implement the above recommendation.

10. APPENDICES

Appendix A - Time Current Plots (See following pages)

THIS SHEET ADDED BY REV 2



R2
RS
2-14-92
2-29-92

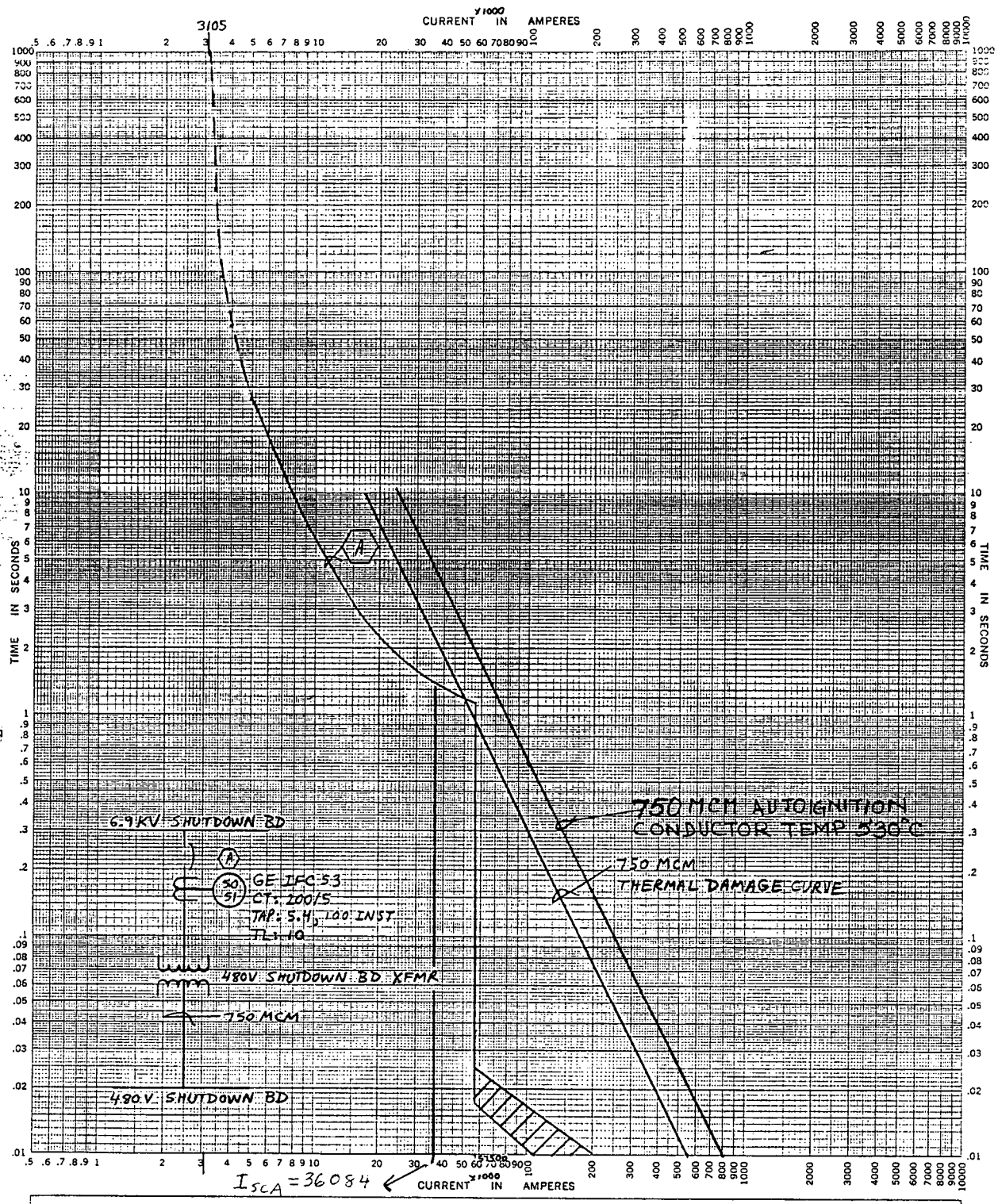
For 6.9KV SHUTDOWN BDS 1A-A, 1B-B, 2A-A, 2B-B TIME-CURRENT CHARACTERISTIC CURVES
Fuse Links. In
BASIS FOR DATA Standards Dated
1. Tests made at Volts a-c at p-f., starting at 25C with no initial load
2. Curves are plotted to Test points so variations should be

No. A.1
Date

K+E TIME-CURRENT CHARACTERISTIC 48 5258
KEUFFEL & ESSER CO. MADE IN U.S.A.

SHEET
PREPARED PDS DATE 1-31-90
CHECKED GCP DATE 2-1-90

APPENDIX A
WBPEVAR9001007



R2
RS
2-14-92

R2
PRK
2/26/92
2-24-92

TIME-CURRENT CHARACTERISTIC CURVES

For 480V SHUTDOWN BD XFMRS 1A1-A, 1A2-A, 1A-A, 1B1-B, 1B2-B, Fuse Links. In

~~BASIS FOR DATA: Standard~~ 1B-B, 2A1-A, 2A2-A, 2A-A, 2B1-B, 2B2-B Dated

~~1. Tests made at~~ ~~Volts a.c. at~~ 2B-B p.f., starting at 25C with no initial load

2. Curves are plotted to Test points so variations should be

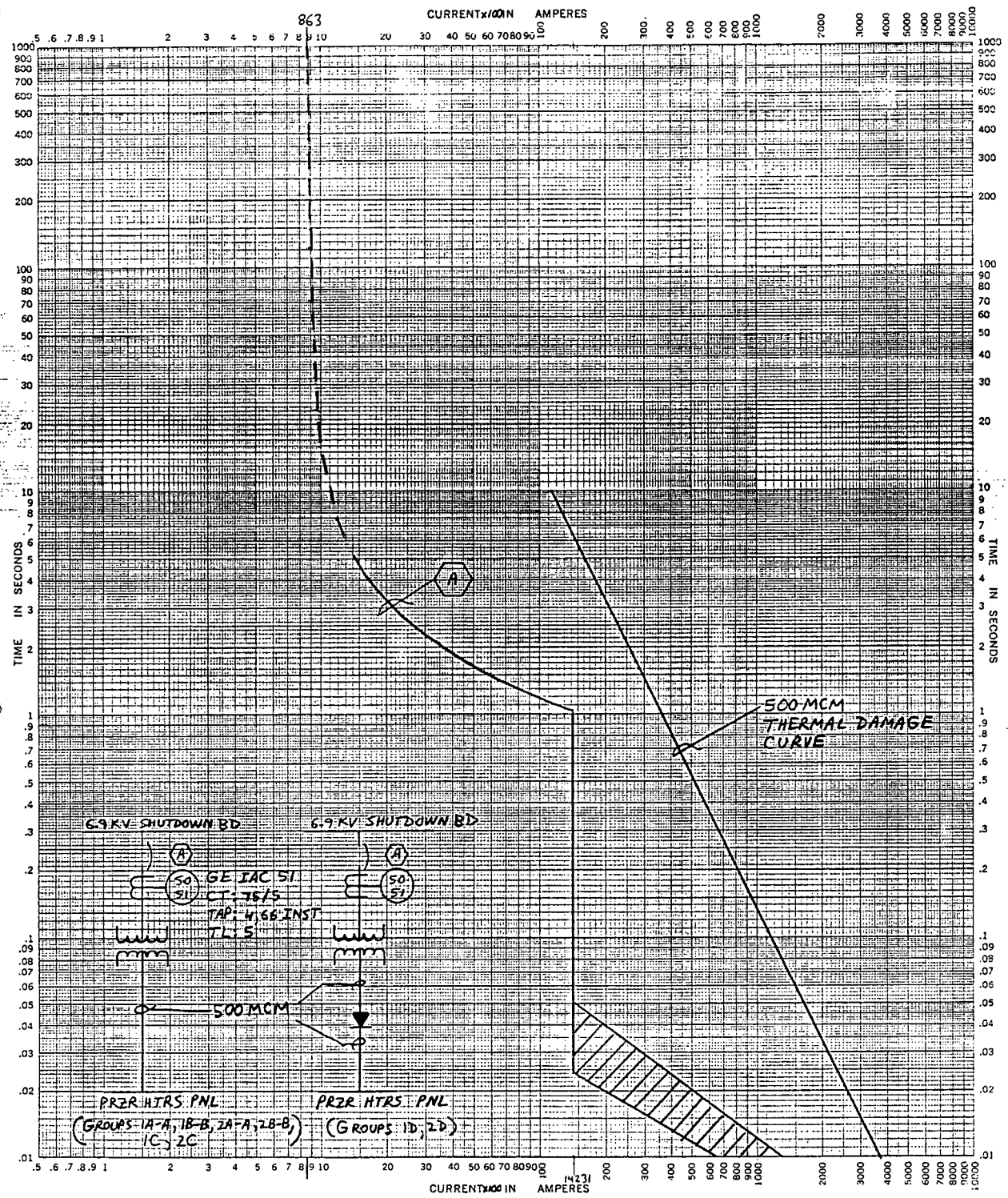
No. A.2

Date

K•E TIME-CURRENT CHARACTERISTIC 48 5258
KEUFFEL & ESSER CO. MADE IN U.S.A.

CHECKED			
PREPARED	PDS	DATE	1-31-90
CHECKED	GCP	DATE	2-1-90

APPENDIX A
WBPEVAR9001007



TIME-CURRENT CHARACTERISTIC CURVES

For PRZR HTR GROUPS 1A-A, 1B-B, 2A-A, 2B-B, 1C, 1D, 2C, 2D 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

2. Curves are plotted to Test points so variations should be

No. A.3

Date

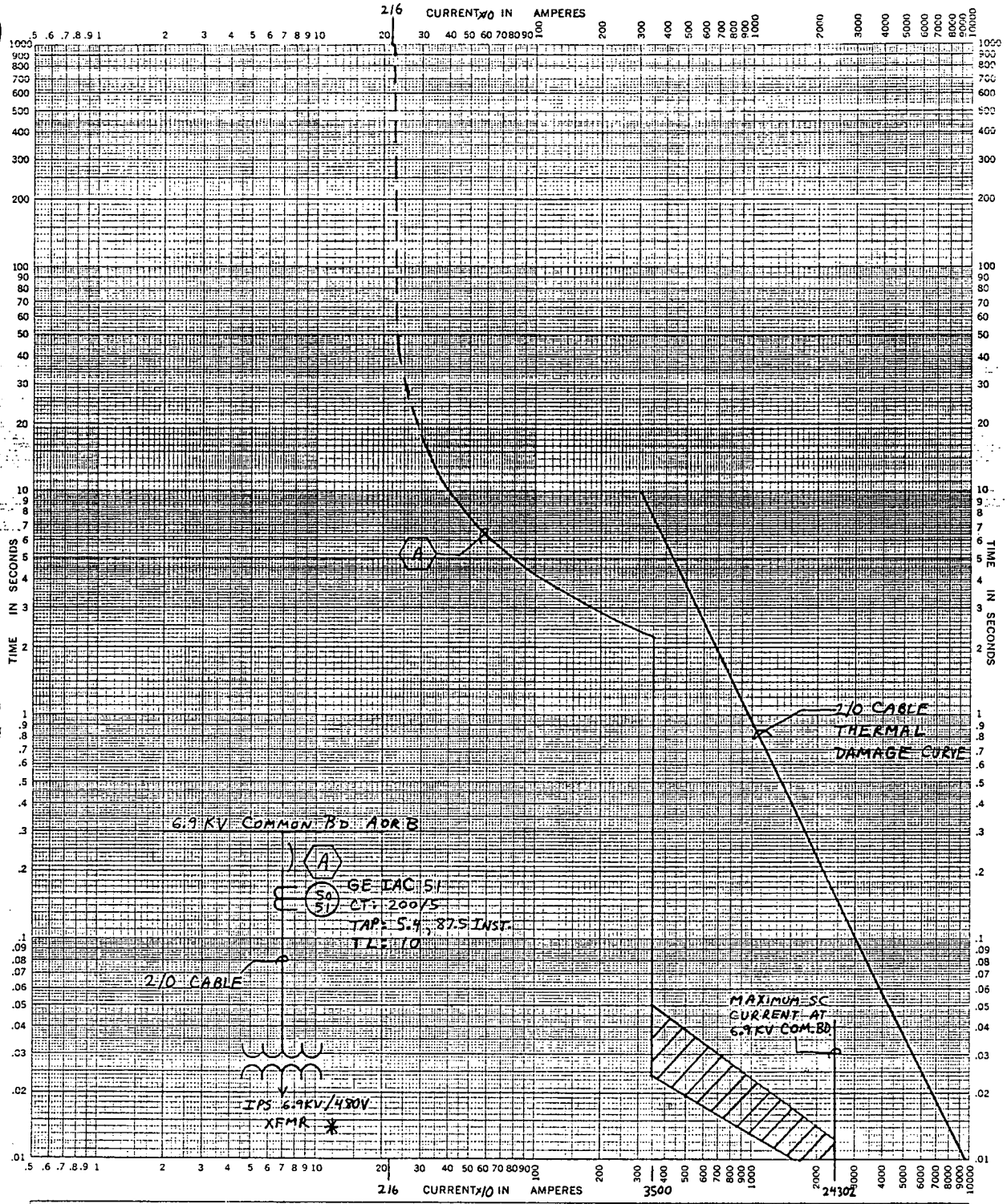
K&E TIME-CURRENT CHARACTERISTIC 48 5258
KEUFFEL & ESSER CO. MADE IN U.S.A.

SHEET

PREPARED PDS DATE 1-31-90

CHECKED GCP DATE 2-1-90

APPENDIX A
WBPEVAR 9001007



For 6.9KV Common Boards A & B TIME-CURRENT CHARACTERISTIC CURVES

BASIS FOR DATA Standards _____ Dated _____ Fuse Links. In _____

1. Tests made at _____ Volts a-c at _____ p-f., starting at 25C with no initial load _____

2. Curves are plotted to _____ Test points so variations should be _____

No. A.4

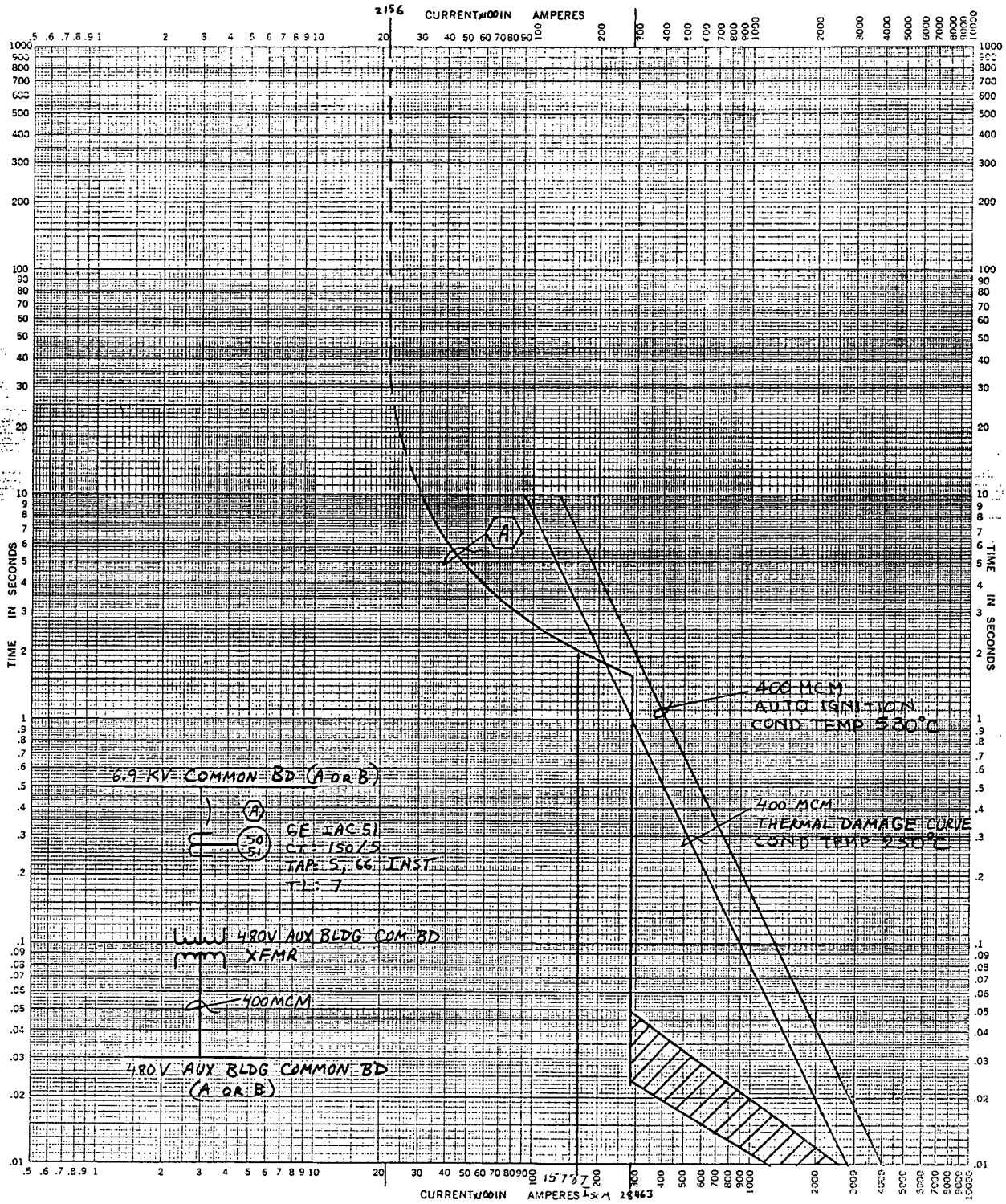
Date _____

K+E TIME-CURRENT CHARACTERISTIC 48 5258
KEUFFEL & ESSER CO. MADE IN U.S.A.

* Transformer secondary is adjacent to board (close-coupled).

SHEET _____
PREPARED PDS DATE 1-31-90
CHECKED GCP DATE 2-1-90

APPENDIX A
WBPEVAR9001007



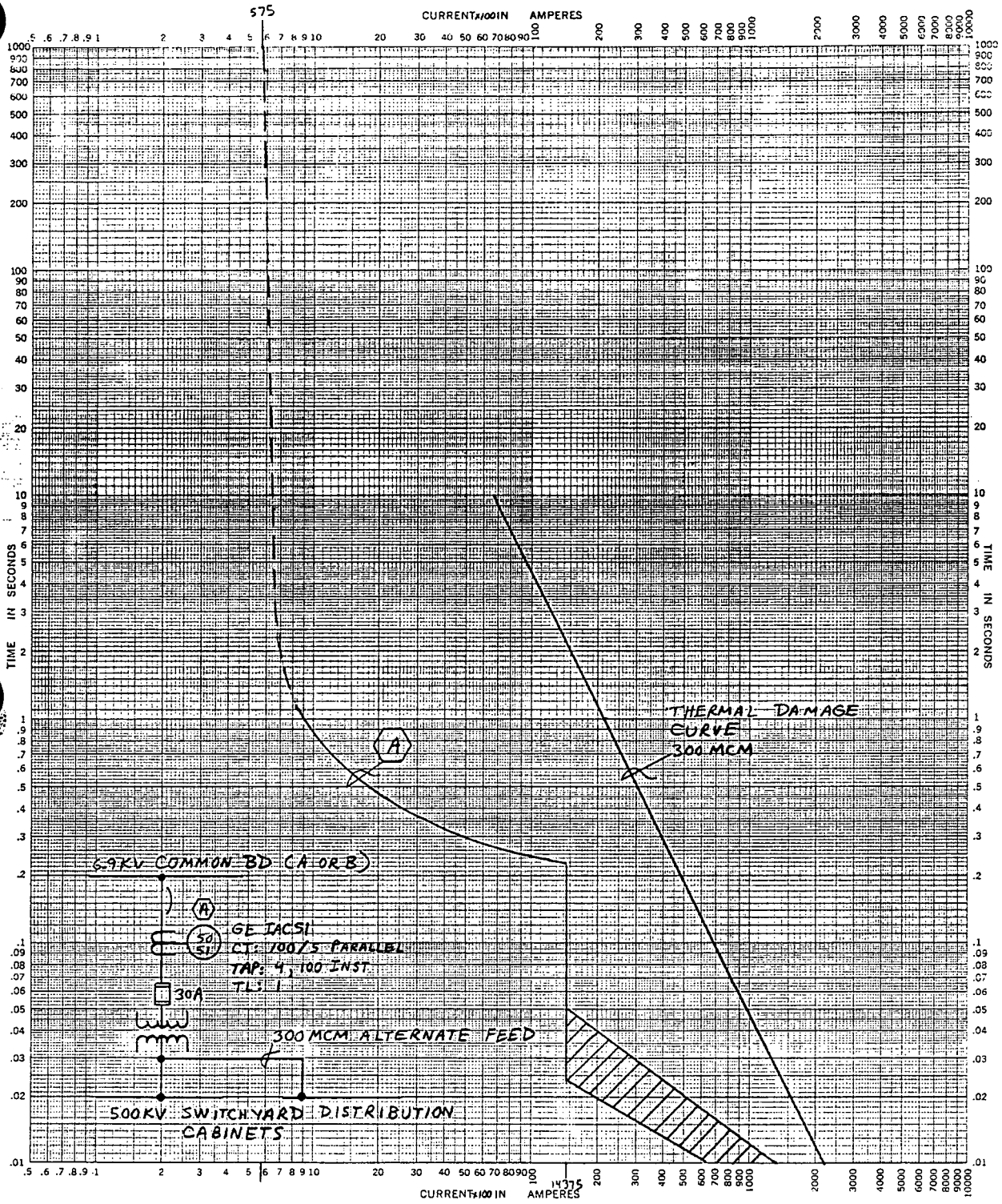
R2
RS
2-14-92
2-28-92

For 480V AUX BLDG COMMON BDS A, B TIME-CURRENT CHARACTERISTIC CURVES
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
2. Curves are plotted to Test points so variations should be
No. A.5
Date

K+E TIME-CURRENT CHARACTERISTIC 48 5258
KEUFFEL & ESSER CO. MADE IN U.S.A.

SHEET
PREPARED PDS DATE 1-31-90
CHECKED GCP DATE 2-1-90

APPENDIX A
WBPEVAR9001007



TIME-CURRENT CHARACTERISTIC CURVES

For 480V SWITCHYARD DISTRIBUTION CABS 1 & 2 Fuse Links. In

~~BASIS FOR DATA Standards~~ ALTERNATE FEED Dated

1. Tests made at Volts a-c at p-f., starting at 25C with no initial load

2. Curves are plotted to Test points so variations should be

No. A.6

Date

K•E TIME-CURRENT CHARACTERISTIC KEUFFEL & ESSER CO. MADE IN U.S.A. 4S 5258

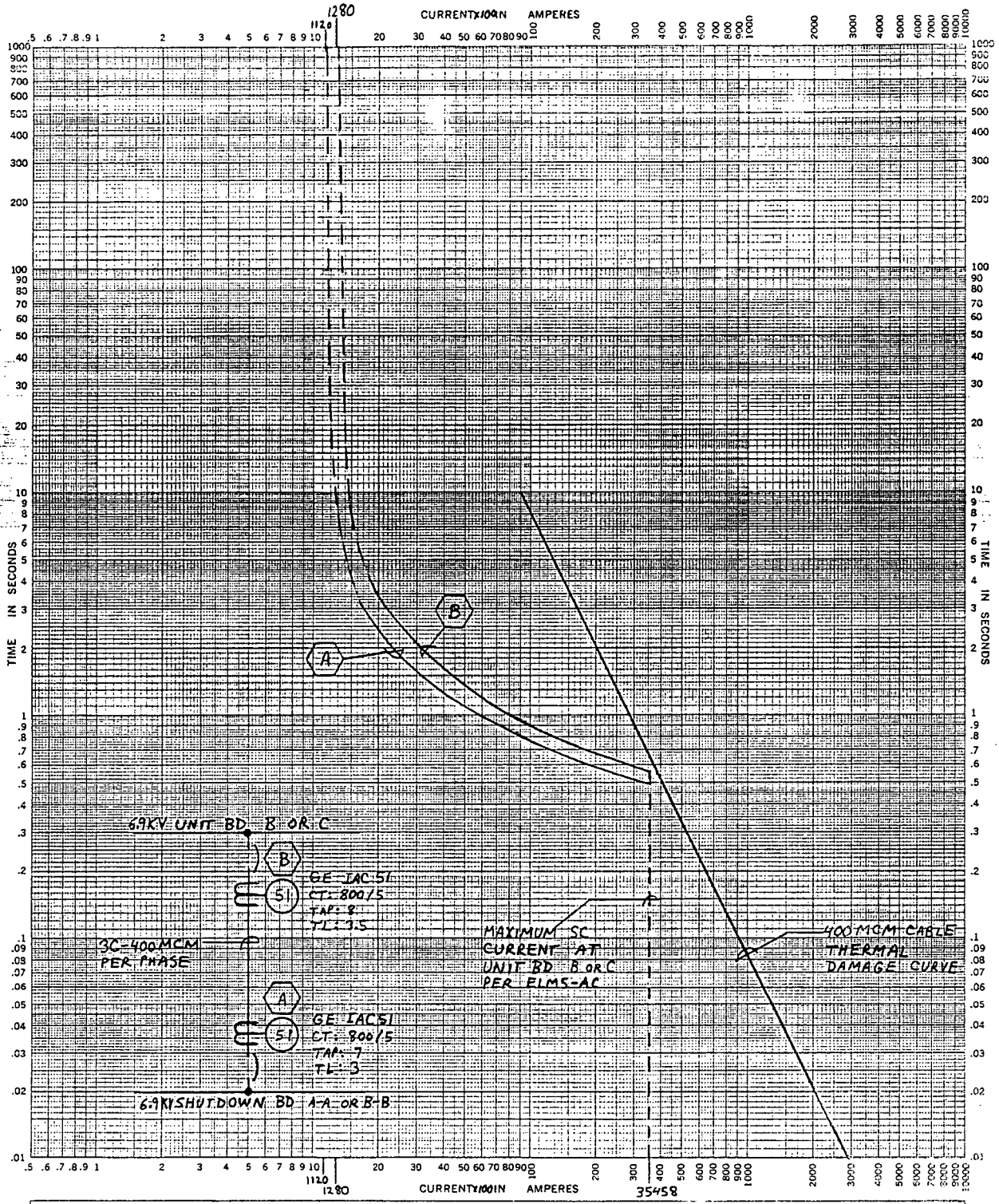
SHEET

PREPARED PDS DATE 1-31-90

CHECKED GCP DATE 2-1-90

APPENDIX A

WBPEVAR9001007



TIME-CURRENT CHARACTERISTIC CURVES

For 6.9 KV SHUTDOWN BDS 1A-A, 1B-B, 2A-A, 2B-B Fuse Links. In

~~BASIS FOR DATA Standards~~ NORMAL FEED Dated

1. Tests made at Volts a-c at p.f., starting at 25C with no initial load

2. Curves are plotted to Test points so variations should be

No A.7

Date

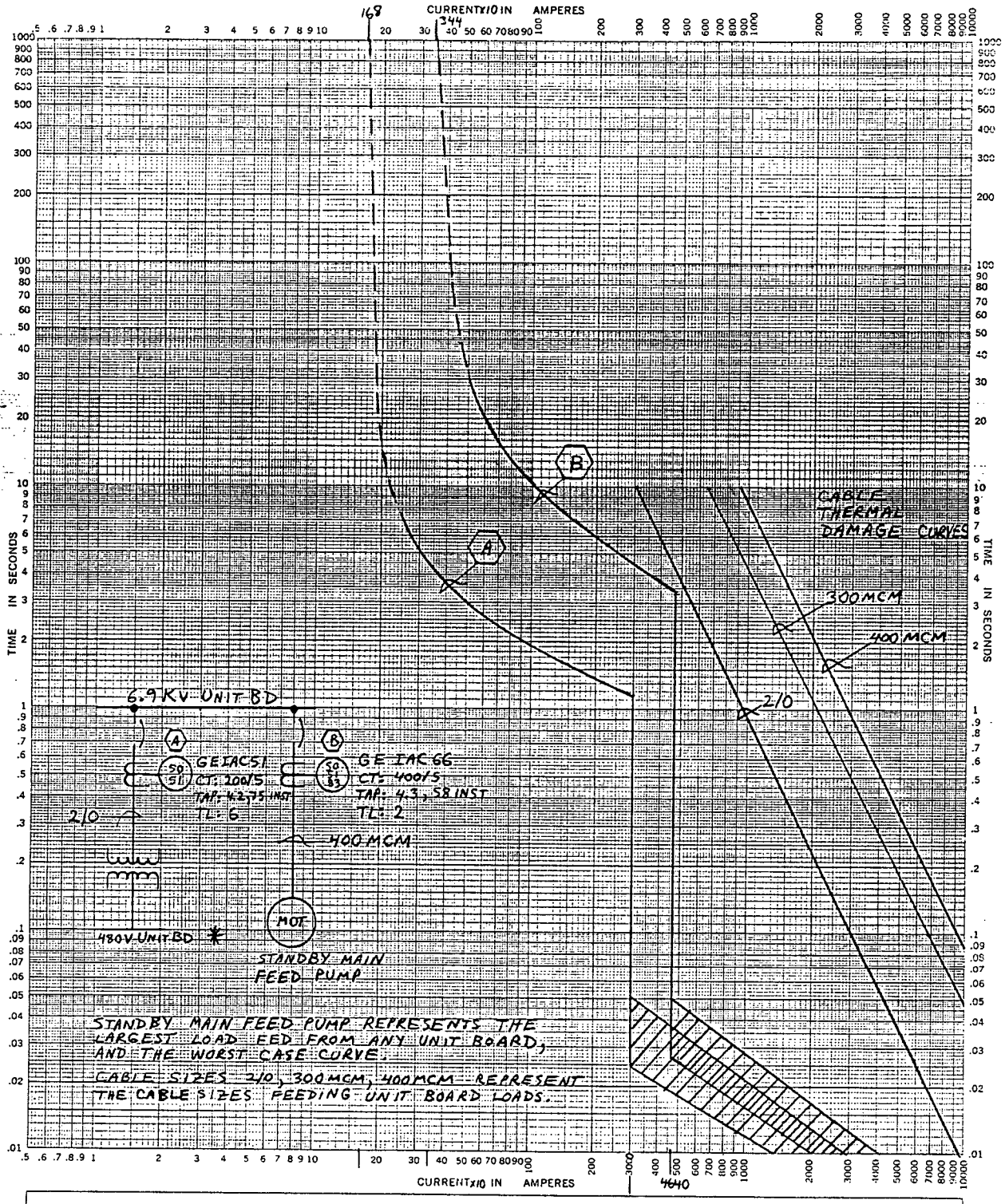
K+E TIME-CURRENT CHARACTERISTIC 48 5258
KEUFFEL & ESSER CO. MADE IN U.S.A.

SHEET

PREPARED PDS DATE 1-31-90

CHECKED GCP DATE 2-1-90

APPENDIX A
WBPE VAR9001007



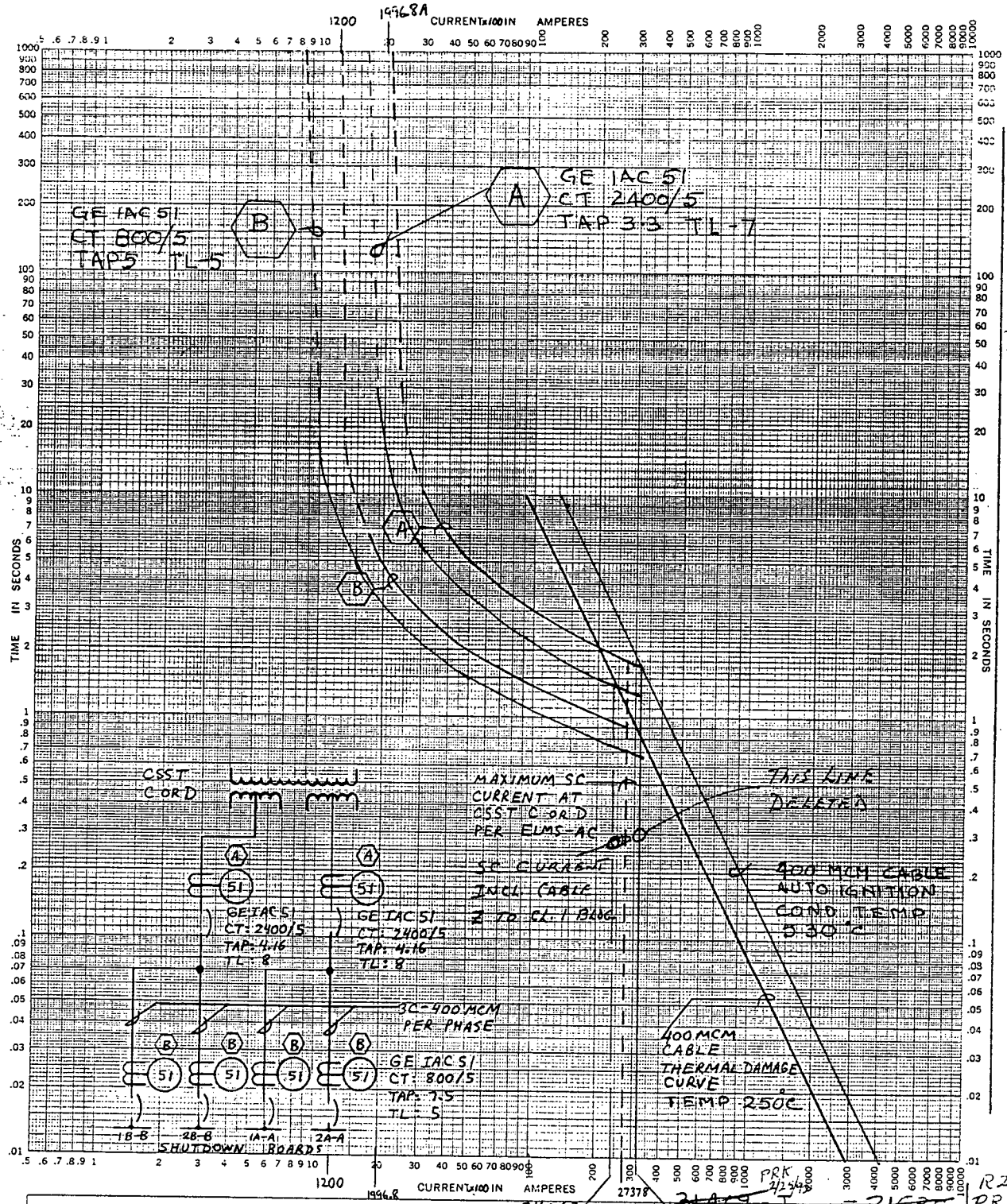
For 6.9KV UNIT BOARDS 1A, 1B, 1C, 1D, 2A, 2B, 2C, 2D _____ TIME-CURRENT CHARACTERISTIC CURVES
Fuse Links. In _____
~~BASIS FOR DATA Standards~~ EXCLUDING 6.9KV SHUTDOWN Dated _____
~~1. Tests made at~~ ~~Volts a.c. at~~ BOARD FEEDERS p-f., starting at 25C with no initial load
2. Curves are plotted to _____ Test points so variations should be _____
No. A.8
Date _____

K+E TIME-CURRENT CHARACTERISTIC 48 5258
KEUFFEL & ESSER CO. MADE IN U.S.A.

* Transformer secondary is adjacent to board (close-coupled).

SHEET _____
PREPARED PDS DATE 1-31-90
CHECKED GCP DATE 2-1-90

APPENDIX A
WBPE VAR 9001007



R2
RS
2-14-92
2-28-92

For 6.9KV SHUTDOWN BOARDS 1A-A, 1B-B, 2A-A, 2B-B Fuse Links. In _____ TIME-CURRENT CHARACTERISTIC CURVES

~~BASIS FOR DATA Summary~~ ALTERNATE FEEDS Dated _____

1. Tests made at _____ Volts a-c at _____ p.f., starting at 25C with no initial load _____
2. Curves are plotted to _____ Test points so variations should be _____

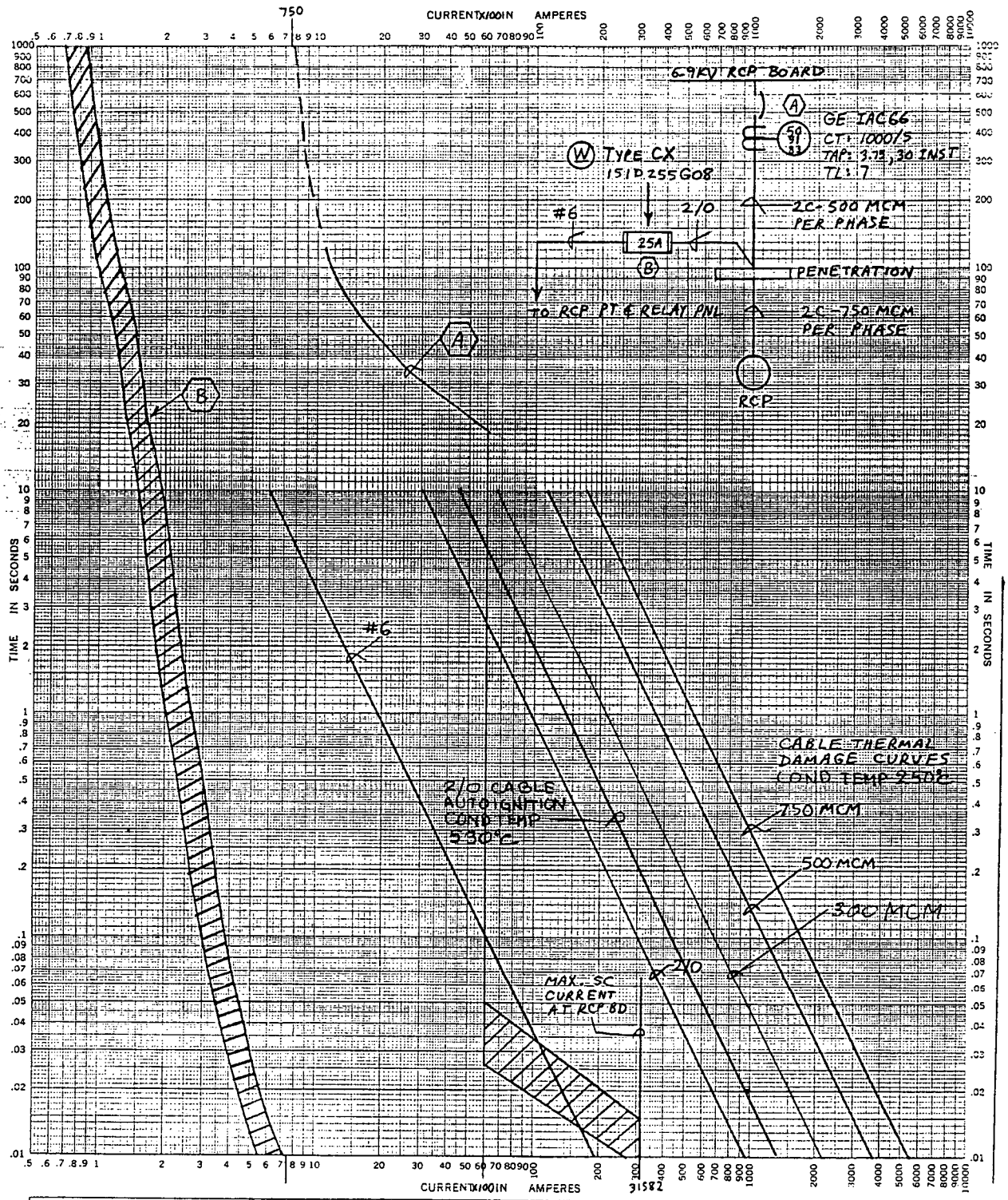
No. A.9
Date _____

R2
PRK
2/25/92
2-28-92

K•E TIME-CURRENT CHARACTERISTIC 48 5258
KEUFFEL & ESSER CO. MADE IN U.S.A.

SHEET _____
PREPARED PDS DATE 1-31-90
CHECKED GCP DATE 2-1-90

APPENDIX A
WBPEVAR9001007



R2
PRK
2/19/92
2-29-92

For 6.9KV RCP BOARDS, 1A, 1B, 1C, 1D, 2A, 2B, 2C, 2D Fuse Links. In _____ TIME-CURRENT CHARACTERISTIC CURVES

BASIS FOR DATA Standards _____ Dated _____

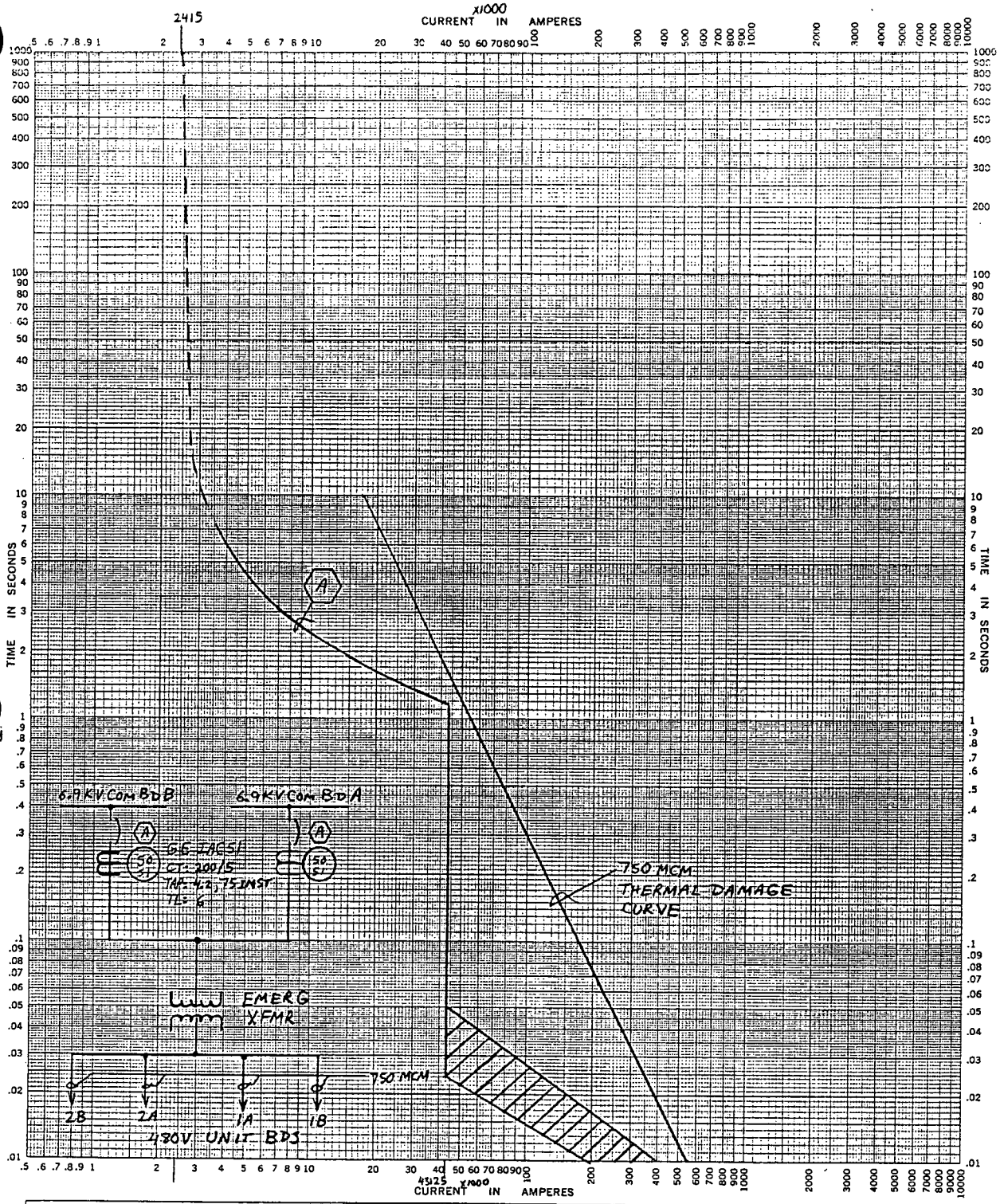
1. Tests made at _____ Volts a-c at _____ p-f., starting at 25C with no initial load _____
2. Curves are plotted to _____ Test points so variations should be _____

No. A10
Date _____

K+E TIME-CURRENT CHARACTERISTIC 48 5258
KEUFFEL & ESSER CO. MADE IN U.S.A.

SHEET
PREPARED PDS DATE 1-31-90
CHECKED GCP DATE 2-1-90

APPENDIX A
WBPEVAR9001007



TIME-CURRENT CHARACTERISTIC CURVES

For 480V UNIT BOARDS 1A, 1B, 2A, 2B EMERG FEEDERS 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

2. Curves are plotted to Test points so variations should be

No. A.11

Date

K•E TIME-CURRENT CHARACTERISTIC 48 5258
KEUFFEL & ESSER CO. MADE IN U.S.A.

SHEET

PREPARED PDS DATE 1-31-90

CHECKED GCP DATE 2-1-90

COMPUTED PDS DATE 1-31-90
CHECKED GCP DATE 2-1-90

11. ATTACHMENTS

ATTACHMENT 1 – Manufacturer's Relay & Fuse Curves (See Following 7-Pages)

ATTACHMENT 2 ABB POWER T&D COMPANY TEST REPORT CSST-C & D SERIAL # MLM 56954 (1 PAGE) R2

ATTACHMENT-3 VERIFICATION WORK SHEET (1 PAGE)

ATTACHMENT-4 AMPACITY REQUIREMENT FOR THE CSST C&D CABLES TO THE 6.9KV SHUTDOWN BOARDS. (2 PAGES)

RS 2-4-92

2-29-92

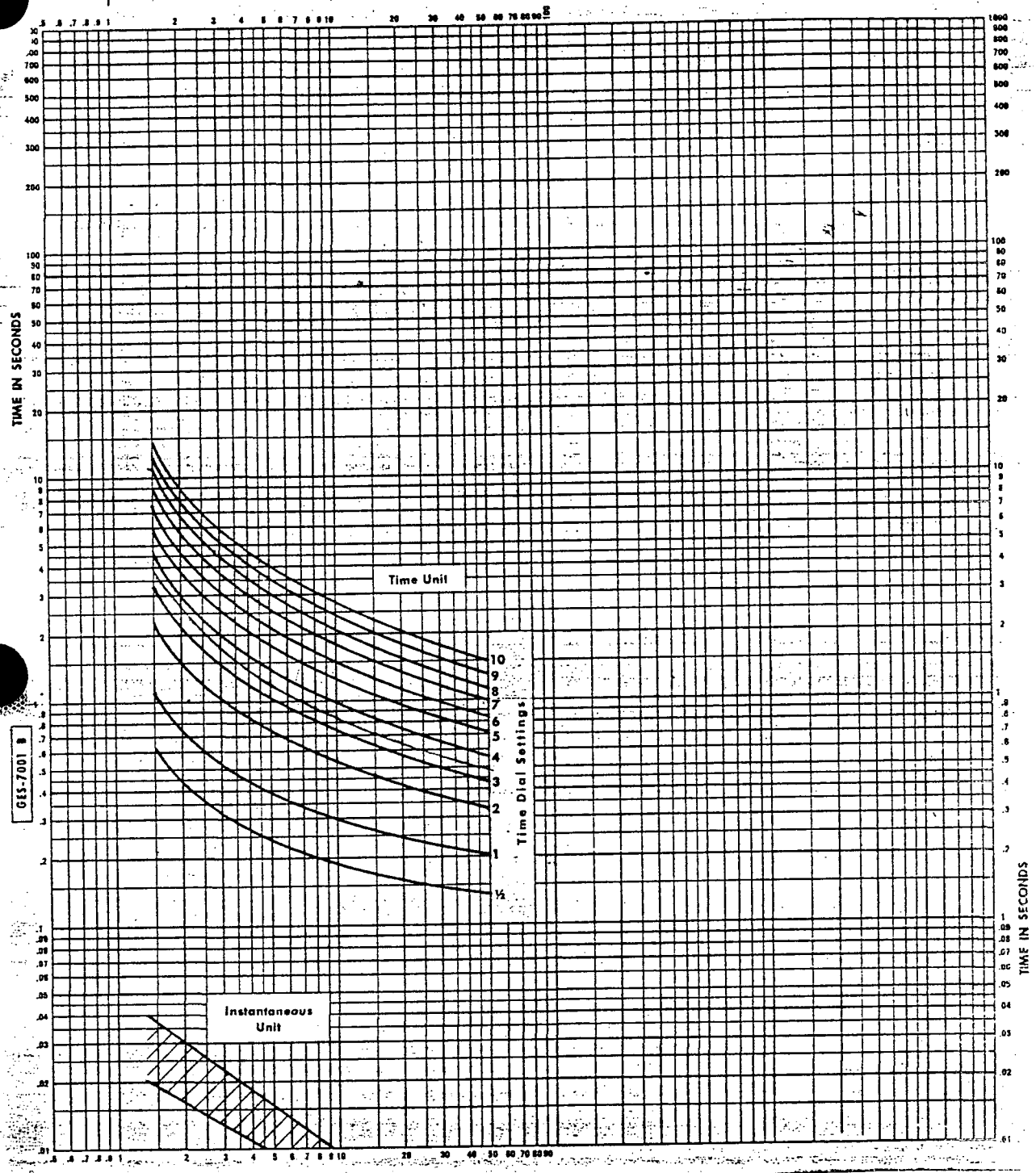
WBPEVAR9001007

PAGE ~~50~~ 1

ATTACHMENT 1 SHEET

PREPARED PDS DATE 1-31-90 3/13/92 RS

CHECKED GCP DATE 2-1-90 LE



GENERAL ELECTRIC

TIME OVERCURRENT RELAY

IAC 51 RELAY

Inverse Standard Time
Time-Current Curves

GES-7001 B

Ratings (Amperes)

Time Unit	Instantaneous Unit	
0.5-2	0.5-4	10-80
0.5-4	2.0-8	20-80
1.5-6	2.0-16	20-160
2.0-16	4.0-16	40-160
4.0-16	10-40	

Other relays with duplicate time delay characteristics
GYC51, IAC52-60, IBC51-52, IBCG51-52,
IBCV51-52, JBC51-52, JBCG51-52,
JBCV51-52

Settings

Time Unit (Taps)	Inst. Unit
0.5,0.6,0.8,1.0,1.2,1.5,2.0	Continuously Adjustable
0.5,0.6,0.7,0.8,1.0,1.2,1.5,2.0,2.5,3.0,4.0	
1.5,2.0,2.5,3.0,4.0,5.0,6.0	
2.0,2.5,3.0,4.0,5.0,6.0,7.0,8.0,10.0,12.0,16.0	
4.0,5.0,6.0,8.0,10.0,12.0,16.0	
4.0,5.0,6.0,7.0,8.0,10.0,12.0,16.0	

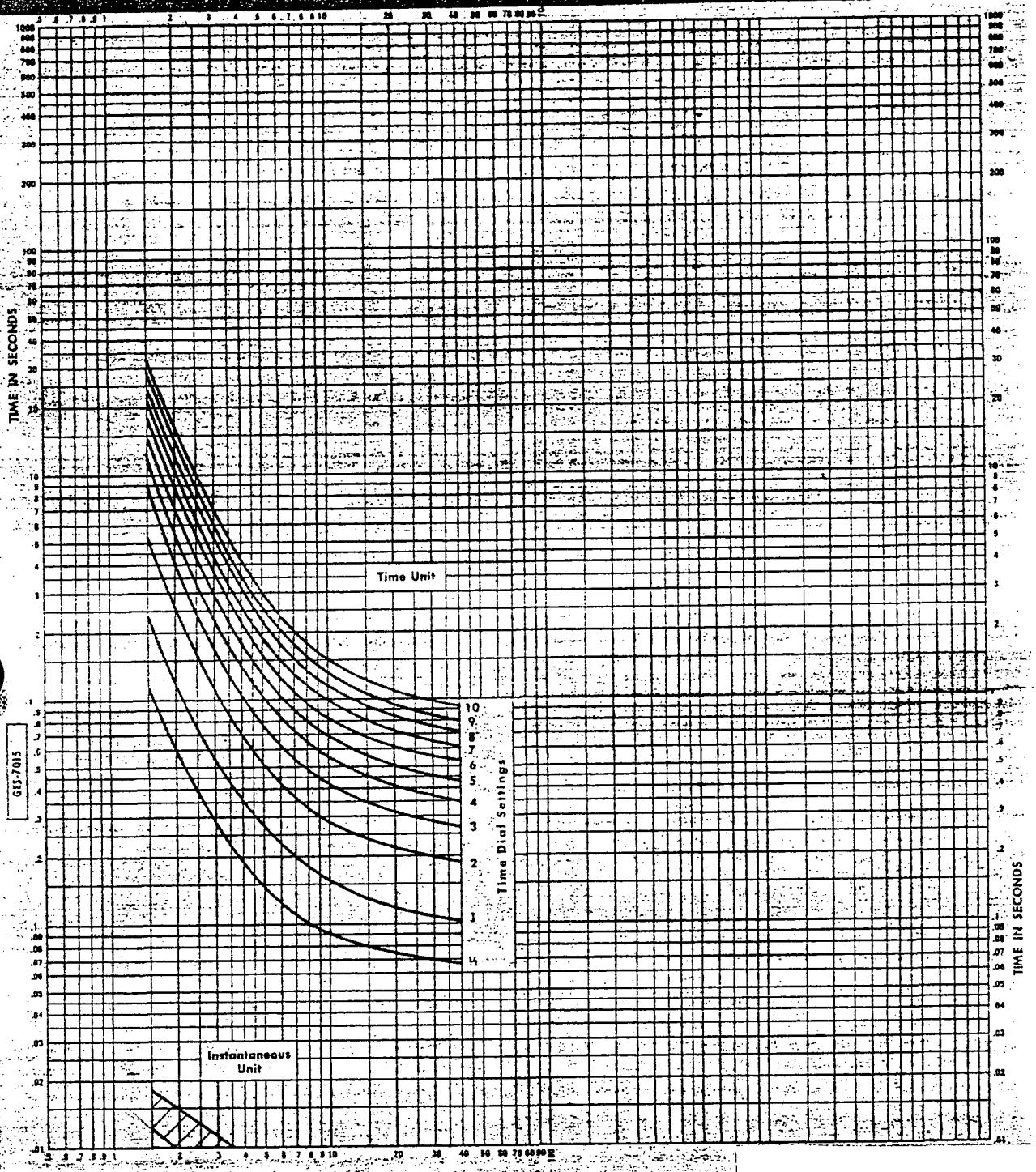
GENERAL ELECTRIC CO., POWER SYSTEMS MANAGEMENT, PHILADELPHIA, PA. 19142

SHEET_____ OF_____

WBPEVAR9001007
ATTACHMENT 1

PAGE ~~51~~ 2
RS LE
2/13/92

SHEET
PREPARED PDS DATE 1-31-90
CHECKED GCP DATE 2-1-90



GENERAL ELECTRIC

TIME OVERCURRENT RELAY

IFC 53 RELAY

Very Inverse Standard Time
Time-current Curves

GES-7015

Ratings (Amperes)
Time Unit: 0.5-4, 1.0-12
Instantaneous Unit: 2-50, 6-150

Frequency Rating
60 Hertz

Settings
Time Unit (Taps) Inst. Unit
Continuously Adjustable

GENERAL ELECTRIC CO., POWER SYSTEMS MANAGEMENT, PHILADELPHIA, PA. 19142

SHEET ____ OF ____

WBPEVAR 9001007

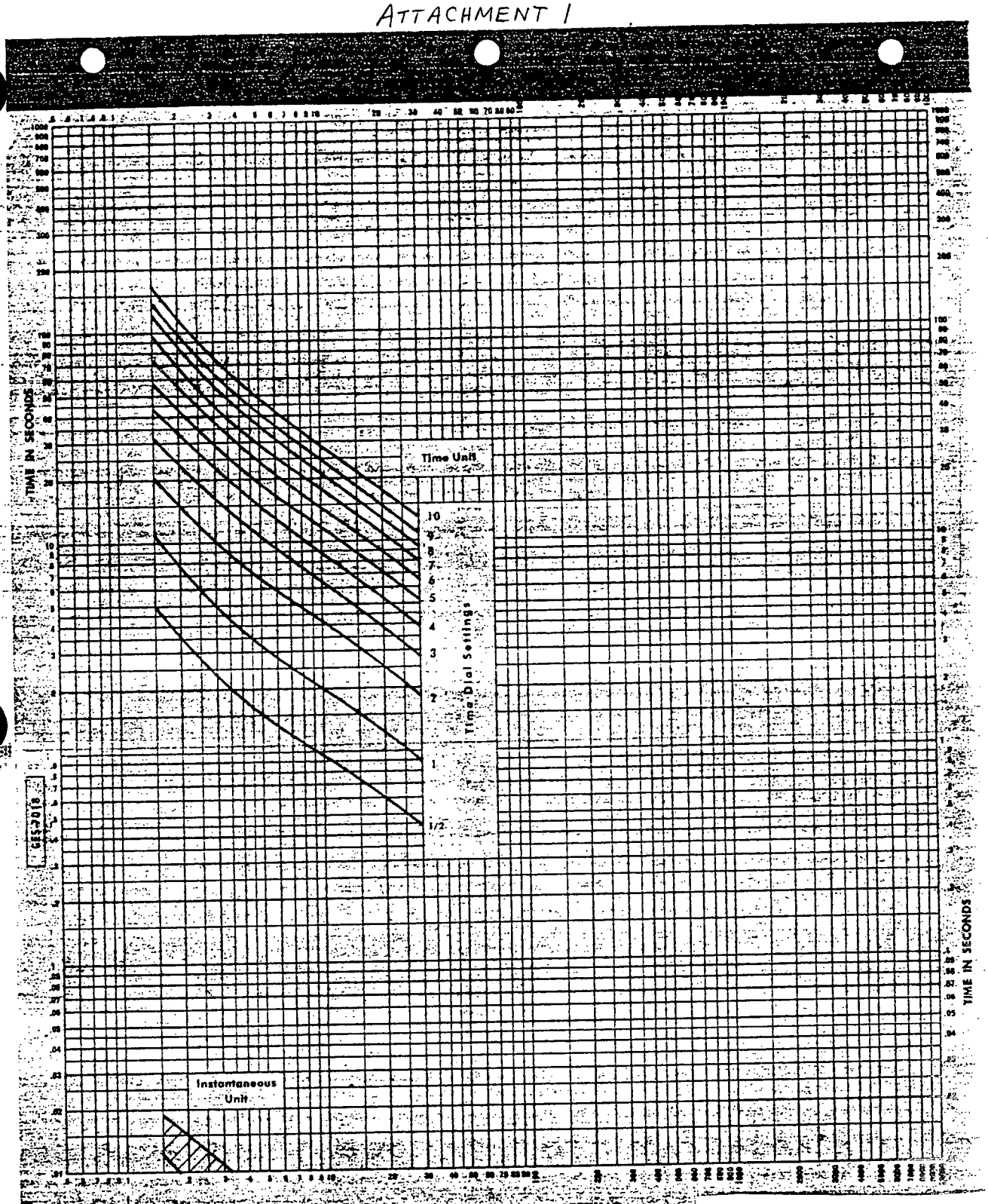
ATTACHMENT 1

PAGE ~~52~~ 3

RS 3/13/92 LE

SHEET PREPARED PDS DATE 1-31-90

CHECKED GCP DATE 2-1-90



MULTIPLES OF PICK-UP SETTING

GENERAL ELECTRIC

TIME OVERCURRENT RELAY

IFC 66 RELAY

Inverse Long Time

Time-current Curves

GES-7018

Ratings (Amperes)

Time Unit: 2.5-7.5

Instantaneous Unit: 6-150

Frequency Rating

60 Hertz

Settings

Time Unit (Tops)

Inst. Unit

Continuous

Adjustable

GENERAL ELECTRIC CO., POWER SYSTEMS MANAGEMENT, PHILADELPHIA, PA. 19142

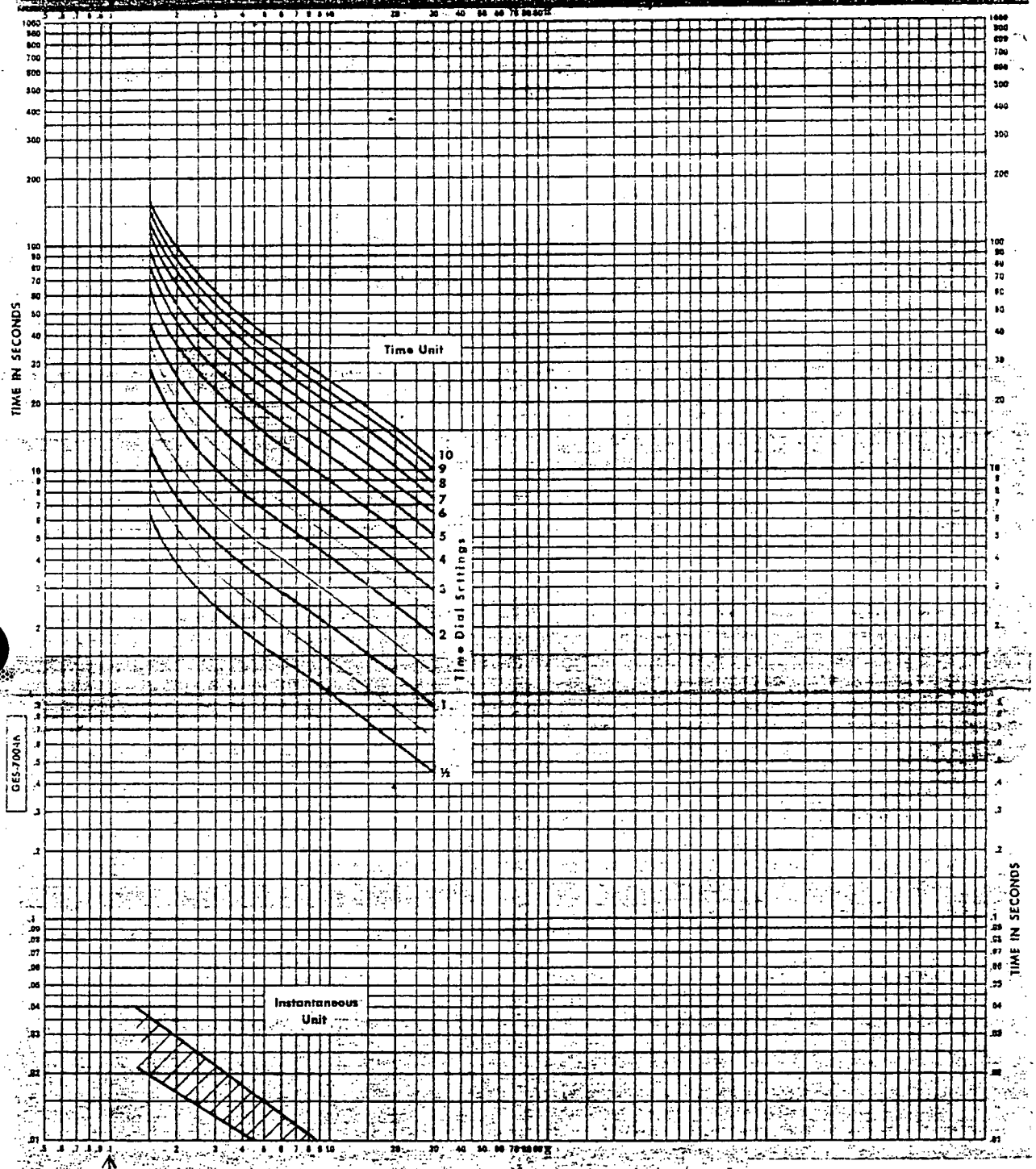
SHEET ____ OF ____

WBPE VAR 9001007

ATTACHMENT 1

PAGE ~~53~~ 4
RS
3/13/92 LE

SHEET
PREPARED PDS DATE 1-31-90
CHECKED GCP DATE 2-1-90



GENERAL ELECTRIC

TIME OVERCURRENT RELAY

IAC 66 RELAY

GES-7004B

Inverse Long Time
Time-Current Curves

(Other relays with duplicate time delay characteristics IAC67, IAC70)

Ratings (Amperes) Time Unit	Instantaneous Unit
0.6-1.2	1-4
1.0-2.0	2-8
1.5-3.0	4-16
2.5-5.0	10-40
4.0-8.0	20-80
	40-160

Settings Time Unit (Taps)	Inst. Unit
0.6, 0.7, 0.8, 0.9, 1.0, 1.1, 1.2	Continuously
1.0, 1.1, 1.2, 1.4, 1.6, 1.8, 2.0	Adjustable
1.3, 1.7, 1.9, 2.0, 2.4, 2.7, 3.0	
2.5, 2.8, 3.1, 3.5, 4.0, 4.5, 5.0	
4.0, 4.5, 5.0, 5.6, 6.3, 7.1, 8.0	

6-76 (2M)

GENERAL ELECTRIC CO., SWITCHGEAR BUSINESS DEPT., PHILADELPHIA, PA.

SHEET_____ OF_____

Westinghouse Electric Corporation
Switchgear Division
East Pittsburgh, Pa. 15112

Application Data
36-733

WBPEVAR 9001007
ATTACHMENT 1

SHEET
PREPARED PDS DATE 1-31-90
CHECKED GCP DATE 2-1-90

March 1982
New Information

Mailed to: E. D. C/2179/DB

Performance Curves

Type CX High Voltage Power Fuses

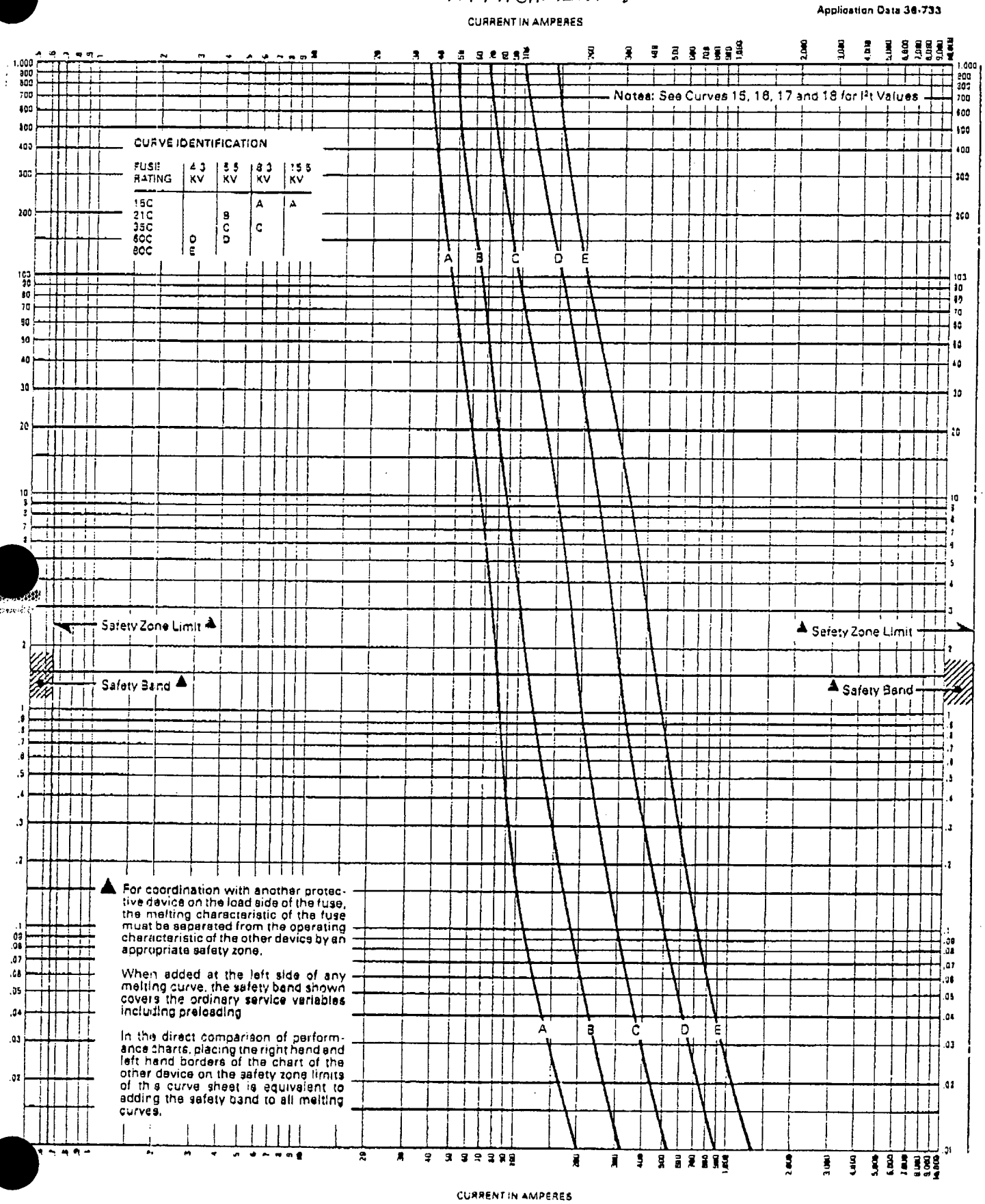
Style Number Index Curve Data Guide

Style Number Series	Curve Numbers
151D253G06-G08	3, 4, 13, 15, 19
151D254G04-G06-G09	3, 4, 13, 16, 20
151D254G11-G12	7, 8, 13, 16, 20
151D255G01-G02-G03	1, 2, 14, 17, 21
151D255G06-G09	3, 4, 14, 17, 21
151D255G11-G12	9, 10, 14, 17, 21
151D883G02	1, 2, 14, 18, 22
151D883G05	3, 4, 14, 18, 22
151D883G01-G11	11, 12, 14, 18, 22
5978C62G01-G02-G03	5, 6, 13, 15, 19
5978C62G04-G05-G06	9, 10, 14, 17, 21
5978C66G01 Thru G05	5, 6, 13, 15, 19
5978C70G01 Thru G08	7, 8, 13, 16, 20
5978C72G01 Thru G05	9, 10, 14, 17, 21
8570D12G01 Thru G08	11, 12, 14, 18, 22

RS 3/13/92 LB

WBPEVAR9001007
ATTACHMENT 1

Application Data 36-733



PREPARED PDS DATE 1-31-90
CHECKED SCP DATE 2-1-90

Type CX Current Limiting Power Fuses

Minimum Melting Time-Current Characteristics, 4.3 Kv Through 15.5 Kv

Curves are based on tests starting with fuse units at an ambient temperature of 25°C and without initial load. Curves are plotted to minimum test points so variations should be positive.

Curve No. 3

Westinghouse Electric Corporation
Switchgear Division, Component Sales, East Pittsburgh, Pa. 15112

Reference Data:
Curve Number "A" Thru "E"
Reference Curve 668792

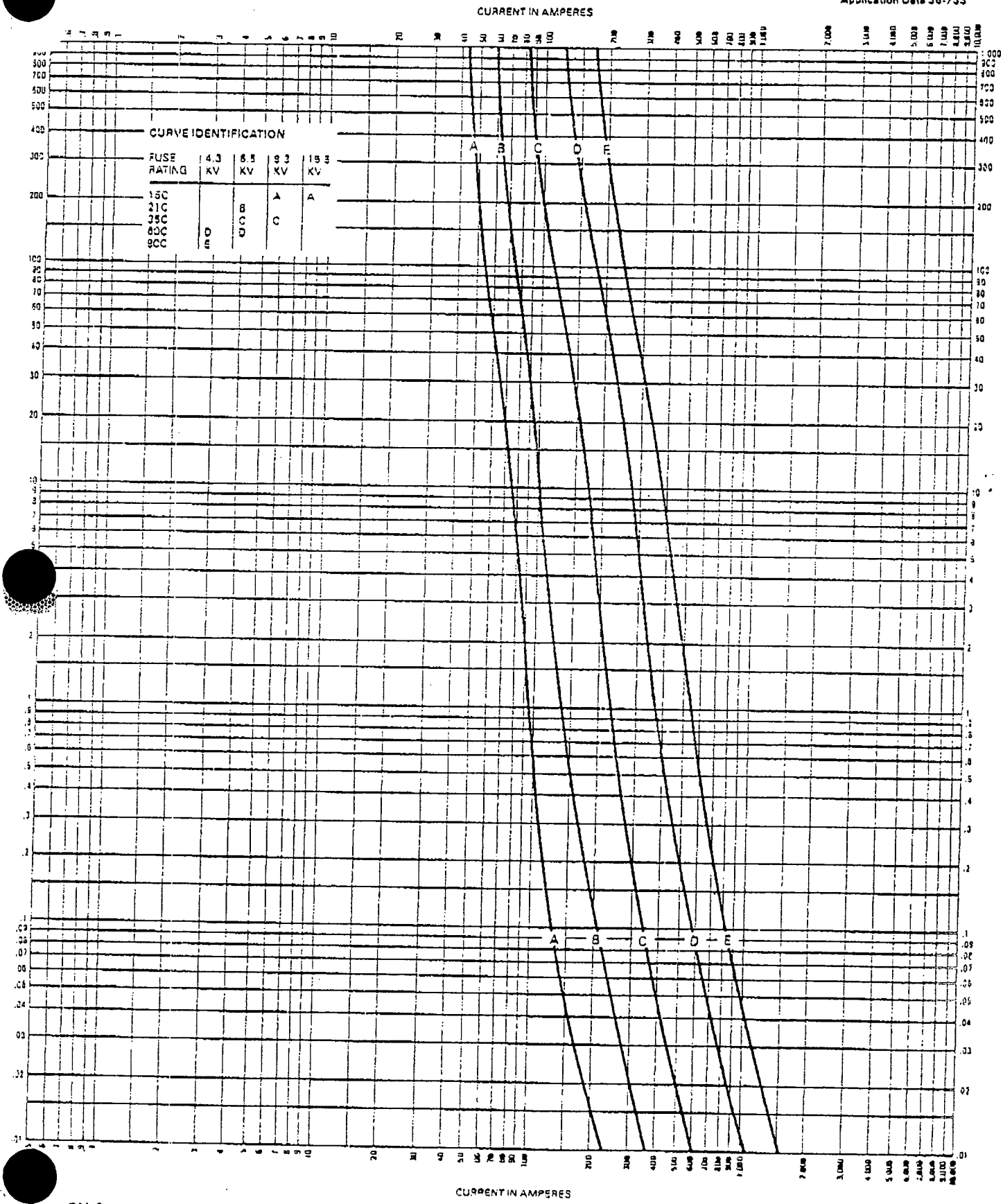
JAN 24 '90 14:45 WESTINGHOUSE ELEC-CHATTANOOGA F.4

RS 3/13/92 LE

WBPEVAR9001007

ATTACHMENT 1

Application Data 36-733



PREPARED PDS DATE 1-31-90
CHECKED GCP DATE 2-1-90

Type CX Current Limiting Power Fuses

Total Clearing Time-Current Characteristics, 4.3 Kv Through 15.5 Kv

Curves are based on tests starting with fuse units at an ambient temperature of 25°C and without initial load. Curves are plotted to maximum test points so variations should be negative.

Curve No. 4

Westinghouse Electric Corporation
Switchgear Division, Component Sales, East Pittsburgh, Pa 15112
Printed in U.S.A.

Reference Date: "A" Thru "E"
Curve Number 868793
Reference Curve 5-14-81
Date

ABB Power T&D Company

WBPEVAR 90011007 R2
ATTACHMENT-D2

PAGE 1 ~~57~~

Purchaser Tennessee Valley Authority

Date of Test 5-25-91 Purchaser's Order No. 90NLB-746788 S.O. COB12483 S.O. No. MLM 5695

Core OA/FOA/FOA Phase Three Hertz 60 Insulating Fluid Oil L. Spec. MLM 5695-08 Polarity See I.P. 3/15/92 LE

Winding	H	Winding	X	Winding	Y
KVA	33000/44000/55000	KVA	24000/32000/40000	KVA	24000/32000/40000
Voltage	161000	Voltage	6900	Voltage	69000

For polarity, additional tap voltages and connections, see Instruction Plates MLM 5695-10 and MLM 5695-11.

RESISTANCES, EXCITING CURRENT, LOSSES AND IMPEDANCE---Based on normal rating, unless otherwise stated. Losses and regulation are based on wattmeter measurements. For three phase transformers the resistances are the sum of the three phases in series.

SERIAL NO.	RESISTANCE IN OHMS AT 75°C WINDINGS H	X	Y	% EXCITE CURRENT AT 100 % RATED VOLTAGE	NO LOAD LOSS WATTS AT 100 % RATED VOLTAGE	161.0 kV TO 6.9 kV 16500 kVA LOAD LOSS WATTS 75°C	% IMP 75°C	161.0 kV TO 6.9 kV 16500 kVA LOAD LOSS WATTS 75°C	% IMP 75°C	6.9 kV TO 6.9 kV 16500 kVA LOAD LOSS WATTS 75°C	% IMP 75°C
MLM56954	1.9928	0.0079	0.0076	0.192	47640	37451	4.98	37282	4.95	90896	9.29
						TOTAL LOSS	%IMP 75°C	TOTAL LOSS	%IMP 75°C	TOTAL LOSS	%IMP 75°C
AVERAGE				0.192	47640	85091	4.98	84922	4.95	138536	9.29
GUARANTEE				0.300	52000	X	5.00	--	5.00	--	9.50

REGULATION AT 75°C		100% PF	90% PF	80% PF	% PF
	AVERAGE	0.351	2.469	3.241	
	GUARANTEE		--	--	

[illegible]ATURE RISE---Average rise in degrees C, corrected to instant of shutdown of transformer.

[illegible]al No. ** MLM56951 with windings connected and loaded as follows:

H Winding 148.925 kV 127.9 Amp.; X Winding 6.296 kV 2200.8 Amp.;

Y Winding 6.296 kV 2200.8 Amp. until constant temperature rise was reached.

LOAD CONSTANT	RISE OF WINDINGS BY RESISTANCE H	X	Y	GUARANTEE	TOP FLUID RISE	AMBIENT TEMP. INGOING WATER	IDLER OR ROOM	WINDING HOT SPOT RISE H	X	Y
100%	42.6	40.3	50.5	65	40.6		22.9			
187%	46.3	47.1	49.5	65	31.8		21.6			

INSULATION TESTS	WINDING	VOLT RATING	TEST VOLTAGE APPLIED IN kV	DURATION OF TEST IN SECONDS
APPLIED POTENTIAL TESTS	H	161000	34	60
	X	6900	26	60
	Y	6900	26	60
(Voltage applied between each winding and all other windings connected to core and ground.)	Wiring, Fans & Pumps	480	1.5	60

REMARKS This transformer was subject to and successfully withstood the impulse tests applied in accordance with the latest ANSI test codes. Copies of the oscillograms are on permanent file at the Muncie Plant.

* See page 8 for guaranteed losses.

** Indicates temperature rises are obtained from MLM56951.

[illegible]reby certify that this is a true report based on factory tests made in accordance with the latest Transformer Test Code of ANSI.

[illegible] Date 06-13-1991 Approved [illegible]

THIS SHEET ADDED BY REV. 2

WBPEVAR9001007 R2

ATTACHMENT-3

RS 3/13/92 LB

VERIFICATION WORKSHEET
FOR CALCULATIONS

Task No. PWL

Document No. WBPEVAR9001007

Revision 2

Title MEDIUM VOLTAGE APPENDIX R AND REG. GUIDE 1.75 ASSOCIATED CIRCUITS ANALYSIS

QUESTIONS TO BE ADDRESSED

1	Were the inputs correctly selected at the correct revision level, and incorporated into the design? YES
2	Are the assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are assumptions identified for subsequent reverification after the detailed design activities are completed? YES
3a	Are the appropriate quality requirements specified?
3b	Are the appropriate quality assurance requirements specified?
4	Are the applicable codes, standards, and regulatory requirements including issue and addenda properly identified, and are their requirements for design met? YES
5	Have applicable construction and operating experience been considered?
6	Have the design interface requirements been satisfied? YES
7	Was an appropriate design method used? YES
8	Is the output reasonable compared to inputs? YES
9	Are the specified parts, equipment, and processes suitable for the required application? Are all applicable construction specifications referenced on the drawing(s)?
10	Are the specified materials compatible with each other and with the design environmental conditions to which the materials will be exposed?
11	Have adequate maintenance features and requirements been specified?
12	Are accessibility and other design provisions adequate for performing needed maintenance and repair?
13	Has adequate accessibility been provided to perform the inservice inspection expected to be required during the plantlife?
14	Has the design properly considered radiation exposure to the public and plant personnel?
15	Is the acceptance criteria incorporated in the design document sufficient to allow verification that design requirements have been satisfactorily accomplished? YES
16	Have adequate preoperational and subsequent periodic test requirements been appropriately specified?
17	Are adequate handling, storage, cleaning and shipping requirements specified?
18	Are adequate identification requirements specified?
19	Are requirements for record preparation review, approval, retention, etc., adequately specified?

For Calculations, only questions 1, 2, 4, 6, 7, 8 and 15 are considered applicable.

Independent Verifier JOSEF BARTOS / J. Bartos (Print/Sign) 2-28-92 (Date)

THIS SHEET ADDED BY REV 2

Ampacity Requirements for the CSST C & D Cables to the 6.9KV Shutdown Boards

WBPEVAR9001007 R2 RS 3/13/9 LE
ATTACHMENT - 4

UNIT 1 ACCIDENT & UNIT 2 NORMAL OPERATION/HOT STANDBY

BOARD NAME	COMP	MOTOR NAME	HP/KVA	CONNECTED FLI	ACCIDENT FLI
6.9KV SHTDN BD 1A-A	13	CNTMT SPRAY PMP 1A-A	700	52.6	52.6
6.9KV SHTDN BD 1A-A	14	RHR PUMP 1A-A	400	30.0	30.0
6.9KV SHTDN BD 1A-A	15	SAFETY INJ PMP 1A-A	400	31.0	31.0
6.9KV SHTDN BD 1A-A	8	ERCW PMP A-A	800	63.0	63.0
6.9KV SHTDN BD 1A-A	9	ERCW PMP B-A	800	63.0	0.0
6.9KV SHTDN BD 1A-A	10	AUX FEEDWTR PMP 1A-A	600	49.5	49.5
6.9KV SHTDN BD 1A-A	18	CNTFGL CHRG PMP 1A-A	600	45.0	45.0
6.9KV SHTDN BD 1A-A	3	6900/480 XFMR 1A1-A (KVA)	2000	167.3	167.3
6.9KV SHTDN BD 1A-A	4	6900/480 XFMR 1A2-A (KVA)	2000	167.3	167.3
6.9KV SHTDN BD 1A-A	20	PRZR HTR GP 1A-A (KVA)	500	41.8	0.0
6.9KV SHTDN BD 1A-A	21	PRZR HTR GP 1D (KVA)	500	41.8	0.0
		TOTAL		752.4	605.8
6.9KV SHTDN BD 1B-B	13	CNTMT SPRAY PMP 1B-B	700	52.6	52.6
6.9KV SHTDN BD 1B-B	14	RHR PUMP 1B-B	400	30.0	30.0
6.9KV SHTDN BD 1B-B	15	SAFETY INJ PMP 1B-B	400	31.0	31.0
6.9KV SHTDN BD 1B-B	8	ERCW PMP F-B	800	63.0	63.0
6.9KV SHTDN BD 1B-B	9	ERCW PMP E-B	800	63.0	0.0
6.9KV SHTDN BD 1B-B	10	AUX FEEDWTR PMP 1B-B	600	49.5	49.5
6.9KV SHTDN BD 1B-B	18	CNTFGL CHRG PMP 1B-B	600	45.0	45.0
6.9KV SHTDN BD 1B-B	3	6900/480 XFMR 1B1-B (KVA)	2000	167.3	167.3
6.9KV SHTDN BD 1B-B	4	6900/480 XFMR 1B2-B (KVA)	2000	167.3	167.3
6.9KV SHTDN BD 1B-B	20	PRZR HTR GP 1B-B (KVA)	500	41.8	0.0
6.9KV SHTDN BD 1B-B	21	PRZR HTR GP 1C (KVA)	500	41.8	0.0
		TOTAL		752.4	605.8
6.9KV SHTDN BD 2A-A	13	CNTMT SPRAY PMP 2A-A	700	52.6	0.0
6.9KV SHTDN BD 2A-A	14	RHR PUMP 2A-A	400	30.0	0.0
6.9KV SHTDN BD 2A-A	15	SAFETY INJ PMP 2A-A	400	31.0	0.0
6.9KV SHTDN BD 2A-A	8	ERCW PMP D-A	800	63.0	63.0
6.9KV SHTDN BD 2A-A	9	ERCW PMP C-A	800	63.0	0.0
6.9KV SHTDN BD 2A-A	10	AUX FEEDWTR PMP 2A-A	600	49.5	49.5
6.9KV SHTDN BD 2A-A	18	CNTFGL CHRG PMP 2A-A	600	45.0	45.0
6.9KV SHTDN BD 2A-A	3	6900/480 XFMR 2A1-A (KVA)	2000	167.3	167.4
6.9KV SHTDN BD 2A-A	4	6900/480 XFMR 2A2-A (KVA)	2000	167.3	167.4
6.9KV SHTDN BD 2A-A	20	PRZR HTR GP 2A-A (KVA)	500	41.8	0.0
6.9KV SHTDN BD 2A-A	21	PRZR HTR GP 2D (KVA)	500	41.8	0.0
		TOTAL		752.4	492.2

Prepared [illegible] Date 2/4/92
Verified E. J. Grover Date 2/5/92

THIS SHEET ADDED BY REV 2

\CSSTCAB

PAGE ~~60~~ 2
WBPEVAR9001007 R2
ATTACHMENT - 4 RS 3/13/92 LE

Ampacity Requirements for the CSST C & D Cables to the 6.9KV Shutdown Boards

UNIT 1 ACCIDENT & UNIT 2 NORMAL OPERATION/HOT STANDBY

BOARD NAME	COMP	MOTOR NAME	HP/KVA	CONNECTED FLI	ACCIDENT FLI
6.9KV SHTDN BD 2B-B	13	CNTMT SPRAY PMP 2B-B	700	52.6	0.0
6.9KV SHTDN BD 2B-B	14	RHR PUMP 2B-B	400	30.0	0.0
6.9KV SHTDN BD 2B-B	15	SAFETY INJ PMP 2B-B	400	31.0	0.0
6.9KV SHTDN BD 2B-B	8	ERCW PMP H-B	800	63.0	63.0
6.9KV SHTDN BD 2B-B	9	ERCW PMP G-B	800	63.0	0.0
6.9KV SHTDN BD 2B-B	10	AUX FEEDWTR PMP 2B-B	600	49.5	49.5
6.9KV SHTDN BD 2B-B	18	CNTFGL CHRG PMP 2B-B	600	45.0	0.0
6.9KV SHTDN BD 2B-B	3	6900/480 XFMR 2B1-B (KVA)	2000	167.3	167.4
6.9KV SHTDN BD 2B-B	4	6900/480 XFMR 2B2-B (KVA)	2000	167.3	167.4
6.9KV SHTDN BD 2B-B	20	PRZR HTR GP 2B-B (KVA)	500	41.8	41.8
6.9KV SHTDN BD 2B-B	21	PRZR HTR GP 2C (KVA)	500	41.8	0.0
				752.4	489.0

Prepared [signature] Date 2/4/92
Verified E. I. Iglarsa Date 2/5/92

NOTES Above values are conservative for the following reasons:

1. All redundant equipment is considered to be operating in the accident unit.

2. Assumes all loads on a 6.9KV Shutdown Board have the same power factor - worst case.

3. Transformer ratings are used but the actual load on each transformer is less than the rating.

4. For the unit in an accident, the RHR, Safety Injection and Centrifugal Charging Pumps are considered to be operating on each train which would be for a short time duration since two of the three pumps are high pressure pumps and one is a low pressure pump.

5. The pressurizer heaters will be an intermittent load in the non-accident unit to maintain pressure control.

Above listing has Unit 1 in an accident and Unit 2 in Hot Standby, but the ampacities calculated also apply to Unit 2 in an accident and Unit 1 in Hot Standby by using the accident and non-accident ampacities.

THIS SHEET ADDED BY REV 2