ENCLOSURE 6
WATTS BAR NUCLEAR PLANT (WBN)
CALCULATION WBN-EEB-MS-TI11-0062
DIESEL GENERATOR CONTROL POWER SYSTEM

QA Record

EBASCO SERVICES INCORPORATED
ONE CALCULATIONS

TITLE 125V DC DIESEL GENERATOR (DG) CONTROL POWER SYSTEM EVALUATION				Plant/Unit WATTS BAR UNIT 1 & 2
PREPARING ORGANIZATION NE, Ebasco Services Inc.	KEY NOUNS (Consult RIMS DESCRIPTORS LIST) DIESEL GEN, PWR SYS, CALC, BATTERIES			
BRANCH/PROJECT IDENTIFIERS WBN-EEB-MS-TI11-0062	Each time these calculations are issued, preparers must ensure that the original (RO) RIMS accession number is filled in.			
	Rev	(for RIMS' use)	RIMS accession number	
	R0	900214B0004	B26 90 0202 406 m.l.m 3/31/92	
APPLICABLE DESIGN DOCUMENT(S) WB-DC-30-27	R4	APR 0 8 1992 (85)	B18 '92 0331 255	
	R5		B26 '92 0411 40(	
SAR SECTION(S) 8.3 / UNID SYSTEM(S) 82	R__			

Revision 0	R4	R5	R	Safety-related? Yes [X] No [ ]
ECN NO.(or indicate Not Applicable) N/A m.l.m 3/25/92	SEE REV. LOG	See rev. Log.		Statement of Problem
Prepared C.G. Peterson*	M.L. Madero 3-25-92	4/10/92 C Peterson		VERIFY ADEQUACY OF DESIGN AND COMPLIANCE WITH DESIGN CRITERIA AND SAR REQUIREMENTS.
Checked W.J. Holbert*	[signature] 3-26-92	4/10/92 E.J. Igbavo		
Reviewed G.L. Nicely*	DE Kendley 3-26-92	S.W. Ashley 4/11/92		
Approved M.C. Brickey*	for JWA 3/30/92 [signature]	[signature] for G.C. Lyhe EA/EB	4/11/92	ORIGINAL
Date 2-2-90	3/30/92	4/11/92		
USE FORM TVA 10534 IF MORE SPACE REQUIRED — List all pages added by this revision	See rev. Log.	See rev. Log		
List all pages deleted by this revision	See rev. Log	See rev. Log		
List all pages changed by this revision	See rev. Log	See rev. Log		

Abstract:

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

This calculation evaluates the adequacy of the 125V DC DG control power system for battery sizing, charger sizing, protective device sizing, short circuit and coordination, Appendix R, Reg Guide 1.75-Associated circuits, cascade fuses and maximum voltage to control circuit components. Adequacy of minimum voltage to control circuit components is verified through pre-op test TVA-14D. See sections 8.0 and 9.0 for results and conclusions.

* See sheet 1 for original signatures.

See revision log for total number of pages and FSAR compliance review.

[ ] Microfilm and store calculations in RIMS Service Center

[X] Microfilm and return calculations to: ~~DCRM, TSOB, WBNP~~ Calculation Control Center

Microfilm and destroy. [ ]

cc: RIMS, SL 26 C-K — D. Kilgore, TR-E7 WBNP

Address: ~~CCC, A-IOB, WBNP~~ IOB 1E, WBN

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1445x

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

Page 1

TITLE	PLANT/UNIT
125VDC Diesel Generator (DG) Control Power System Evaluation	Watts Bar Unit 1 & 2

PREPARING ORGANIZATION	KEY NOUNS (Consult RIMS DESCRIPTORS LIST)
NE-EE-WBEP	Diesel Gen, Pwr Sys, Calc, Batteries

BRANCH/PROJECT IDENTIFIERS: WBN-EEB-MS-TI11-0062

APPLICABLE DESIGN DOCUMENT(S): WB-DC-30-27

Each time these calculations are issued, preparers must ensure that the original (RO) RIMS accession number is filled in.

Rev	(for RIMS' use) (136)	RIMS accession number
R0	900214B0004	B26 '90 0202 40
R1	900327B0009	B26 '90 0308 40
R2	911022C0041 (18)	B26 '91 0919 402
R3	920110C0010 (75)	B26 '91 1219 40

SAR SECTION(S)	UNID SYSTEM(S)
8.3	82

	Revision 0	R1	R2	R3
ECN No. (or indicate Not Applicable)	N/A	N/A	See rev. Log	SEE REV. LOG
Prepared	C.A. Peterson	3/8/90 WJH	9/18/91 C Peterson	WJH 12-19-91
Checked	W.J. Holbert	3/8/90	9/18/91 WJH	12-19-91
Reviewed	[signature]	[signature]	WJH 9/18/91 T.W. Ashley 9/18/91	R. Sahy 12-19-91
Approved	[signature]	[signature]	[signature] 9/18/91	[signature] 12-19-91 12/19/91
Date	2-2-90	3-8-90	9-19-91	C.C. Lyke for McB
List all pages added by this revision.			See rev. Log	SEE REV LOG
List all pages deleted by this revision.			See rev. Log	SEE REV LOG
List all pages changed by this revision.			See rev. Log	SEE REV LOG

Use form TVA 10534 if more space required.

Safety-related? Yes ☒ No ☐

Statement of Problem

Verify adequacy of design and compliance with design criteria and SAR requirements.

ORIGINAL

Abstract

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

This calculation evaluates the adequacy of the 125VDC DG Control Power System for battery sizing, charger sizing, protective device sizing, short circuit and coordination, Appendix R, Reg Guide 1.75 - associated circuits, cascade fuses and maximum voltage to components. Adequacy of minimum voltage to control circuit components is verified through pre-op test TVA-14D.

R1, FSAR Compliance Review [signature] LE 3-8-90 Date

R0, FSAR Compliance Review [signature] ABC/LE 2-2-90 Date

For the total number of pages see the revision Log

☐ Microfilm and store calculations in RIMS Service Center.

☒ Microfilm and return calculations to: Calculation Control Center ~~Amy Young, IOB~~

Microfilm and destroy. ☐ EEB

Address: QAC-IC-WBN EEB

cc: RIMS, SL 26 C-K

TVA

Title: 125VDC DC Control Power System Evaluation	REVISION L(OG) WBN-EEB-MS-TI(1)-0062	
Revision No.	**DESCRIPTION OF REVISION**	**Da(te) Appr(oved)**
0	Initial issue 136 pages. FSAR Review: FSAR Section 8.3 and 9.5.6 were reviewed to verify compliance. The specific values for battery loading require revision to reflect the results of this calculation. Gp 1/29/90 WTH 1/30/90	
1	Affected design inputs were reviewed and were corrected as necessary. Affected engineering judgements and assumptions were reviewed and were revised as necessary to ensure adequacy. Revised the cable insulation damage temperature for polyethylene cable from 125°C to 150°C per R2 of Design Criteria WB-DC-30-13 dated 2/13/90. Revised time-current curves and short circuit values to reflect the change in insulation damage temperature to 150°C. Changed assumption 5.9 to an unverified assumption and expanded the conclusions in paragraph 9.13. There is no impact to the above FSAR review. Pages revised are coversheet, 6, 11, 21, 26, 27, 29, 36, 37, 39, 41, & 45. Total number of pages 136. WJH 3/8/90 Gp 3/8/90	~~DEC 1 9~~

TVA

REVISION LOG

Title: 125VDC DG CONTROL POWER SYSTEM EVALUATION

WBN EEB-MS-TI11-006

Revision No.	DESCRIPTION OF REVISION	Date Approved
2	General text revision incorporating changes for findings from EE's Self-Assessment Program. Revised battery duty cycle and provided justification for use of 50°F as minimum temperature for battery sizing. Revised references. Deleted Attachment 10.9, Cable Pull Cards and provided reference in Table 3.4. This revision supersedes R1 in its entirety; all pages reformatted and renumbered. Total pages R2 = 48. FSAR Section 8.3 requires revision for specific current values of the battery duty cycle. R2 FSAR COMPLIANCE [signature] / 9-19-91 APPROVE / DATE	see cover sheet
3	ADDED ATTACHMENT: P04575A ADDED PAGE: 3B PAGES DELETED: NONE REVISED PAGES: 1, 2A, 4 TOTAL PAGES REV 3: 75 ATTACHMENT P04575A SIZES FUSES FOR THE PRIMING FUEL PUMP MOTORS AND AIR START SOLENOID VALVES. SEE ATTACHMENT SECTION 8 FOR RESULTS. REVIEWED R1 THROUGH R3 TO VERIFY THAT THE UVA'S WERE APPROPRIATELY CONSIDERED FOR THE EFFECT ON DESIGN MARGINS AND THAT THE RESULTS AND CONCLUSIONS ARE UNCHANGED. EXISTING DESIGN MARGINS ARE NOT ADVERSELY AFFECTED BY THIS REVISION AND, THEREFORE, EXISTING DESIGN INPUTS AND PREVIOUSLY MADE ENGINEERING JUDGEMENTS AND ASSUMPTIONS ARE NOT INVALIDATED. FSAR SECTIONS 8.3.1.1 AND 8.3.1.2.2 WERE REVIEWED. NO DISCREPANCIES WERE IDENTIFIED IN THESE SECTIONS. FSAR COMPLIANCE REVIEW C.C. Lyke for MCB DATE 12/19/91	See cover sheet [initials] 12/19/91

TVA 10534 (EN DES-4-78)

TITLE: 125V DC DG CONTROL POWER SYSTEM EVALUATION	REVISION LOG WBN EEB-MS-TI11-0062

REVISION NUMBER	DESCRIPTION OF REVISION	DATE APPROVED
4	ADDED ATTACHMENT S-15660-A (PAGES 1 THRU 7) 1. DOCUMENTED REPLACEMENT FUSE FOR "MIS 1" ADDED PAGES: 1A, 2B, 3C DELETED PAGES: NONE REVISED PAGES: 4 TOTAL PAGES IN ENTIRE CALCULATION: 85 REVIEWED REV. 4 TO VERIFY THAT THE UVA'S WERE APPROPRIATELY CONSIDERED FOR THE EFFECT ON DESIGN MARGINS AND THAT THE RESULTS AND CONCLUSIONS ARE UNCHANGED. EXISTING DESIGN MARGINS ARE NOT ADVERSELY AFFECTED BY THIS REVISION AND, THEREFORE, EXISTING DESIGN INPUTS AND PREVIOUSLY MADE ENGINEERING JUDGEMENTS AND ASSUMPTIONS ARE NOT INVALIDATED. SECTION 8.3.2 OF THE FSAR WAS REVIEWED AND NO DISCREPANCIES IDENTIFIED. m.e.m 3/25/92 R4 FSAR COMPLIANCE REVIEW [signature] 3/30/92 ABC/LE DATE	SEE COVER SHEET m.e.m 3/25/92 [initials] 3-26-92
5	Revised per corrective action for WBPER 920037 to re-evaluate battery and battery charger sizing for corrected dc fuel oil and dc lube oil pump motor starting transients. Added evaluation of KCR-7 replacement cells (DCN M11793A) for capacity only. Revised pages 1A, 2B, 4, 6, 9, 10, 11, 13, 14, 29, 31, 12 Added pages 3D, 12A, 13a-13d, 47-55. Total Pages R5 = 100 Reviewed R5 to verify that the UVA's were appropriately considered for effect on design margins and that the results and conclusions are unchanged. Existing design margins are not adversely affected by this revision and therefore, existing design ~~margins~~ inputs and previously made engineering judgements and assumptions are not invalidated. FSAR section 8.3 was reviewed and does not require changes for this revision. R5 FSAR Compliance C. C. Lyke for MCB / 4/11/92 ABC/LE Date	See cover sheet for approval and date. GP 4/10/92 EJJ 4/10/92

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CALCULATION DESIGN VERIFICATION (INDEPENDENT REVIEW) FORM

WBN-EEB-MS-TI11-0062 — 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.

Reviewed the calculation revision for technical adequacy and reasonableness and found acceptable. The design input data and assumptions were reviewed and found appropriate and reasonable. The calculation methods were based on Branch Technical Instruction EEB-TI-11 R0. The results and conclusions are adequate.

[signature] — Design Verifier (Independent Reviewer)

3/8/90 — Date

CALCULATION DESIGN VERIFICATION (INDEPENDENT REVIEW) FORM

WBN EEB-MS-TI11-0062 — Calculation No.

R2 — 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.

Reviewed R2 for technical adequacy per NEP 3.1 Attachment 10. The design inputs were reviewed and found to be appropriate and reasonable. The results and conclusions are adequate.

William L. Holbert — Design Verifier (Independent Reviewer)

9/18/91 — Date

CALCULATION DESIGN VERIFICATION (INDEPENDENT REVIEW) FORM

WBN EEB-MS-TI11-0062 — Calculation No.

3 — 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.

[signature]
Design Verifier
(Independent Reviewer)

~~12-17-91~~ 12-19-91 J.I.H.
Date

THIS SHEET ADDED BY REV 3

CALCULATION DESIGN VERIFICATION (INDEPENDENT REVIEW) FORM

WBN EEB-MS-TI11-0062	4
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.

[signature] 3-26-92

Design Verifier (Independent Reviewer) Date

THIS SHEET ADDED BY REV 4

CALCULATION DESIGN VERIFICATION (INDEPENDENT REVIEW) FORM

WBN EEBMSTI11 0062 — Calculation No.

R5 — 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 c the calculation and explain how the adequacy was verified (calculation is similar to another, based on accepted handboc 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 calculatic 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.

Independently reviewed calculation WBN EEB-MS-TI11-0062 revision 5 for technical adequacy as addressed in NEP 3.1, Attachment 10

The design input data and assumptions were verified and were found appropriate and reasonable. The methodology, results and conclusions are technically adequate.

E. I. Igharas — Design Verifier (Independent Reviewer)

4/10/92 — Date

TABLE OF CONTENTS Page

R5 GP 4/10/9_ EJJ 4/10/9_

R3 R4 R5 GP 4/10/9_ EJJ 4/1_

1.0 Purpose

The purpose of this calculation is to evaluate the adequacy of the 125VDC Diesel Generator Control Power System for compliance with FSAR and design criteria requirements for the following:

-battery sizing
-battery charger sizing
-protective device sizing
-short-circuit protection and coordination
-Appendix R power supply and associated circuits
-Reg Guide 1.75 associated circuits
-cascade fuse analysis
-voltage to components

2.0 Assumptions

Refer to Section 5.0 for documentation and justification of assumptions.

3.0 References and Sources of Design Input Data

3.1 WBN FSAR Sections 8.3.

3.2 Design Criteria WB-DC-30-27, "AC and DC Control Power Systems",DIMS WB-DC-30-27-1 (B26890324040), WB-30-27-2 (B26900510078).

3.3 WBN Preop Test 14D R0.

3.4 TVA drawings and vendor documents listed in Table 3.4, (page 7).

3.5 DS-E8.1.1 R7,"Substitution Standard for Low-Voltage Power and Control Fuses (600 Volts or Less)".

3.6 IEEE Standard 485 (1978), IEEE Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations".

3.7 SQN Calculation SQN-CPS-007 R0, "Diesel Generator Battery Capacity", B43861210901.

3.8 SQN Calculation SQN-CPS-012 R0, "Diesel Generator Lube Oil Pump Voltage", B43870401904.

3.9 Walkdown data for DG distribution panels included as attachment to meno from R.W. Bradford to H.B. Bounds, dated Nov. 28, 1988, "Watts Bar Nuclear Plant-Unit 1 and 2-Walkdown of Electrical Equipment -Walkdown Procedure WP-37", C24881128629.

3.10 National Electric Code, Chapter 9, Table 8, "Properties of Conductors" (dc resistance at 25°C).

3.11 DS-E12.6.3 R2, "Auxiliary and Control Power Cable Sizing, up to 15,000 Volts".

3.12 Design Criteria WB-DC-30-13 R2, "10 CFR 50, Appendix R, Type I, II, and III Circuits".

3.13 C & D Batteries, Discharge Characteristics, Type DU and DCU (Att. 10.2); Type KCR (Att. 10.12). | R5 GP 4/10/92 EJJ 4/10

3.14 Buss fuse time-current characteristics for KLM and FNM fuses, Form FSB, (Attachments 10.4 and 10.5).

3.15 Square-D FA characteristic curve for 15A breaker, curve no. 650-241, (Attachment 10.3).

3.16 Square-D molded-case circuit breaker catalog data, (Attachment 10.6).

3.17 EEB-TI-7, "AC/DC Short-Circuit Analysis".

3.18 EEB-TI-8, "AC/DC Short-Circuit Protection".

3.19 EE PM87-26 R2, "Cable Length/Impedence to be Used in Electrical Calculations".

3.20 EE PM88-03 R0, "Calculations Which Identify Limiting Conditions".

3.21 IEEE Sed 946-1985, "IEEE Recommended Practice for the Design of Safety-Related DC Auxiliary Power Systems for Nuclear Power Generating Stations".

3.22 Telecopy from MKW Power Systems to TVA (J. Mannone, ESI), start time for DC lube oil pumps.

3.23 Maintenance Request Form A-617680, DC lube oil and DC fuel oil motor starting currents, (Att. 10.10). | R5 GP 4/10/92 EJJ 4/10/92

4.0 Design Input Data

The design input data, provided by sources listed in Section 3.0, is specifically documented in the analysis in Section 6.0.

TABLE 3.4-REFERENCE DRAWINGS

15N210-4 R10
15W814-5 R24
45W727 R9
45W728-1 R6
45W760-82-1 R9,-2 R7,-3 R9,-4 R13,-5 R12,-6 R13,-11 R6,
-12 R5,-13 R8,-14 R8,-15 R7,-16 R5
45W1761-1 R20
45W1762-1 R14
45W1763-1 R19
45W1780-1 R15,-2 R8,-3 R14,-4 R10,-5 R5,-6 R10
45W1781-1 R16,-2 R8,-3 R13,-4 R10,-5 R2,-6 R8
45W1782-1 R8,-2 R6,-3 R6,-4 R7,-5 R2,-6 R7
45W1787-1 R14
45W2761-1 R17
45W2763-1 R19
45W2780-1 R14,-2 R9,-3 R13,-4 R11,-5 R2,-6 R9
45W2781-1 R16,-2 R9,-3 R14,-4 R10,-5 R2,-6 R8
47E235-29 R2,-30 R2

Pull Card Data

PL2512A	PL3336B	PL3349B	PP504A
PL2517A	PL3337B	PL3350B	PP508A
PL2564B	PL3338B	PL3351B	PP622B
PL2569B	PL3339B	PL3354S	PP624B
PL3293S	PL3340A	PL3355S	PP628B
PL3323A	PL3341A	PL3356S	PP742B
PL3329A	PL3342A	PL3357S	PP744B
PL3330A	PL3343A	PL3358S	PP748B
PL3331A	PL3344A	PL3359S	PP1627S
PL3332A	PL3345A	PP382A	PP1628S
PL3333A	PL3346B	PP384A	PP1640S
PL3334B	PL3347B	PP388A	PP1678S
PL3335B	PL3348B	PP502A	PP1880S

Vendor Documents

Contract 83090
DG Manual Vol 1&2,TVA IDs 979,980 (DG 1A-A,1B-B,2A-A,2B-B);DG Manual Vol 1&2,TVA IDs 1548,1549 (DG C-S)
650-242,244;655-241
6036B11010 RC, SH 1-10
6036C04501 RA
C379C11501 R905
6036C11501 R904
6036F07006 RO
6036F07001 RO

5.0 Documentation of Assumptions

5.1 The minimum ambient temperature of the rooms containing the diesel batteries is 50°F.

Justification: TVA drawings 47E235-29R2 and 47E235-30R2 list the average DG room temperature at 75°F and a normal minimum of 50°F. Supplemental heat will be provided to assure the room temperature is 50°F or higher. Ref. DCN M11594A.

5.2 The diesel batteries shall support two start attempts; one at the beginning of its 30 minute duty cycle and the other at the end.

Justification: If the diesel fails to reach 200 rpm within 5 seconds of initial start, a fail to start condition exists and the diesel is locked out, requiring a manual reset for a restart attempt. Experience with the diesel has proven that if it does not start at the initial start command, the time required for response and problem correction is significant such that it is reasonable to assume one subsequent restart attempt in the 30 minute period. Assuming the second attempt occurs in the final minute is conservative.

5.3 It is assumed for short-circuit analysis that the DG battery system voltage is determined by the base emf of the battery at 2.06 volts-per-cell such that the battery voltage used in analysis is 117.4V (57 cells x 2.06V).

Justification: Under short-circuit conditions, the charger voltage declines as the output is current-limited. The use of 2.06 volts per cell will provide conservative results.

5.4 Resistance of components on the 125VDC DG distribution panel such as breakers, fuses, busbars, connections, etc., and the short cables between the battery and the distribution panel is negligible.

Justification: This assumption is conservative since is maximizes short-circuit currents.

5.5 Cable temperature of 25°C is used for short-circuit calculations.

Justification: This assumption is conservative since is maximizes short-circuit currents.

5.6 The battery short-circuit current is ten times the batteries one-minute rate.

Justification: The factor of ten is recommended by EEB-TI-7 and IEEE Std 946-1985 for estimating short-circuit currents.

5.7 Diesel generator field flash current is assumed to be 45 amps.

Justification: Preop test TVA-14D attachment for section 5.4.1.35, records a field flash current at 25.2 amps. 45 amps is an approximate value based on field impedance and is conservative.

5.8 A DG battery minimum terminal voltage of 105VDC is sufficient to support diesel generator start and operation. Preop test TVA-14D will be revised to simulate the battery duty cycle contained in this calculation such that a diesel start is attempted with the battery discharged to 105V.

Justification: FSAR Table 14-2-1, Lists of Preoperational Tests, sheet 139, Test Objectives Summary of Testing and Acceptance Criteria, includes the requirement to verify the capability of the DG batteries to properly supply actual loads. This method was used to successfully verify adequate minimum voltage at SQN in properational test TVA-14DRT1. The SQN diesel control circuits and diesel battery system use the same type components and have similar physical arrangements.

This assumption requires later verification.

5.9 The DG distribution panel main breaker adjustable instantaneous trips are adjusted to the high limit.

Justification: Adjustment to the high limit maximizes selective coordination with the branch circuit breakers. Reference DCN M08699A.

5.10 Deleted. ~~The 1/2 hp fuel oil pumps and the 3/4 hp lube oil each have starting currents of four times full load current.~~ R5 GA 4/1: ES 4/1c

~~Justification: Preop test TVA-14D, section 5.4.1.35, recorded the combined starting currents of the control circuits and fuel oil pumps at 26 amps (the lube oil pumps were not included). This would correlate to value of approximately three times full load current, thus, a factor of four provides margin. Since the lube oil motors are similar in size, type and application, the factor of four is valid approximation for those as well.~~

R5 4/10/92

5.11 The diesel generator control circuits require 2.0 amps.

Justification: 2.0 amps is consistent with the value used SQN's battery sizing calculation (reference 3.7). The SQN value was determined by testing for diesels having similar control circuits.

5.12 Buss KLM3 fuses will be used for the instrument circuit for the DG Distribution Panels. Reference DCN M08699A.

Justification: The Buss KLM3 fuse has an adequate dc rating and will provide selective coordination with the main breaker (section 6.4.3.b).

6.0 Analysis

The design basis of the 125VDC DG control power system is to provide control power for the control and field flashing of the DG sets under normal conditions, a loss of all AC power and any single failure within the DG control power system.

6.1 Battery Sizing

The loss of AC power event imposes the greatest demands on the battery. The design criteria (ref 3.2), section 8.2.1, requires that the batteries supply diesel generator loads - without benefit of chargers - for a period of 30 minutes. The following sequence of events and operating conditions are used in evaluating worst-case battery loading.

Sequence of Events

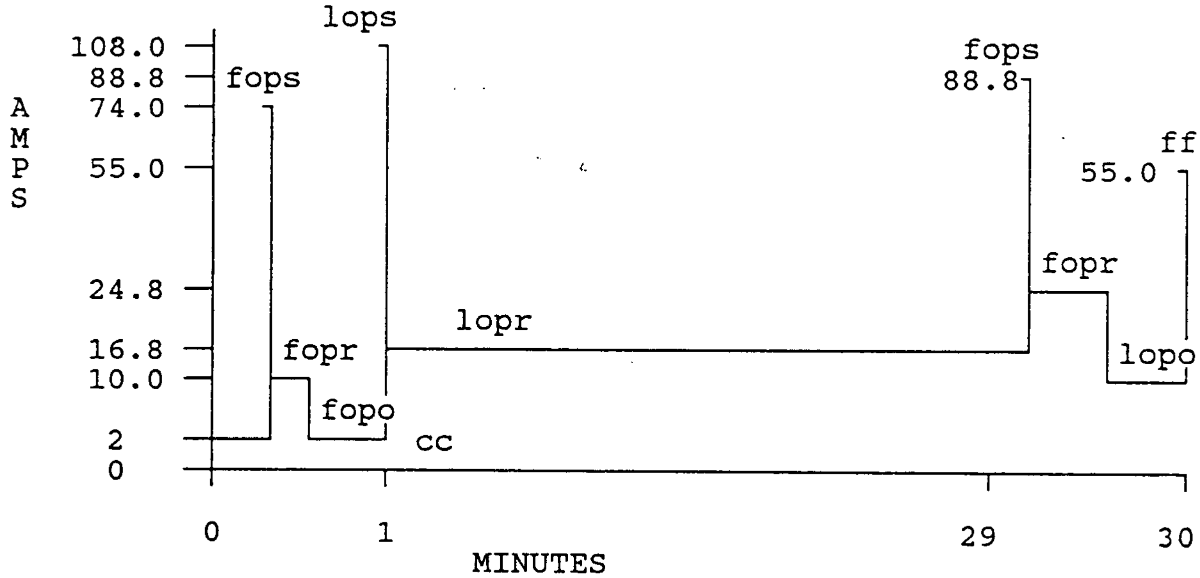
- at time equal 0, an emergency start signal is received by the diesel control circuits
- at time equal 0+, the fuel oil pumps start while the air starting circuits cycle attempting to start the diesel
- at time equal 5.0 seconds, the shutdown relay is actuated terminating the start attempt and causing the fuel oil pumps to stop.
- at time equal 10 to 60 seconds, the lube oil pressure decreases to setpoint causing the dc lube oil pumps to start.
- from time 1 minute, 0 seconds to 29 minutes, 50 seconds; the load consists of the control circuit demand plus two lube oil pump running currents.
- at 29minutes, 50+ seconds, the second start attempt begins with the fuel oil pumps again starting followed by the field flash current. The lube oil pumps are shut off at 450 rpm and the field is flashed at 550 rpm.

Battery Duty Cycle Loads

-control circuits (cc)	2.0a	assumption 5.11, SQN-TVA-14DRT1
-fuel oil pump starting (fops)	36.0a, ea.	reference 3.23, MR A-617680
-fuel oil pump running (fopr)	4.0a, ea.	motor data
-lube oil pump starting (lops)	53.0a, ea.	reference 3.23, MR A-617680
-lube oil pump running (lopr)	7.4a, ea.	motor data
-field flash (ff)	45.0a	assumption 5.7, WBN-TVA-14D

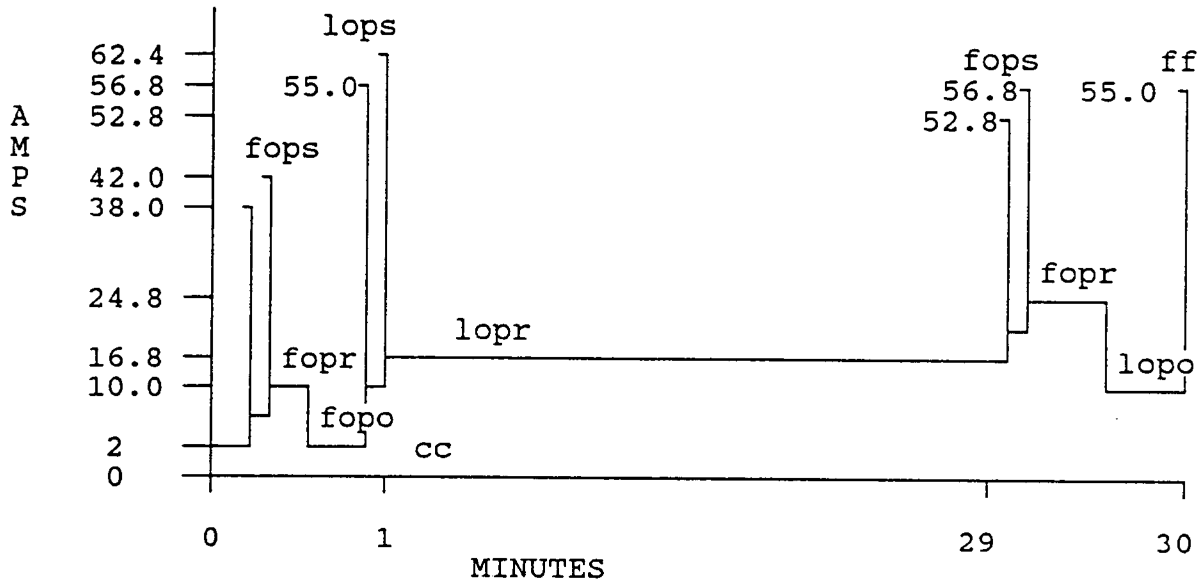
R5 GA 4/10/92 EJJ 4/10/92

Battery Duty Cycle - Simultaneous Motor Starts

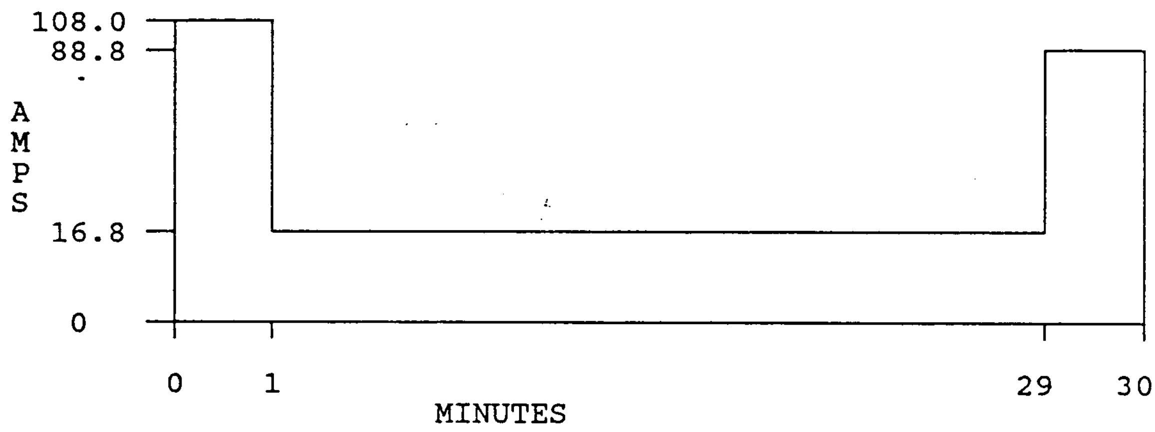


R5 4/10/... EW 4/10

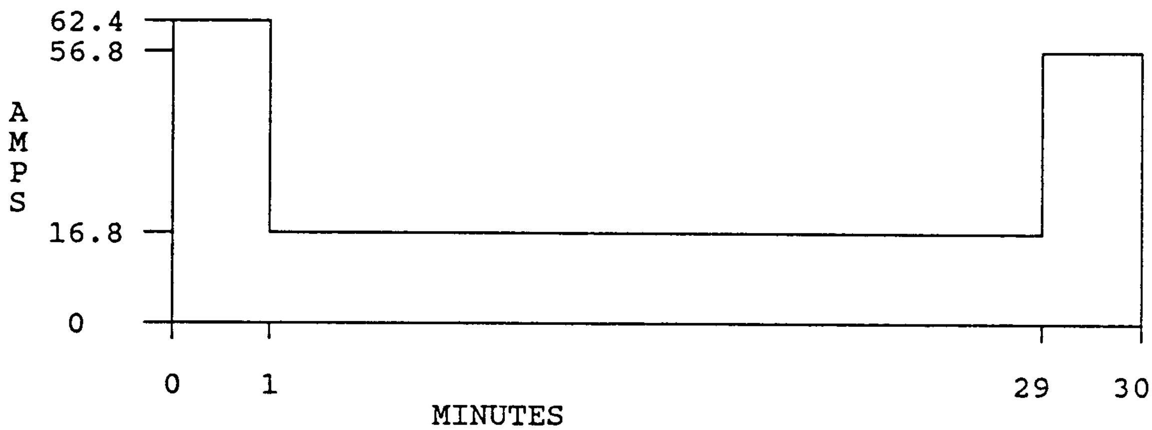
Battery Duty Cycle - Nonsimultaneous Motor Starts



Simplified Duty Cycle - Simultaneous Motor Starts



Simplified Duty Cycle - Nonsimultaneous Motor Starts



The IEEE 485 worksheets are completed using the above simplified battery duty cycle, a 50 F ambient, an aging factor of 1.25, and a minimum cell voltage of 1.84V. Both the 3-DCU-9 battery cell and the KCR-7 battery cell (DCN M11793A) are evaluated. The KCR-7 is evaluated in Section 6.1 only to confirm viability as a replacement.

An alternative worst-case scenario is a successful diesel start on the first attempt with consideration given to DC lube oil pump starting transients concurrent with field flash. Contrary to Attachment 10.9, the DC lube oil pumps started as soon as 2.5 seconds in testing performed at SQN. This could result in a one-minute demand of 161a for simultaneous motor starts and 115.4a for nonsimultaneous motor starts where the loads are the control circuits (2a), the fuel oil pumps (8a), the field flash (45a), and the lube oil pumps (60.4a or 106a). The one-minute rate to 1.84v considering derating factors for temperature and aging is 67.2a for the 3DCU-9 cell and 117.4a for the KCR-7 cell.

CELL SIZING WORKSHEET

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(For Ref. See ESC-291)

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Superseded by Pages 13a for R5

Lowest Expected Electrolyte Temp °F	Minimum Cell Voltage	Cell Mfg:	Cell Type	Sized By
—				

(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T Min Rate (6A) Amps/Pos (R_T) or (6B) K Factor (K_T)	(7) Required Section Size (3) × (6A) = Positive Plates or (3) × (6B) = Rated Amp Hrs — Pos Values	(7) Neg Values
Section 1 — First Period Only — If A2 is greater than A1, go to Section 2.							
1	A1 = 61.2	A1−0 = 61.2	M1 = 1	T=M1 = 1	25	2.45	• • •
					Sec 1 Total	2.45	• • •
Section 2 First Two Periods Only If A3 is greater than A2, go to Section 3							
1	A1 =	A1−0 =	M1 =	T=M1+M2 =			
2	A2 =	A2−A1 =	M2 =	T=M2 =			
					Sec 2 Sub Tot		
					Sec 2 Total		• • •
Section 3 First Three Periods Only If A4 is greater than A3, go to Section 4							
1	A1 = 61.2	A1−0 = 61.2	M1 = 1	T=M1+M2+M3 = 30	14.8	4.14	
2	A2 = 16.8	A2−A1 = −44.4	M2 = 28	T=M2+M3 = 29	14.8		3.00
3	A3 = 55.0	A3−A2 = 38.2	M3 = 1	T=M3 = 1	25	1.53	
					Sec 3 Sub Tot	5.67	3.00
					Sec 3 Total	2.67	• • •
Section 4 First Four Periods Only If A5 is greater than A4, go to Section 5							
1	A1 =	A1−0 =	M1 =	T=M1+ M4 =			
2	A2 =	A2−A1 =	M2 =	T=M2+M3+M4 =			
3	A3 =	A3−A2 =	M3 =	T=M3+M4 =			
4	A4 =	A4−A3 =	M4 =	T=M4 =			
					Sec 4 Sub Tot		
					Sec 4 Total		• • •
Section 5 First Five Periods Only If A6 is greater than A5, go to Section 6							
1	A1 =	A1−0 =	M1 =	T=M1+ M5			
2	A2 =	A2−A1 =	M2 =	T=M2+ M5			
3	A3 =	A3−A2 =	M3 =	T=M3+M4+M5			
4	A4 =	A4−A3 =	M4 =	T=M4+M5			
5	A5 =	A5−A4 =	M5 =	T=M5			
					Sec 5 Sub Tot		
					Sec 5 Total		• • •
Section 6 First Six Periods Only If A7 is greater than A6, go to Section 7							
1	A1 =	A1−0 =	M1 =	T=M1+ M6 =			
2	A2 =	A2−A1 =	M2 =	T=M2+ M6 =			
3	A3 =	A3−A2 =	M3 =	T=M3+ M6 =			
4	A4 =	A4−A3 =	M4 =	T=M4+M5+M6 =			
5	A5 =	A5−A4 =	M5 =	T=M5+M6 =			
6	A6 =	A6−A5 =	M6 =	T=M6 =			
					Sec 6 Sub Tot		
					Sec 6 Total		• • •
Section 7 First Seven Periods Only If A8 is greater than A7, go to Section 8							
1	A1 =	A1−0 =	M1 =	T=M1+ M7 =			
2	A2 =	A2−A1 =	M2 =	T=M2+ M7 =			
3	A3 =	A3−A2 =	M3 =	T=M3+ M7 =			
4	A4 =	A4−A3 =	M4 =	T=M4+ M7 =			
5	A5 =	A5−A4 =	M5 =	T=M5+M6+M7 =			
6	A6 =	A6−A5 =	M6 =	T=M6+M7 =			
7	A7 =	A7−A6 =	M7 =	T=M7 =			
					Sec 7 Sub Tot		
					Sec 7 Total		• • •
Random Equipment Load Only (if needed)							
R	AR =	AR−0 =	MR =	T=MR =			• • •

Maximum Section Size (8) 2.67 + Random Section Size (9) — = Uncorrected Size (US) (10) 2.67

US (11) 2.67 × Temp Corr (12) 1.19 × Design Marg (13) 1.00 × Aging Factor (14) 1.25 = (15) 3.97

When the cell size (15) is greater than a standard cell size, the next larger cell is required.

Required cell size (16) 4 (A) — Positive Plates.

(B) — ~~Ampere Hours. Therefore cell (17) — is required.~~

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CELL SIZING WORKSHEET

(For Ref. See ESC-291)

Project Watts Bar Nuclear Plant Date Page

Lowest Expected Electrolyte Temp °F 50 Minimum Cell Voltage 1.84 Cell Mfg. C&D Cell Type 3DCU-9 Sized By

(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T Min Rate (6A) Amps/Pos (R_T) or (6B) K Factor (K_T)	(7) Required Section Size (3) × (6A) = Positive Plates or (3) × (6B) = Rated Amp Hrs — Pos Values	Neg Values
Section 1 — First Period Only — If A2 is greater than A1, go to Section 2.							
1	A1 = 108.0	A1−0 = 108.0	M1 = 1	T = M1 = 1	25	4.32	•••
					Sec 1 Total	4.32	•••
Section 2 First Two Periods Only If A3 is greater than A2, go to Section 3							
1	A1 =	A1−0 =	M1 =	T = M1 + M2 =			
2	A2 =	A2−A1 =	M2 =	T = M2 =			
					Sec 2 Sub Tot		
					Total		•••
Section 3 First Three Periods Only If A4 is greater than A3, go to Section 4							
1	A1 = 108.0	A1−0 = 108.0	M1 = 1	T = M1 + M2 + M3 = 30	14.8	7.30	
2	A2 = 16.8	A2−A1 = −91.2	M2 = 28	T = M2 + M3 = 29	14.8		−6.16
3	A3 = 88.8	A3−A2 = 72	M3 = 1	T = M3 = 1	25	2.88	
					Sec 3 Sub Tot	10.18	−6.16
					Total	4.02	•••
Section 4 First Four Periods Only If A5 is greater than A4, go to Section 5							
1	A1 =	A1−0 =	M1 =	T = M1 + M4 =			
2	A2 =	A2−A1 =	M2 =	T = M2 + M3 + M4 =			
3	A3 =	A3−A2 =	M3 =	T = M3 + M4 =			
4	A4 =	A4−A3 =	M4 =	T = M4 =			
					Sec 4 Sub Tot		
					Total		•••
Section 5 First Five Periods Only If A6 is greater than A5, go to Section 6							
1	A1 =	A1−0 =	M1 =	T = M1 + M5			
2	A2 =	A2−A1 =	M2 =	T = M2 + M5 =			
3	A3 =	A3−A2 =	M3 =	T = M3 + M4 + M5			
4	A4 =	A4−A3 =	M4 =	T = M4 + M5			
5	A5 =	A5−A4 =	M5 =	T = M5			
					Sec 5 Sub Tot		
					Total		•••
Section 6 First Six Periods Only If A7 is greater than A6, go to Section 7							
1	A1 =	A1−0 =	M1 =	T = M1 + M6 =			
2	A2 =	A2−A1 =	M2 =	T = M2 + M6 =			
3	A3 =	A3−A2 =	M3 =	T = M3 + M6 =			
4	A4 =	A4−A3 =	M4 =	T = M4 + M5 + M6 =			
5	A5 =	A5−A4 =	M5 =	T = M5 + M6 =			
6	A6 =	A6−A5 =	M6 =	T = M6 =			
					Sec 6 Sub Tot		
					Total		•••
Section 7 First Seven Periods Only If A8 is greater than A7 go to Section 8							
1	A1 =	A1−0 =	M1 =	T = M1 + M7 =			
2	A2 =	A2−A1 =	M2 =	T = M2 + M7 =			
3	A3 =	A3−A2 =	M3 =	T = M3 + M7 =			
4	A4 =	A4−A3 =	M4 =	T = M4 + M7 =			
5	A5 =	A5−A4 =	M5 =	T = M5 + M6 + M7 =			
6	A6 =	A6−A5 =	M6 =	T = M6 + M7 =			
7	A7 =	A7−A6 =	M7 =	T = M7 =			
					Sec 7 Sub Tot		
					Total		•••
Random Equipment Load Only (if needed)							
R	AR =	AR−0 =	MR =	T = MR =			•••

Maximum Section Size (8) 4.32 + Random Section Size (9) 0 = Uncorrected Size (US) (10) 4.32

US (11) 4.32 × Temp Corr (12) 1.19 × Design Marg (13) 1.00 × Aging Factor (14) 1.25 = (15) 6.43

When the cell size (15) is greater than a standard cell size, the next larger cell is required.

Required cell size (16) 7 (A) — Positive Plates.

~~(B) — Ampere Hours.~~ Therefore cell (17) ______ is required.

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CELL SIZING WORKSHEET

(For Ref. See ESC-291)

Project *Watts Bar Nuclear Plant* Date Page

Lowest Expected Electrolyte Temp °F *50* Minimum Cell Voltage *1.84* Cell Mfg: *C&D* Cell Type *3DCU-9* Sized By:

(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T Min Rate (6A) Amps/Pos (R_T) or (6B) K Factor (K_T)	(7) Required Section Size (3) (6A) = Positive Plates or (3) × (6B) = Rated Amp Hrs — Pos Values	Neg Values

Section 1 — First Period Only – If A2 is greater than A1, go to Section 2.

Period	Load	Change in Load	Duration	Time to End	Capacity	Pos Values	Neg Values
1	A1 = *62.4*	A1−0 = *62.4*	M1 = *1*	T=M1 = *1*	*25*	*2.50*	• • •
					Sec 1 Total		• • •

Section 2 First Two Periods Only If A3 is greater than A2, go to Section 3

Period	Load	Change in Load	Duration	Time to End	Capacity	Pos Values	Neg Values
1	A1 =	A1−0 =	M1 =	T=M1+M2=			
2	A2 =	A2−A1 =	M2 =	T=M2=			
					Sec 2 Sub Tot		
					Total		• • •

Section 3 First Three Periods Only If A4 is greater than A3, go to Section 4

Period	Load	Change in Load	Duration	Time to End	Capacity	Pos Values	Neg Values
1	A1 = *62.4*	A1−0 = *62.4*	M1 = *1*	T=M1+M2+M3= *30*	*14.8*	*4.22*	
2	A2 = *16.8*	A2−A1 = *45.6*	M2 = *28*	T=M2+M3= *29*	*14.8*		*3.08*
3	A3 = *56.8*	A3−A2 = *40*	M3 = *1*	T=M3= *1*	*25*	*1.60*	
					Sec 3 Sub Tot	*5.82*	*3.08*
					Total	*2.74*	• • •

Section 4 First Four Periods Only If A5 is greater than A4, go to Section 5

Period	Load	Change in Load	Duration	Time to End	Capacity	Pos Values	Neg Values
1	A1 =	A1−0 =	M1 =	T=M1+ M4=			
2	A2 =	A2−A1 =	M2 =	T=M2+M3+M4=			
3	A3 =	A3−A2 =	M3 =	T=M3+M4=			
4	A4 =	A4−A3 =	M4 =	T=M4=			
					Sec 4 Sub Tot		
					Total		• • •

Section 5 First Five Periods Only If A6 is greater than A5, go to Section 6

Period	Load	Change in Load	Duration	Time to End	Capacity	Pos Values	Neg Values
1	A1 =	A1−0 =	M1 =	T=M1+ M5			
2	A2 =	A2−A1 =	M2 =	T=M2+ M5			
3	A3 =	A3−A2 =	M3 =	T=M3+M4+M5			
4	A4 =	A4−A3 =	M4 =	T=M4+M5			
5	A5 =	A5−A4 =	M5 =	T=M5			
					Sec 5 Sub Tot		
					Total		• • •

Section 6 First Six Periods Only If A7 is greater than A6, go to Section 7

Period	Load	Change in Load	Duration	Time to End	Capacity	Pos Values	Neg Values
1	A1 =	A1−0 =	M1 =	T=M1+ M6=			
2	A2 =	A2−A1 =	M2 =	T=M2+ M6=			
3	A3 =	A3−A2 =	M3 =	T=M3+ M6=			
4	A4 =	A4−A3 =	M4 =	T=M4+M5+M6=			
5	A5 =	A5−A4 =	M5 =	T=M5+M6=			
6	A6 =	A6−A5 =	M6 =	T=M6=			
					Sec 6 Sub Tot		
					Total		• • •

Section 7 First Seven Periods Only If A8 is greater than A7, go to Section 8

Period	Load	Change in Load	Duration	Time to End	Capacity	Pos Values	Neg Values
1	A1 =	A1−0 =	M1 =	T=M1+ M7=			
2	A2 =	A2−A1 =	M2 =	T=M2+ M7=			
3	A3 =	A3−A2 =	M3 =	T=M3+ M7=			
4	A4 =	A4−A3 =	M4 =	T=M4+ M7=			
5	A5 =	A5−A4 =	M5 =	T=M5+M6+M7=			
6	A6 =	A6−A5 =	M6 =	T=M6+M7=			
7	A7 =	A7−A6 =	M7 =	T=M7=			
					Sec 7 Sub Tot		
					Total		• • •

Random Equipment Load Only (if needed)

R	AR=	AR−0=	MR=	T=MR=			• • •

Maximum Section Size (8) *2.74* + Random Section Size (9) *0* = Uncorrected Size - (US) (10) *2.74*
US (11) *2.74* × Temp Corr (12) *1.19* × Design Marg (13) *1.00* × Aging Factor (14) *1.25* = (15) *4.08*
When the cell size (15) is greater than a standard cell size, the next larger cell is required.

Required cell size (16) *4* (A) — Positive Plates.
~~(B) — Ampere Hours~~. Therefore cell (17) ______ is required.

CELL SIZING WORKSHEET

(For Ref. See ESC-291)

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Project *Watts Bar Nuclear Plant* Date *4/7/92* Page

Lowest Expected Electrolyte Temp °F *50* Minimum Cell Voltage *1.84* Cell Mfg. *C&D* Cell Type *KCR-7* Sized By

(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T Min Rate (6A) Amps/Pos (R_T) or (6B) K Factor (K_T)	(7) Required Section Size (3) (6A) = Positive Plates or (3) × (6B) = Rated Amp Hrs — Pos Values	Neg Values

Section 1 — First Period Only — If A2 is greater than A1, go to Section 2.

1	A1 = *108.0*	A1−0 = *108.0*	M1 = *1*	T = M1 = *1*	*51(1.141) = 58.2*	*1.86*	• • •
					Sec 1 Total	*1.86*	• • •

Section 2 First Two Periods Only If A3 is greater than A2, go to Section 3

1	A1 =	A1−0 =	M1 =	T = M1 + M2 =			
2	A2 =	A2−A1 =	M2 =	T = M2 =			
					Sec 2 Sub Tot		
					Total		• • •

Section 3 First Three Periods Only If A4 is greater than A3, go to Section 4

1	A1 = *108.0*	A1−0 = *108.0*	M1 = *1*	T = M1 + M2 + M3 = *30*	*40(1.141) = 45.6*	*2.37*	
2	A2 = *16.8*	A2−A1 = *−91.2*	M2 = *28*	T = M2 + M3 = *29*	*40(1.141) = 45.6*		*2.00*
3	A3 = *88.8*	A3−A2 = *72*	M3 = *1*	T = M3 = *1*	*51(1.141) = 58.2*	*1.24*	
					Sec 3 Sub Tot	*3.61*	*2.00*
					Total	*1.61*	• • •

Section 4 First Four Periods Only If A5 is greater than A4, go to Section 5

1	A1 =	A1−0 =	M1 =	T = M1 + M4 =			
2	A2 =	A2−A1 =	M2 =	T = M2 + M3 + M4			
3	A3	A3−A2 =	M3 =	T = M3 + M4 =			
4	A4 =	A4−A3 =	M4 =	T = M4 =			
					Sec 4 Sub Tot		
					Total		• • •

Section 5 First Five Periods Only If A6 is greater than A5, go to Section 6

1	A1 =	A1−0 =	M1 =	T = M1 + M5			
2	A2 =	A2−A1 =	M2 =	T = M2 + M5 =			
3	A3 =	A3−A2 =	M3 =	T = M3 + M4 + M5			
4	A4 =	A4−A3 =	M4 =	T = M4 + M5			
5	A5 =	A5−A4 =	M5 =	T = M5			
					Sec 5 Sub Tot		
					Total		• • •

Section 6 First Six Periods Only If A7 is greater than A6, go to Section 7

1	A1 =	A1−0 =	M1 =	T = M1 + M6 =			
2	A2 =	A2−A1 =	M2 =	T = M2 + M6 =			
3	A3 =	A3−A2 =	M3 =	T = M3 + M6 =			
4	A4 =	A4−A3 =	M4 =	T = M4 + M5 + M6 =			
5	A5 =	A5−A4 =	M5 =	T = M5 + M6 =			
6	A6 =	A6−A5 =	M6 =	T = M6 =			
					Sec 6 Sub Tot		
					Total		• • •

Section 7 First Seven Periods Only If A8 is greater than A7 go to Section 8

1	A1 =	A1−0 =	M1 =	T = M1 + M7 =			
2	A2 =	A2−A1 =	M2 =	T = M2 + M7 =			
3	A3 =	A3−A2 =	M3 =	T = M3 + M7 =			
4	A4 =	A4−A3 =	M4 =	T = M4 + M7 =			
5	A5 =	A5−A4 =	M5 =	T = M5 + M6 + M7 =			
6	A6 =	A6−A5 =	M6 =	T = M6 + M7 =			
7	A7 =	A7−A6 =	M7 =	T = M7 =			
					Sec 7 Sub Tot		
					Total		• • •

Random Equipment Load Only (if needed)

R	AR =	AR−0 =	MR =	T = MR =			• • •

Maximum Section Size (8) *1.86* + Random Section Size (9) *0* = Uncorrected Size (US) (10) *1.86*
US (11) *1.86* × Temp Corr (12) *1.19* × Design Marg (13) *1.00* × Aging Factor (14) *1.25* = (15) *2.77*
When the cell size (15) is greater than a standard cell size, the next larger cell is required.

Required cell size (16) *3* (A) — Positive Plates.

(B) — Ampere Hours. Therefore cell (17) ______ is required.

CELL SIZING WORKSHEET

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Project Watts Bar Nuclear Plant   Date

Lowest Expected Electrolyte Temp °F 50   Minimum Cell Voltage 1.84   Cell Mfg. C&D   Cell Type KCR-7   Sized By

(1) Period	(2) Load (amperes)	(3) Change in Load (amperes)	(4) Duration of Period (minutes)	(5) Time to End of Section (minutes)	(6) Capacity at T Min Rate (6A) Amps/Pos (R_T) or (6B) K Factor (K_T)	(7) Required Section Size (3) (6A) = Positive Plates or (3) x (6B) = Rated Amp Hrs — Pos Values	Neg Values

Section 1 — First Period Only — If A2 is greater than A1, go to Section 2.

1	A1 = 62.4	A1−0 = 62.4	M1 = 1	T=M1 = 1	51(1.141) = 58.2	1.07	•••
					Sec 1 Total	1.07	•••

Section 2 First Two Periods Only If A3 is greater than A2, go to Section 3

1	A1 =	A1−0 =	M1 =	T=M1+M2 =			
2	A2 =	A2−A1 =	M2 =	T=M2 =			
					Sec 2 Sub Tot		
					Total		•••

Section 3 First Three Periods Only If A4 is greater than A3, go to Section 4

1	A1 = 62.4	A1−0 = 62.4	M1 = 1	T=M1+M2+M3 = 30	40(1.141) = 45.6	1.37	
2	A2 = 16.8	A2−A1 = 45.6	M2 = 28	T=M2+M3 = 29	40(1.141) = 45.6		1.00
3	A3 = 56.8	A3−A2 = 40	M3 = 1	T=M3 = 1	51(1.141) = 58.2	0.69	
					Sec 3 Sub Tot	2.06	1.00
					Total	1.06	•••

Section 4 First Four Periods Only If A5 is greater than A4, go to Section 5

1	A1 =	A1−0 =	M1 =	T=M1+ M4 =			
2	A2 =	A2−A1 =	M2 =	T=M2+M3+M4 =			
3	A3 =	A3−A2 =	M3 =	T=M3+M4 =			
4	A4 =	A4−A3 =	M4 =	T=M4 =			
					Sec 4 Sub Tot		
					Total		•••

Section 5 First Five Periods Only If A6 is greater than A5, go to Section 6

1	A1 =	A1−0 =	M1 =	T=M1+ M5			
2	A2 =	A2−A1 =	M2 =	T=M2+ M5			
3	A3 =	A3−A2 =	M3 =	T=M3+M4+M5			
4	A4 =	A4−A3 =	M4 =	T=M4+M5			
5	A5 =	A5−A4 =	M5 =	T=M5			
					Sec 5 Sub Tot		
					Total		•••

Section 6 First Six Periods Only If A7 is greater than A6, go to Section 7

1	A1 =	A1−0 =	M1 =	T=M1+ M6 =			
2	A2 =	A2−A1 =	M2 =	T=M2+ M6 =			
3	A3 =	A3−A2 =	M3 =	T=M3+ M6 =			
4	A4 =	A4−A3 =	M4 =	T=M4+M5+M6 =			
5	A5 =	A5−A4 =	M5 =	T=M5+M6 =			
6	A6 =	A6−A5 =	M6 =	T=M6 =			
					Sec 6 Sub Tot		
					Total		•••

Section 7 First Seven Periods Only If A8 is greater than A7, go to Section 8

1	A1 =	A1−0 =	M1 =	T=M1+ M7 =			
2	A2 =	A2−A1 =	M2 =	T=M2+ M7 =			
3	A3 =	A3−A2 =	M3 =	T=M3+ M7 =			
4	A4 =	A4−A3 =	M4 =	T=M4+ M7 =			
5	A5 =	A5−A4 =	M5 =	T=M5+M6+M7 =			
6	A6 =	A6−A5 =	M6 =	T=M6+M7 =			
7	A7 =	A7−A6 =	M7 =	T=M7 =			
					Sec 7 Sub Tot		
					Total		•••

Random Equipment Load Only (if needed)

R	AR =	AR−0 =	MR =	T=MR =			•••

Maximum Section Size (8) 1.06 + Random Section Size (9) 0 = Uncorrected Size (US) (10) 1.06

US (11) 1.06 x Temp Corr (12) 1.19 x Design Marg (13) 1.00 x Aging Factor (14) 1.25 = (15) 1.58

When the cell size (15) is greater than a standard cell size, the next larger cell is required.

Required cell size (16) 2 (A) — Positive Plates.

(B) ~~— Ampere Hours.~~ Therefore cell (17) ______ is required.

6.2 Charger Sizing

DG battery 2B-B configured with 57 C&D DCU cells was tested during the performance of Preop Test TVA-14D. Control loads during standby and run were measured and recorded in test section 5.4.1.35.

Inspection of the recording provides the following:

1. Control load current during standby is 2.0 amps.
2. Control load current during run is 10.0 amps. This includes fuel oil pumps but not lube oil pumps.

The charger is required to continuously supply all steady state loads and maintain the batteries in the design maximum charged state or to fully recharge the batteries from the design minimum discharge state within an acceptable time interval. No specific time requirement is given in either FSAR Section 8.3 or Design Criteria WB-DC-30-27, section 8.2.2.2.

The ampere-hours to be recharged are taken from the worst-case simplified duty cycle in Section 6.1:

$$AH = 108.0(1/60) + 16.8(28/60) + 88.8(1/60) = 11.12$$

R5 op 4/10/92 EB 4/10/92

The battery charger supplied for the DG battery system is a LaMarche A11-20-130V-C3, having a continuous output current rating of 20 amps. The battery recharge time is calculated as follows:

$$I_{ch} = I_{load} + (1.1)(AH)/T$$

$$T = (1.1)(AH)/(I_{ch}-I_{load}) = (1.1)(11.12)/(20 - 10.0) = 1.22 \text{ hrs}$$

R5 op 4/10/92 EB 4/10/92

The battery recharge time is slightly over one hour. In comparison, the recharge time for the 125VDC Vital Batteries is 36 hours following a plant blackout and 12 hours following an accident with a 30 minute AC power outage.

6.3 Protective Device Sizing

The main and branch circuit protective devices on the 125VDC DG distribution panels should be sized such that continuous load current does not exceed 80% of the trip (or fuse) rating and that circuit transients should not cause the device to actuate.

The 125VDC DG Distribution Panel protective devices are tabulated as follows:

-main breaker	150a,	SQD KAP26150
-main fuses	150a,	Buss NON150
-engine cont pnl	20a,	SQD FA26020
-gen prot relays	20a,	SQD FA26020
-excitation	80a,	SQD FA26080
-battery charger	20a,	SQD FA26020
-dc lube oil pumps	20a,	SQD FA26020
-swgr cntrl (5th diesel)	20a,	SQD FA26020

From sections 6.1 and 6.2, the total continuous load on all DG control circuits was 10.0 amps. Since this is less than 80% of the smallest breaker (20a), all DG control branch circuit breakers are acceptable for continous loading.

The branch circuit breaker for the excitation controls is 80a. Since the field flash is 45a, this breaker is properly sized for transient conditions.

The breaker for the dc lube oil pumps is 20a. This circuit supplies the pump motors which experience a transient current of less than 59.2a (four times full load current). Since the Square D type FA circuit breakers have time-delay overload trip characteristics, it is acceptably sized.

The breaker for the battery charger is 20a. Since the battery charger rated output current is 20a and is current-limited at 140% (28a) this breaker is not acceptable.

The total continuous current and maximum transient currents are less than 80% of the continuous ratings of the main breaker and fuse, thus, these devices are also acceptable.

6.4 Short Circuit Protection and Coordination

The 125VDC Diesel Generator Control Power System is to be designed to provide adequate short circuit protection and coordinated in accordance with the following criteria from WB-DC-30-27, paragraph 8.2.6:

- -Protective devices shall be rated to properly interrupt maximum fault current.
- -Each circuit shall be protected by a thermal-magnetic circuit breaker.

-The battery charger input breaker shall be considered a branch circuit.
-The battery input circuit shall be protected by a thermal-magnetic breaker and a coordinated fuse.

6.4.1 Computation of Maximum Short Circuit Current

Battery(I_{bsc})- Battery one-minute rate for 3DCU-9 cell is 148a (one-minute rate to 1.75vpc). The short circuit current is ten times the one-minute rate, or 1480 amps.

Battery Charger(I_{bcsc})- The battery charger is current-limited to 140% of full load current or 28a.

Motor Contribution(I_{msc}) - The short circuit current provided by the motors is based on the sum of the horsepower ratings of both fuel oil pump motors and both lube oil pump motors, or 2 1/2 hp.

$I_{msc} = v/R'd$, where v is rated voltage and R'd is the transient armature resistance
$R'd = (r'd)(R)$; r'd is the per unit transient armature resistance
$R = v^2/(hp)(746w/hp) = (125)^2/(2.5)(746)$

$r'd = 0.07$, from EEB-TI-07, section 7.5.2
$R'd = 0.07(125)^2/(2.5)(746) = 213a$

Total Short Circuit Current -

$$I_{sc} = I_{bsc} + I_{bcsc} + I_{msc}$$
$$= 1480 + 28 + 213 = 1721a$$

6.4.2 Evaluation of Protective Device Ratings - DG Distribution Panel

component	type	rating(aic)
main cb	SQD KAP26150	10,000 @ 250VDC
main fuse	BUSS NON150	10,000 @ 250VDC*
branch cb	SQD FA26100	10,000 @ 250VDC
branch cb	SQD FA26080	10,000 @ 250VDC
branch cb	SQD FA26020	10.000 @ 250VDC
chgr out cb	West EB2035	5,000 @ 250VDC
instr fuse	BUSS KTK3	no dc rating

All protective components on the DG distribution panel have adequate interrupting ratings except for the fuses for the nonsafety-related instrumentation circuits which are not rated for dc applications.

6.4.3 Coordination of DG Distribution Panel Protective Devices

a. Branch Circuits - Selective coordination between the branch circuit breakers and the main circuit breaker or fuse is desirable but not essential for all possible fault current values. The cables and loads involved are all located within their respective diesel generator room and will be exposed only to the hazards/failures within that room. Since the cables remain within their respective diesel generator room, any failure/event requiring protective actuation of the circuit breakers is bounded by the single failure criteria.

From SQD curve #655-241 (Figure 7.3), the minimum pickup at the high limits setting of the magnetic element of the type KA main breaker is 8-times rated current, or 1200a. Although selective coordination will be lost for any fault in excess of that value, that is acceptable.

b. Instrument Circuit - Since the fused circuit to the panel instrumentation is nonsafety-related, selective coordination is required between the fuse and the main circuit breaker. (Note: the shunt circuits, inherently energy limited and in a single pole, do not pose a protection concern). The Buss KTK3 fuse used in the circuit as determined by walkdown does not have a dc rating. The dc-rated counterpart is the Buss KLM3 which has the same time-current characteristic and is analyzed in the following:

Verification of selective coordination between the main breaker and the KLM3 fuse is accomplished by verifying coordination first with the Littelfuse FLAS5 for which data is available for peak let-through current for times less than 0.01 seconds, then demonstrating that the Buss KLM3 is more current-limiting. Peak let-through current testing performed on the FLAS5 as documented by memorandum from Richard L.

Morley, Chief, Central Laboratories Services Branch to W. S. Raughley, Chief, Electrical Engineering Branch, "Peak Let Through Current Test", dated October 27, 1987 (E13871027167), provided fuse charateristics for time periods less than 0.01 seconds. From Table I, of the test report, it was determined that the fuse would clear a 3400a fault with a peak let-through current of less than 300a at a time less than 0.800 milliseconds. This point would be on the fuses total clearing time curve and the fuse characteristic can be interpolated from 0.01 seconds from published curves to the 0.008 seconds from the test. Comparison of the FLAS5 fuse and SQD KA26150 curve indicates a substantial margin of coordination as shown in Figure 7.4. Comparison of the KLM3 fuse curve with the FLAS5 in the 0.01 seconds to 100.0 seconds time period indicates that the KLM3 is more current-limiting. It is therefore concluded that coordination of the main breaker with a Buss KLM3 fuse is verified.

6.4.4 Cable Insulation Damage

Evaluation of branch circuit cables for protection from cable insulation damage is accomplished by comparison of the branch circuit time-current curves with the cable damage curves as determined by IPCEA formula for copper cables:

$$(I/A)^2 t = 0.0297 \log_{10}(T_f+234/T_o+234)$$

where I = short circuit current in amperes
A = conductor csa in circular mils
t = time of short circuit current in seconds
T_o = max operating temp - ^oC
T_f = cable damage temp - ^oC
for 75^oC cable, Tf = 150^oC
90^oC cable, Tf = 250^oC

CABLE INSULATION DAMAGE CURRENT

mk no	size	T_o	csa	t=0.010	t=0.016	t=0.10	t=1.0	t=10.0
	#14	75	4110	2176	1720	688	218	69
wgb-1, wlb	#12	90	6530	4698	3714	1486	470	149
wfb	#10	75	10380	5495	4344	1738	550	174
wfb-1	#10	90	10380	7468	5904	2362	747	236
	#2	75	66360	35132	27775	11110	3513	1111
wdg, wdg-1	#2	90	66360	47746	37746	15098	4775	1510

Figures 7.1a, 7.1b and 7.2 show the cable insulation damage curves plotted with the branch and main circuit breaker curves. Figures 7.1a and 7.1b show that a SQD FA26020 will prevent cable insulation damage for all possible ranges of fault current for the #12 and #10 cables. Figure 7.2 shows that a SQD FA26080 will similarly protect #2 cables.

6.4.5 Appendix R

Design Criteria WB-DC-30-13 requires an evaluation to ensure that the upstream protective devices that supply a board or panel will not trip as a result of a high impedence fault. The condition to be evaluated is the total current loading of all the normal loads that could be operating plus all required Appendix R loads plus a high impedence fault on the largest non-required Appendix R load. For the faulted non-required load, the current drawn is just below the continuous rating of the protective device.

Review of the diesel generator control circuits indicates that only the alarms are non-required Appendix R circuits. All other circuits are required. From drawing D379F02501 sh3 and 6036F02501 sh3, the alarm circuits are supplied through a 10a fuse. The total continuous current measured during diesel operation is SQN preop test TVA-14DRT1 (see Assumption 5.11) was 2.0a. Using the 2.0a value for the engine controls plus 10a for the faulted alarm relay circuit would be 12a which is less than the 20a rating of the branch circuit breaker.

6.4.6 Reg Guide 1.75 - Associated Circuits

From review of the DG control schematics and connection diagrams, associated circuits were identified in the alarm circuits of the engine controls. The alarm portion of the engine controls is fused with Buss FNM10 fuses in DG 1A-A, 1B-B, 2A-A and 2B-B and fused with Buss KLM10 fuses in DG C-S. Figure 7.4 shows that these fuses are sufficient to prevent insulation damage in the associated circuits. The cables identified as associated circuits for each DG are #14. The cable damage curve is taken from data from section 6.4.4.

6.4.7 Cascade Fuse Analysis

From section 6.4.6, the alarm circuit portion of the engine controls are associated circuits and as such, are required to have short circuit protection which which isolates them from the balance of the engine control circuits.

The alarm circuit is fused with Buss FMN10 fuses in DG 1A-A, 2A-A, 1B-B, and 2B-B and Buss KLM10 fuses in DG C-S. These fuses are in series with a SQD FA22015 circuit breaker. The engine controls are supplied by a SQD FA26020 circuit breaker located in the DG distribution panel. The trip/fuse characteristics are plotted in Figure 7.4.

From figure 7.4, it is seen that there is no selective coordination above 180a due to overlap between the 20a breaker and the 15a breaker or 10a fuses. Short circuit current at the engine control panel is calculated:

Equivalent source impedence, Z_s, equals the supply voltage divided by the maximum available short circuit current from section 6.1 Z_s = 117.4/1721a = 0.0682

Cable impedence using straight line

distance betwween the DG distribution panel and the engine control panel for 30 feet of #10 cable at 25°C, Z_c;

Z_c = 2(30)(1.04 /1000) = 0.0624 (ref 3.19, 15N210-4)

Short circuit current at the control panel,

$I_{sc} = 117.4v/(Z_s+Z_c) = 117.4v/(0.0630+0.0624) = 936a$

Thus selective coordination does not exist for worst-case conditions.

6.5 Voltage Analysis

6.5.1 Minimum Voltage to Components

Adequate minimum voltage for functioning of of essential components under worst-case operating conditions wiill be verified through preoperational test TVA-14D in accordance with Assumption 5.8.

6.5.2 Maximum Voltage to Components

Exceeding component maximum voltage ratings is a concern during battery equalizing. The overall battery voltage during equalizing is 132.8v (2.33vpc x 57 cells).

The diesel generator control circuits were reviewed to identify all type components which may be continuously energized during diesel standby and run modes. Components having only momentary actuations were excluded. The identified components with their nominal and maximum values are listed in Table 6.5.2.

Review of the component maximum voltage ratings indicates that all exceed battery equalizing voltage except the contactor and control relay used in the DC lube oil pump circuits. Their rating is 132v versus the equalizing voltage of 132.8v. This difference in voltage is negligible since (1) the difference in voltage is small, (2) the voltage drop in supply cables was not considered, (3) the diesel generators are run during testing only two hours per month and (4) battery equalizing occurs infrequently.

TABLE 6.5.2

component	nom volt	max volt	note
Square D KPD-13 relay	120v	140v	1
Agastat 7012 TD relay	120v	140v	1
Agastat 7022 TD relay	120v	140v	1
West. MG-6 relay	125v	137.5v	2
GE HGA relay	125v	137.5v	2
Square D HCO-1 contactor	120v	140v	1
Synchrostart speedswitch		140v	1
Dynalco speedswitch	125v	137.5v	2
West. KLF-1 relay	125v	137.5v	2
GE IAV relay		140v	1
Potter-Brumfield MDR-5065-1		140v	1
DC lube oil pump motor	125v	137.5v	2
Square D HCO-2 contactor	120v	132v	3,2
Square D KPD-13 relay	120v	132v	3,2
DC fuel oil pump motor	125v	137.5v	2
Woodward governor control	125v	137.5v	2

Notes:
1. Maximum value per Engine-Generator Control Panel Material List, 6036B11010 RC, Sheets 1-10.
2. Maximum value per standard +10% rating.
3. Components identified on 15W814-5 R24.

7.0 Supporting Graphics

Figure 7.1A Prep: GP 1/29/90 Check: WSH

FA CHARACTERISTIC CURVE

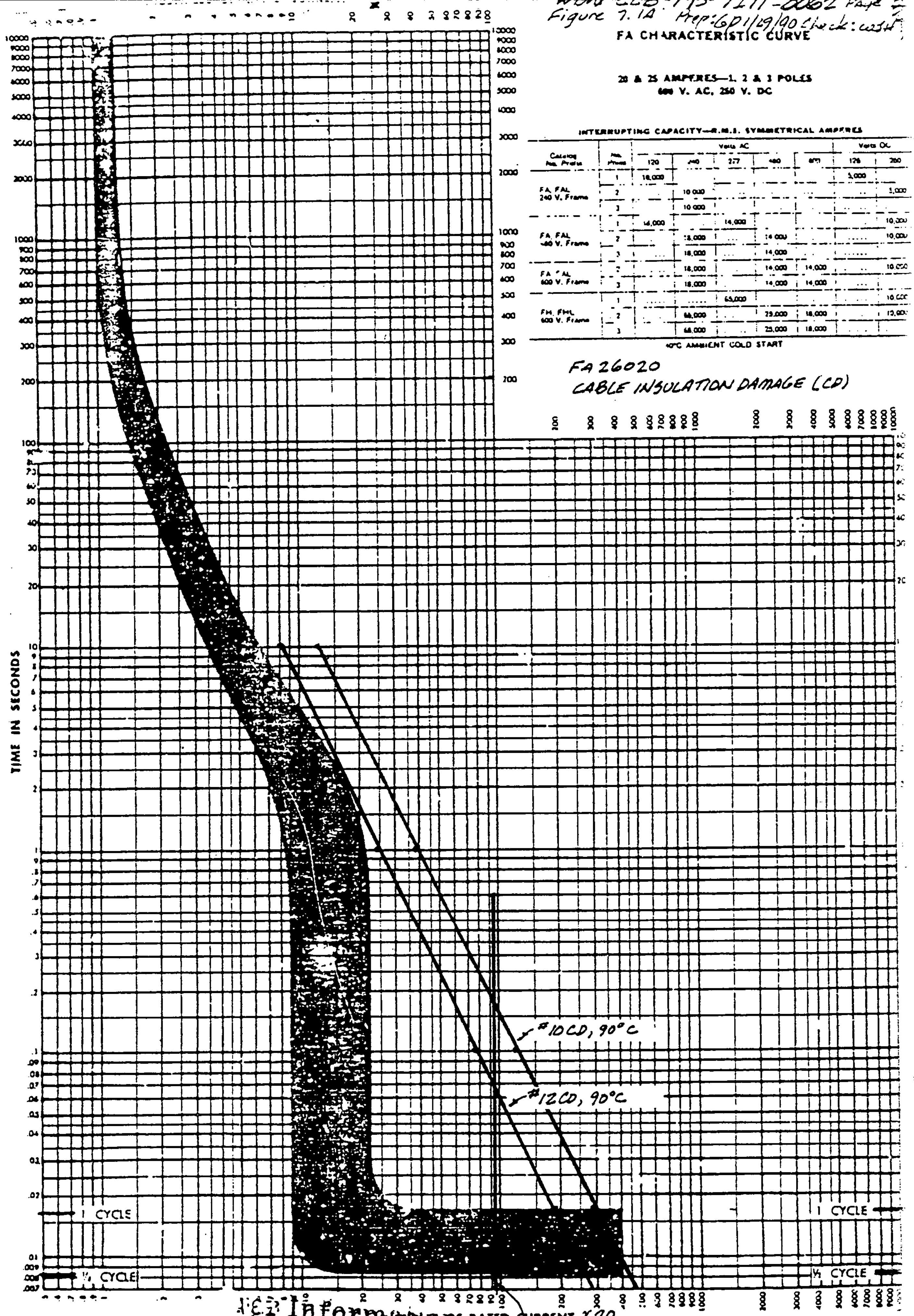
20 & 25 AMPERES—1, 2 & 3 POLES
600 V. AC, 250 V. DC

INTERRUPTING CAPACITY—R.M.S. SYMMETRICAL AMPERES

Catalog No. Prefix	No. Poles	Volts AC 120	240	277	480	600	Volts DC 125	250
FA, FAL 240 V. Frame	1	10,000					5,000	
	2	...	10 000	...	...	...	...	5,000
	3		10 000				...	
FA, FAL 480 V. Frame	1	14,000		14,000				10,000
	2	...	18,000	...	14 000	...	.....	10,000
	3	...	18,000	...	14,000	...	.....	
FA, FAL 600 V. Frame	2	...	18,000	...	14,000	14,000	...	10,000
	3		18,000	...	14,000	14,000	...	
FH, FHL 600 V. Frame	1	.....	.....	65,000		...	...	10,000
	2	...	65,000	...	25,000	18,000	...	10,000
	3		65,000	...	25,000	18,000	...	...

40°C AMBIENT COLD START

FA 26020
CABLE INSULATION DAMAGE (CD)



NRC Information

SQUARE D COMPANY DATE MAY 10 1977 BY: D. R. PATTERSON

TVA MAY 12 1977

Curve No. 650-24
Curve No. 650-242T
March, 197

FA CHARACTERISTIC CURVE

Prep WTH 3/3/90

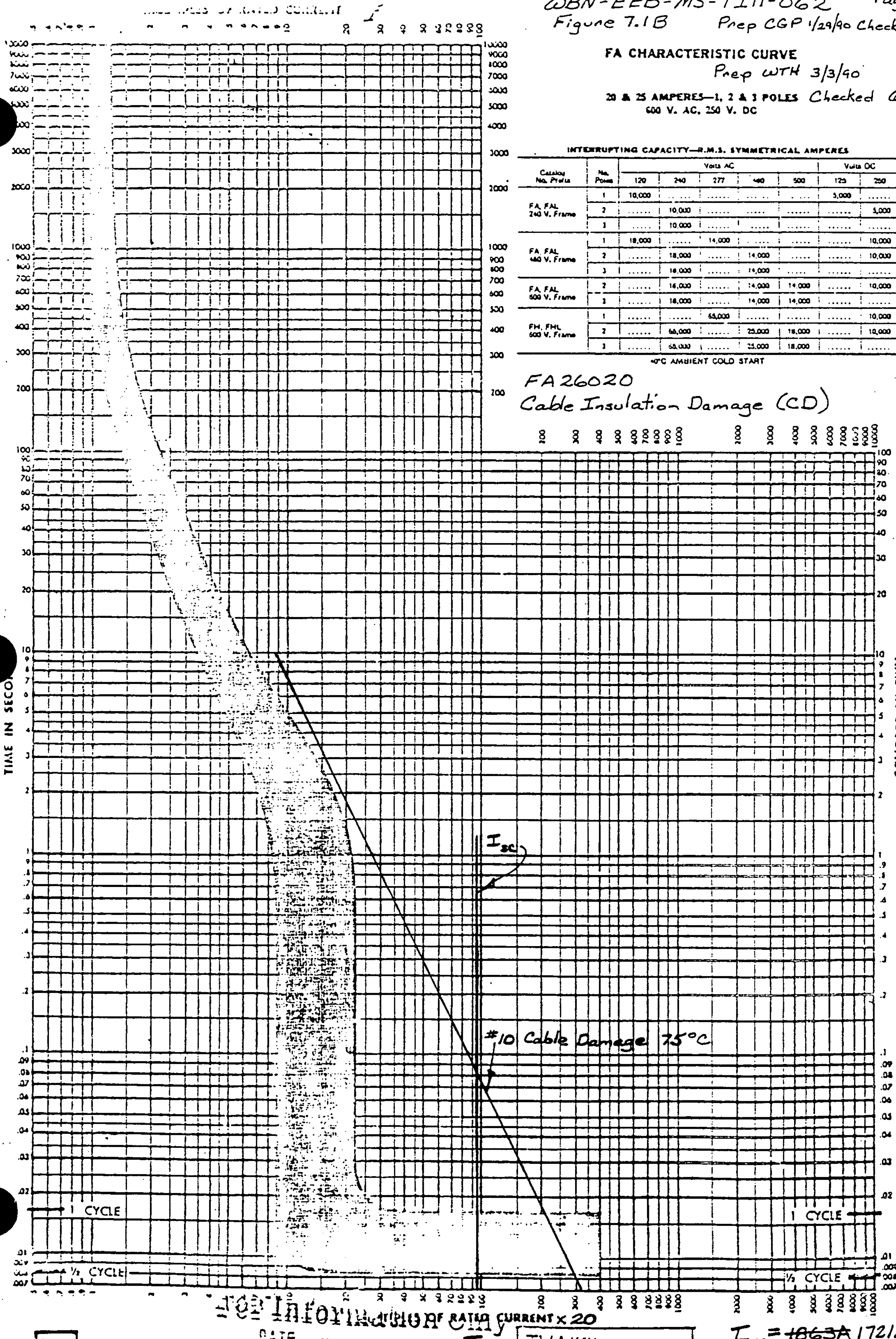
20 & 25 AMPERES—1, 2 & 3 POLES Checked Gp 3/8/90
600 V. AC, 250 V. DC

INTERRUPTING CAPACITY—R.M.S. SYMMETRICAL AMPERES

Catalog No. Prefix	No. Poles	Volts AC 120	Volts AC 240	Volts AC 277	Volts AC 480	Volts AC 600	Volts DC 125	Volts DC 250
FA, FAL 240 V. Frame	1	10,000	......	......	......	......	5,000	......
	2	......	10,000	......	......	......	......	5,000
	3	......	10,000	......	......	......	......	......
FA, FAL 480 V. Frame	1	18,000	......	14,000	......	......	......	10,000
	2	......	18,000	......	14,000	......	......	10,000
	3	......	18,000	......	14,000	......	......	......
FA, FAL 600 V. Frame	2	......	16,000	......	14,000	14,000	......	10,000
	3	......	18,000	......	14,000	14,000	......	......
FH, FHL 600 V. Frame	1	......	......	65,000	......	......	......	10,000
	2	......	65,000	......	25,000	18,000	......	10,000
	3	......	65,000	......	25,000	18,000	......	......

40°C AMBIENT COLD START

FA26020
Cable Insulation Damage (CD)



For Information Only

DATE MAY 18 1977

TVA MAY 12 1977

SQUARE D CO.

I_{sc}

I_{sc} = ~~1863A~~ 1721A gp 9/18/91

Figure 7.2 Prep CGP 1/29/90 Checked WTH
R1 by WTH 3/8/90 Chked GP 3/8/90

FA CHARACTERISTIC CURVE

15-60 AMPERES—1, 2 & 3 POLES
600 V. AC, 250 V. DC

INTERRUPTING CAPACITY—R.M.S. SYMMETRICAL AMPERES

Catalog No. Prefix	No. Poles	Volts AC 120	240	277	480	600	Volts DC 125	250
FA, FAL 240 V. Frame	1	10,000	......	......	......	......	5,000	......
	2	......	10,000	......	......	......	......	5,000
	3	......	10,000	......	......	......	......	......
FA, FAL 480 V. Frame	1	18,000	......	14,000	......	......	......	10,000
	2	......	18,000	......	14,000	......	......	10,000
	3	......	18,000	......	14,000	......	......	......
FA, FAL 600 V. Frame	2	......	18,000	......	14,000	14,000	......	10,000
	3	......	18,000	......	14,000	14,000	......	......
FH, FHL 600 V. Frame	1	65,000	......	25,000	......	......	......	10,000
	2	......	65,000	......	25,000	18,000	......	10,000
	3	......	65,000	......	25,000	18,000	......	......

40°C AMBIENT COLD START

FA 26080
Cable Insulation Damage (CD)

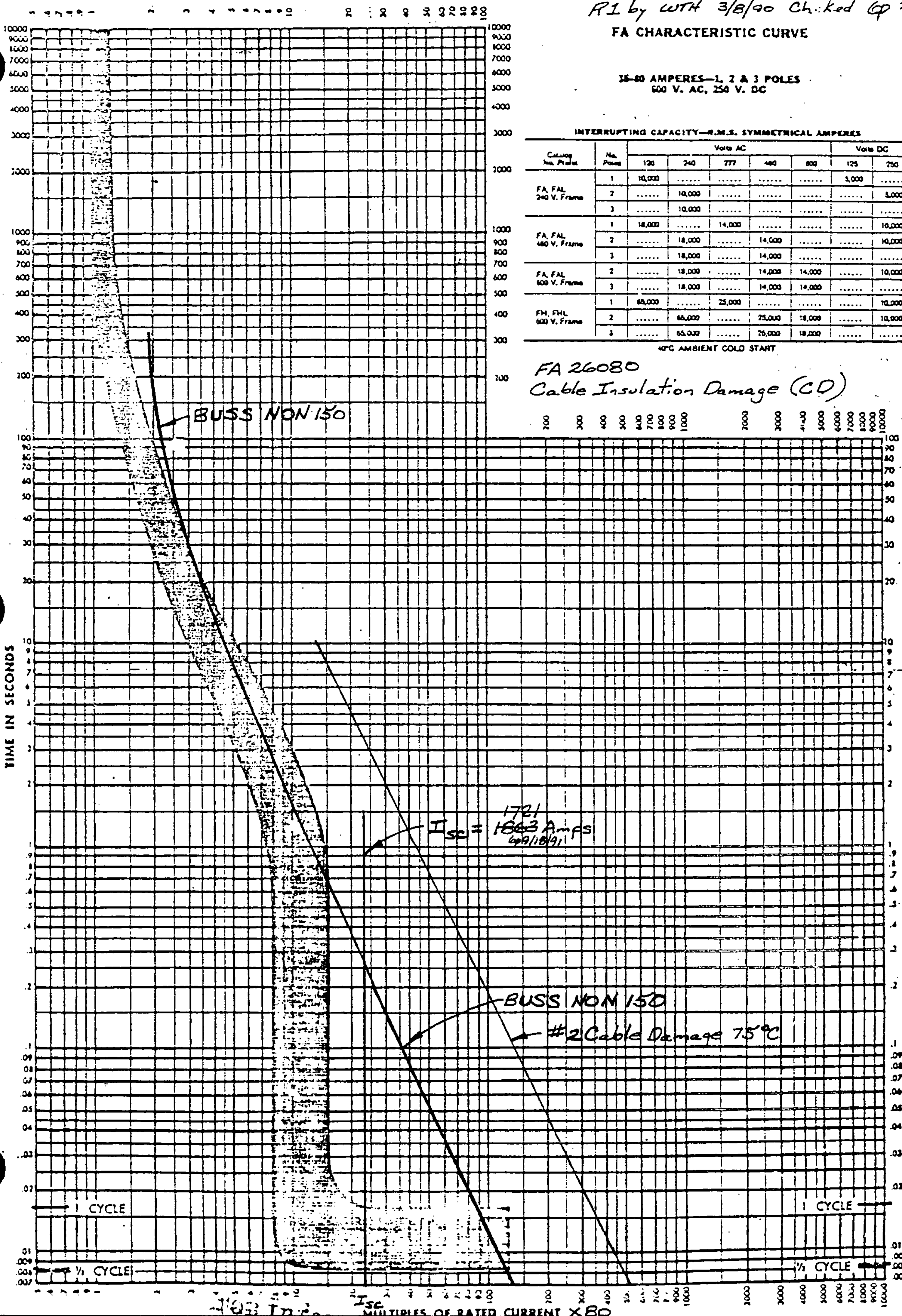


Figure 7.3 Prep: [illegible] 1/29/90 Check: [illegible] 1/30

KA CHARACTERISTIC CURVE

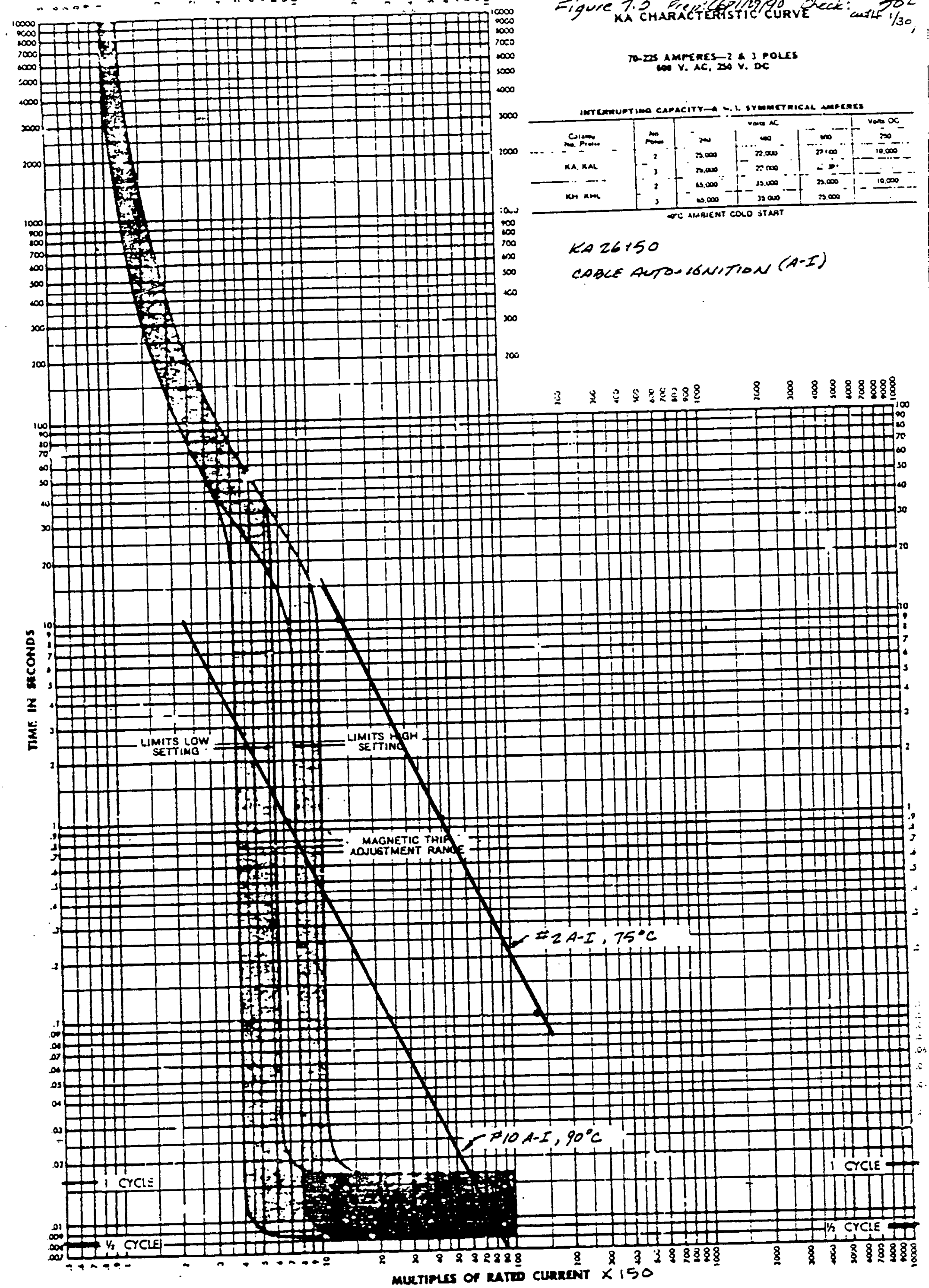
70-225 AMPERES—2 & 3 POLES
600 V. AC, 250 V. DC

INTERRUPTING CAPACITY—A. C. I. SYMMETRICAL AMPERES

Catalog No. Prefix	No. Poles	Volts AC 240	Volts AC 480	Volts AC 600	Volts DC 250
KA, KAL	2	25,000	22,000	22,000	10,000
	3	25,000	22,000	[illegible]	
KH, KHL	2	65,000	35,000	25,000	10,000
	3	65,000	35,000	25,000	

40°C AMBIENT COLD START

KA 26150
CABLE AUTO-IGNITION (A-I)



SQUARE D COMPANY

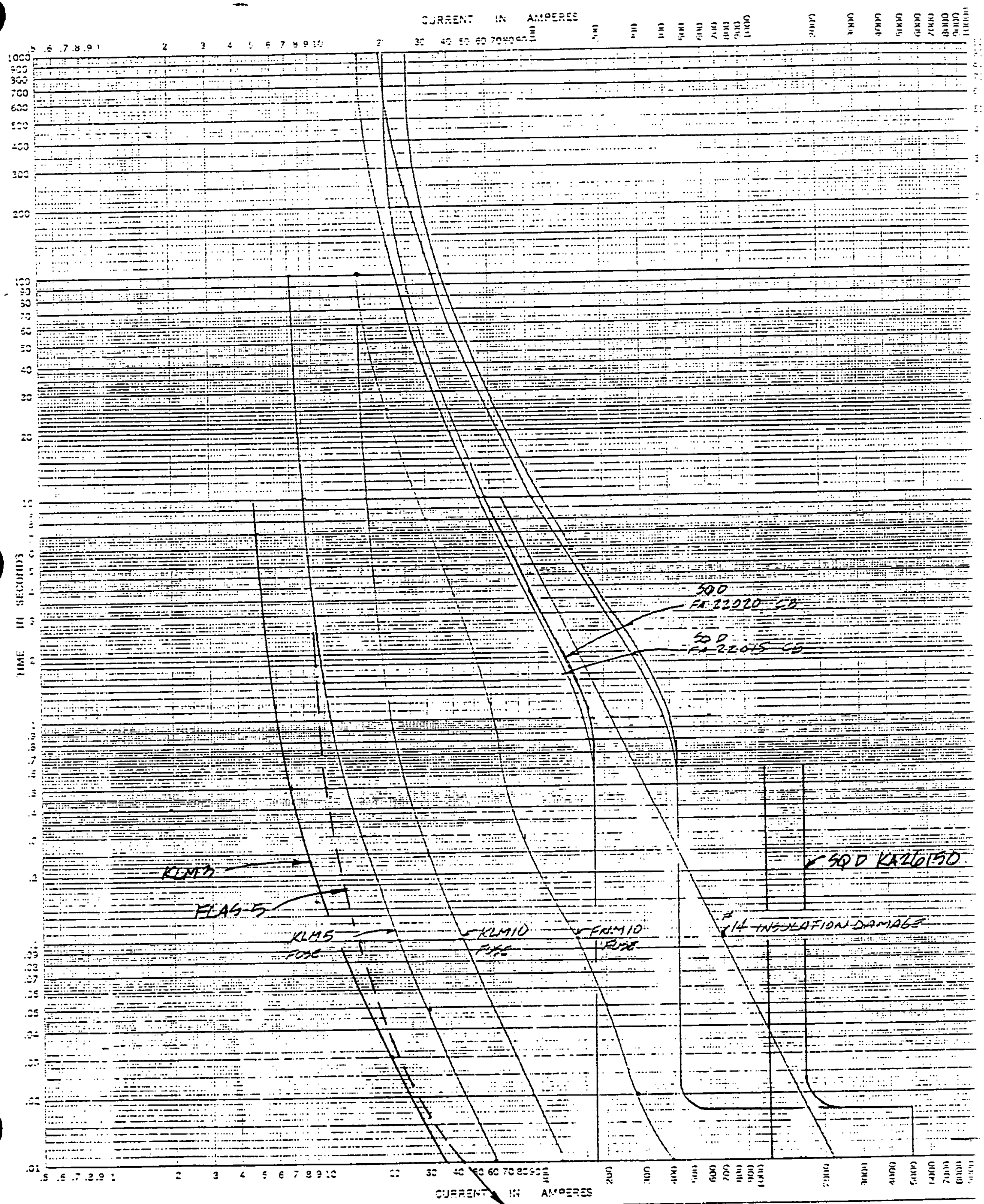
For Information Only

Curve No. 666-241
Curve No. 666-241T
March, 1975

WBN-EEB-MS-TI11-0062

Figure 7.4 Prep CGP 1/29/90 Checked WTH 1/30/90

Prep WTH 3/3/90 Checked GP 3/3/90



TIME-CURRENT CHARACTERISTIC CURVES

For ________ Fuse Links ________

8.0 Summary of Results

8.1 Battery Sizing

The 3DCU-9 battery cell has 4 positive plates per cell and is inadequate when considering simultaneous motor starting transient currents; 6.43 positives required by the calculated results. The 3DCU-9 is marginally adequate when considering nonsimultaneous motor starting transients; 4.08 positives by the calculated result.

The KCR-7 has 3 positive plates per cell and is adequate when considering the simultaneous motor starting transients; 2.77 positives by the calculated result. 1.58 positives are required for the nonsimultaneous starts.

The 3DCU-9 and the KCR-7 are inadequate for DC lube oil pump motor starts concurrent with field flash.

R5 4/10/92 4/10/92

8.2 Battery Charger Sizing

The battery charger is capable of carrying normal loads and recharging the battery in less than 1 1/2 hours for the worst case load profile.

8.3 Protective Device Sizing

The branch circuit protective devices on the DG Distribution Panels are properly sized for full load and transient conditions with the exception of the battery charger breaker which is undersized for battery charger current-limit and full load current ratings.

8.4 Short Circuit Protection and Coordination

8.4.1 Short Circuit Current - Maximum short circuit current available at the DG distribution panel is a maximum of 1721a.

8.4.2 Protective Device Ratings - All protective devices on the DG distribution panel have adequate interrupting ratings except for the instrument fuses. Buss KLM3 fuses are an acceptable substitute for the instrument fuses having an adequate dc rating and coordinating selectively with the main breaker. Additionally, the main fuses are not covered by the fuse substitution standard DS-E8.1.1.

8.4.3 Selective Coordination - Selective coordination between the branch circuit breakers and the main breaker is not required. Replacement of the instrument fuses with Buss KLM3 is acceptable.

8.4.4 Cable Insulation Damage Protection - All cables have adequate protection to prevent cable insulation damage.

8.4.5 Appendix R - The diesel engine controls have alarm circuits which are non-required for Appendix R. A high impedence fault occuring in these circuits would not result in a loss of required engine control circuits.

8.4.6 Associated Circuits - Associated circuits in the alarm circuits of the engine controls have adequate protection to prevent cable damage. The #14 cables are shown to be protected by the 10a fuses supplying the circuit.

8.4.7 Cascade Fuses - Selective coordination is not provided for the engine control alarm circuits for DG 1A-A, 2A-A, 1B-B, and 2B-B. These circuits have Buss FNM10 fuses which must coordinate with SQD FA26020 breakers. Selective coordination cannot be verified for DG C-S alarm circuit which is fused with Buss KLM10 fuses.

8.5 Voltage Analysis

8.5.1 Minimum Voltage - Adequacy of minimum voltage to components is to be verified through performance of preop test WBN-TVA-14D.

8.5.2 Maximum Voltage - The voltage ratings of continuously energized components are adequate for the maximum applied voltage during battery equalizing.

9.0 Conclusions

9.1 The 3DCU-9 battery cell is inadequate considering simultaneous motor starting transient currents and marginally adequate with no margin considering nonsimultaneous starts. Circuit modifications would be required to assure that the motors would not start simultaneouly.

The KCR-7 is adequate with 8.3% margin considering simultaneous starts and 89.9% margin considering nonsimultaneous starts.

A time delay or interlock feature should be added to the DC lube oil pumps to provide assurance that they will not start concurrent with field flashing. (DCN M08699A)

9.2 Battery charger size is adequate.

9.3 Existing 20a breakers on the battery charger supply should be replaced with 40a breakers. (DCN M08699A)

9.4 All protective devices on the DG distribution panel have adequate interrupting ratings except for instrument and main fuses which should be replaced with fuses having adequate dc ratings (e.g., Buss KLM3 for the instrument fuses; Buss KWNR150 for the main fuses). (DCN M08699A)

9.5 Protective devices provide sufficient cable thermal damage protection.

9.6 Protective device sizes are adequate for Appendix R requirements.

9.7 Protective devices are adequate to prevent cable damage for Reg Guide 1.75 - associated circuit requirements.

9.8 The Buss FMN10 and KLM10 fuses used in the engine control alarm circuits should be replaced with fuses that provide selective cascade coordination between safety and non-safety circuits. (DCN M08699A)

9.9 Adequacy of minimum voltage to components will be verified by preoperational test WBN-TVA-14D.

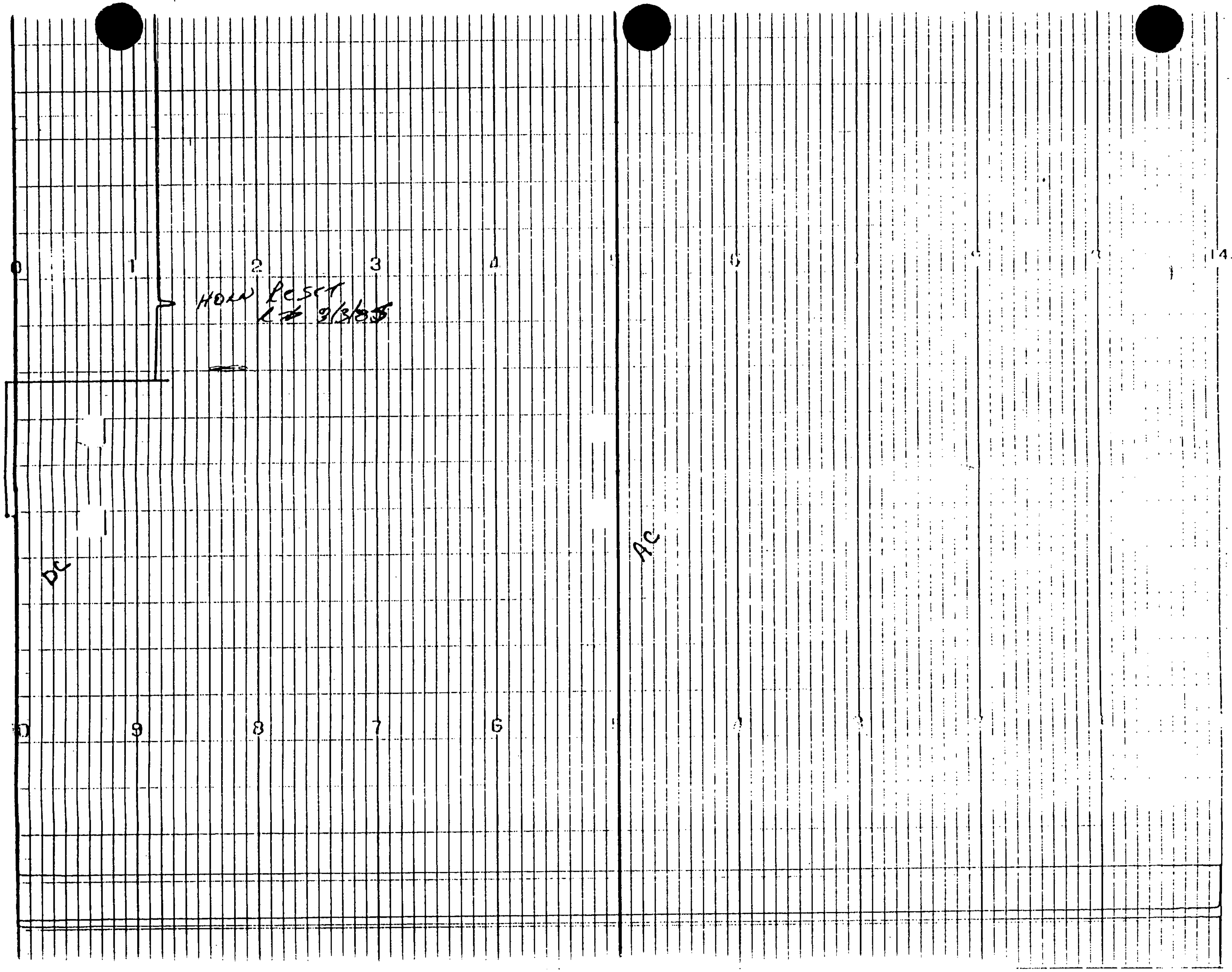
9.10 The voltage ratings of continuously energized components are adequate for maximum voltage requirements.

9.11 The requirement to have the DG distribution panel main breaker adjustable trip set to the high limit should be included in a design output document in accordance with EE PM88-03. (DCN M08699A)

ATTACHMENT
Step 5.4.1.35
CN-13
TVA-14D

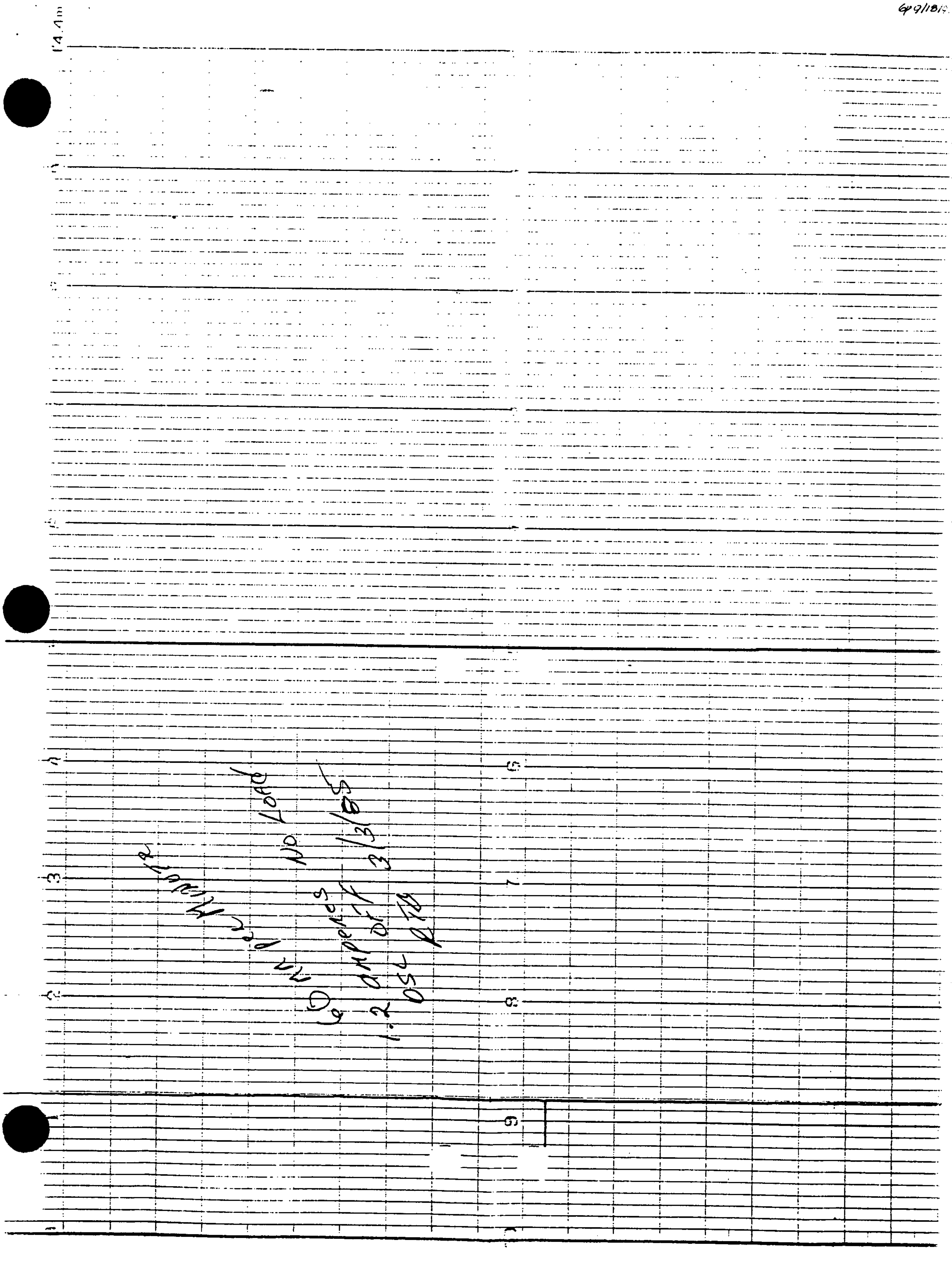
RT

OFFICIAL COPY

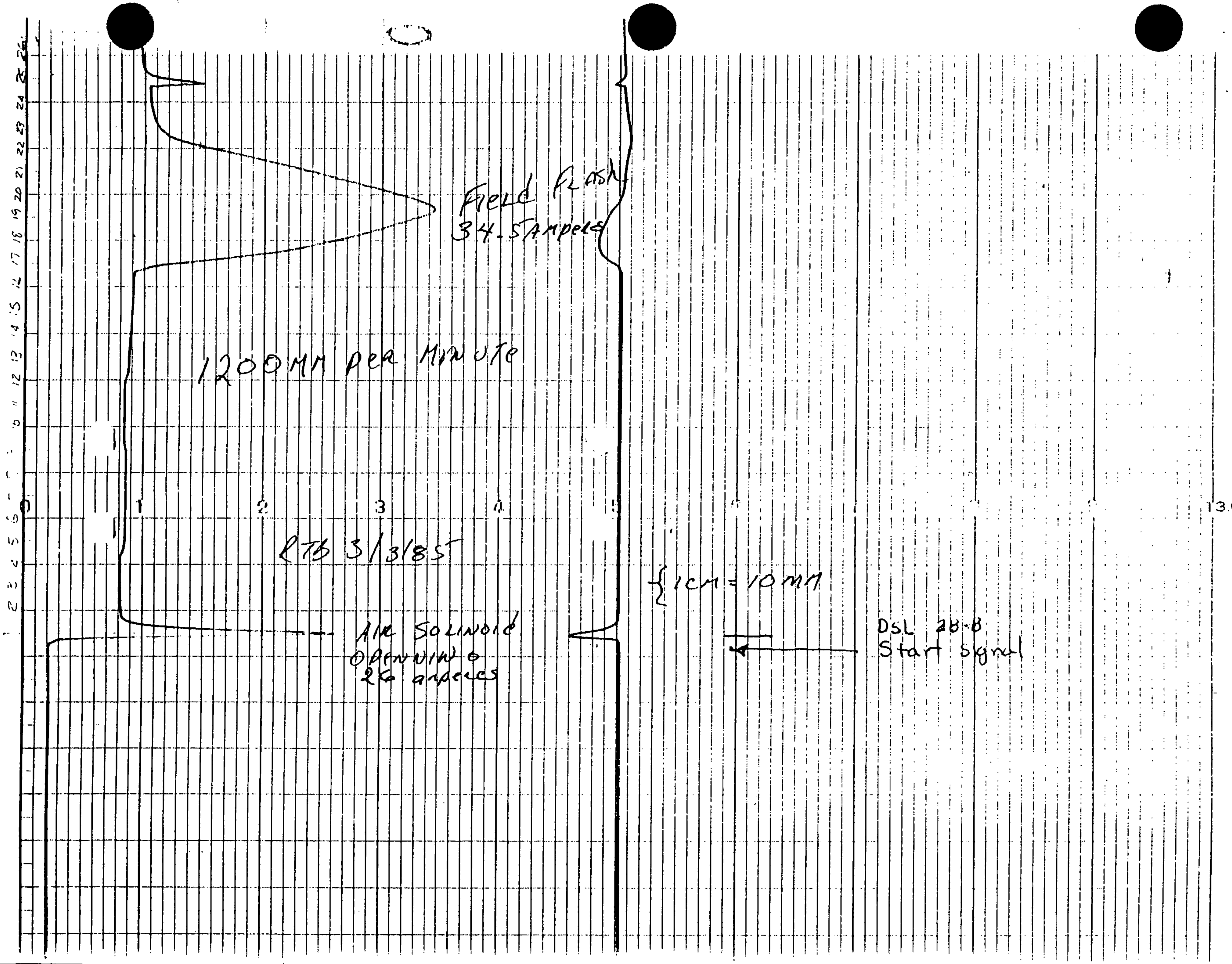


WSN EED-MS-TI1-0062

PAGE #~~7~~ 33
9/18/91



14.4m
60 ma per Minute
1.2 amperes No Load
OSC OFF 3/3/85
RTB



WBN EEB-MS-TI11-0062

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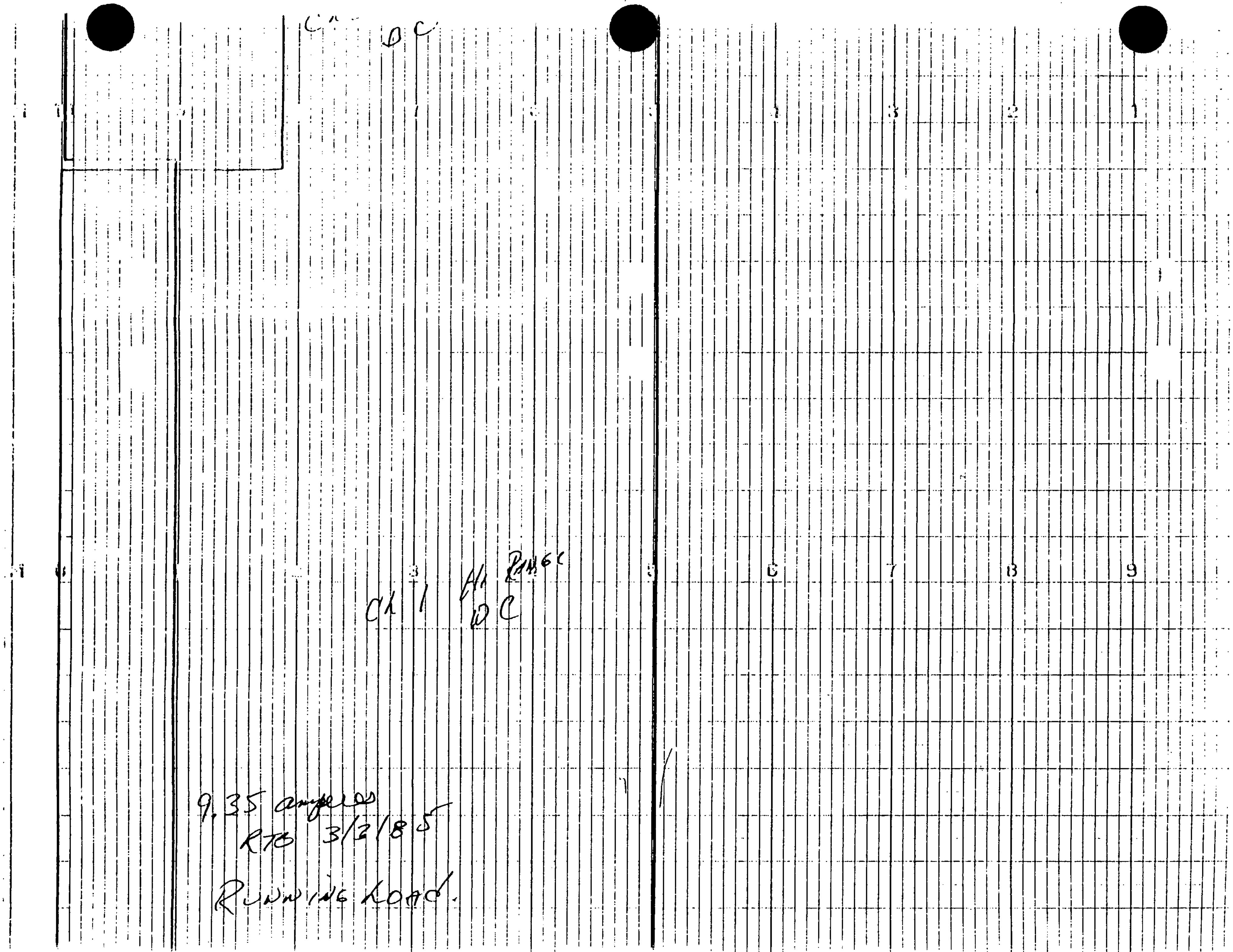
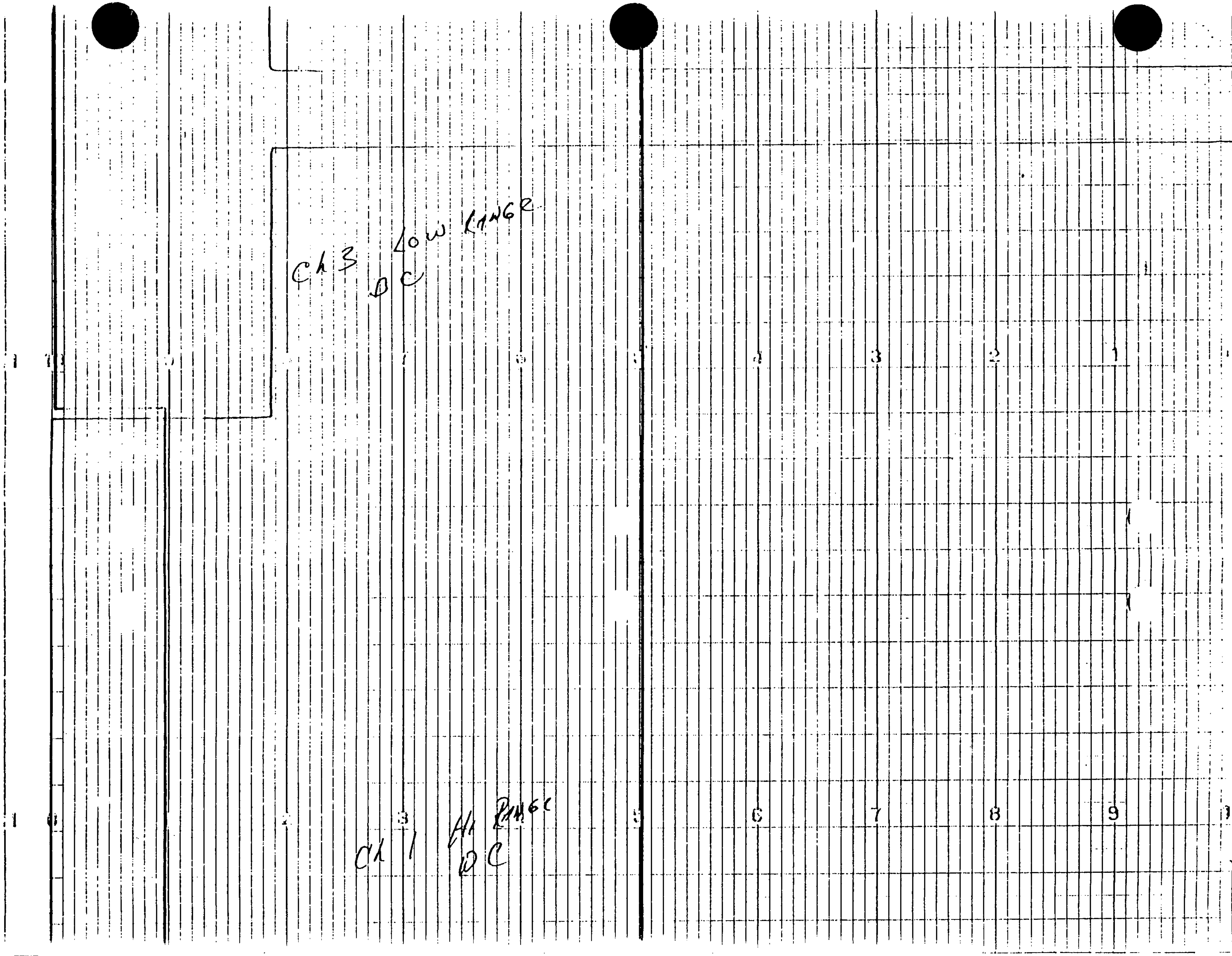
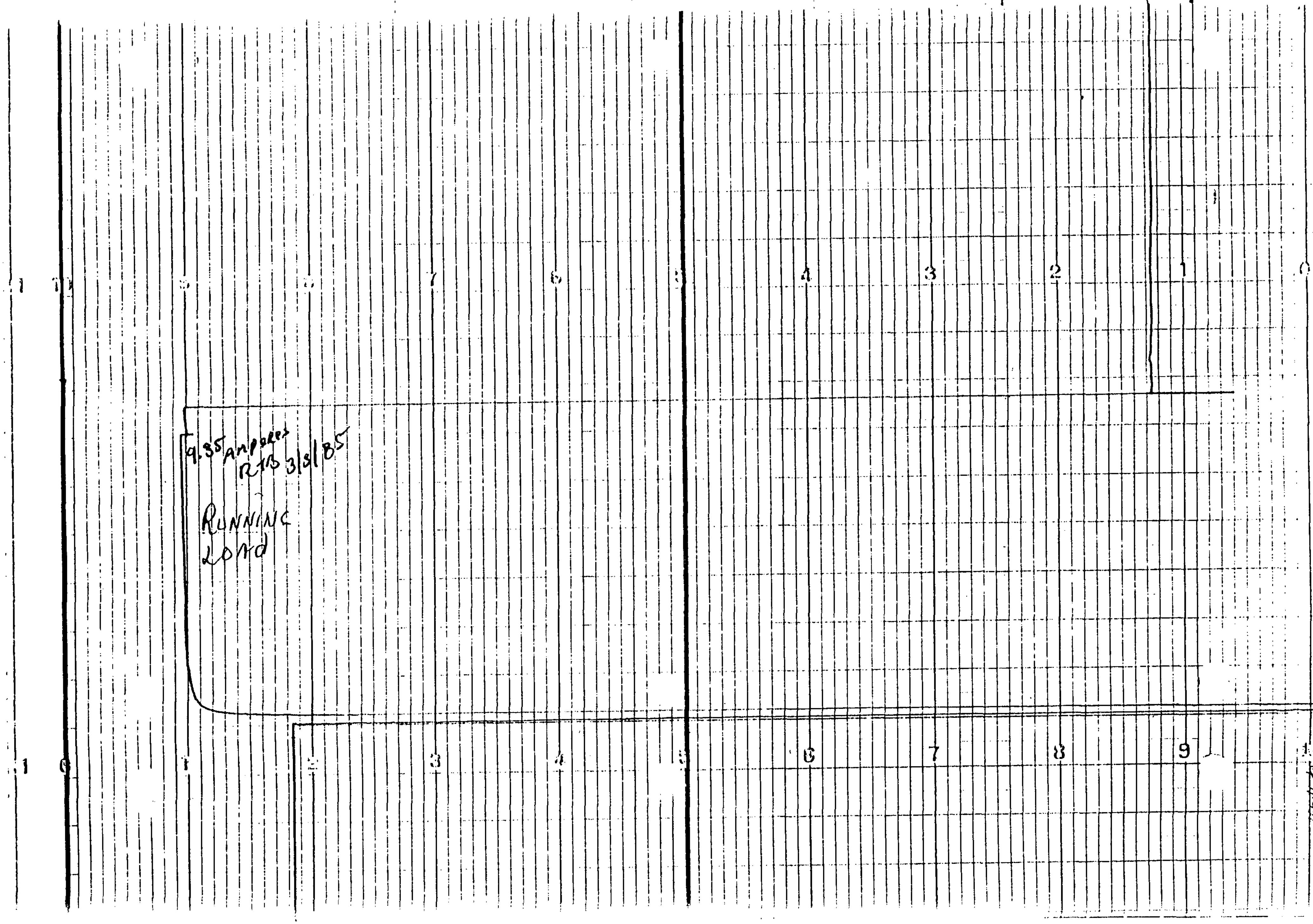




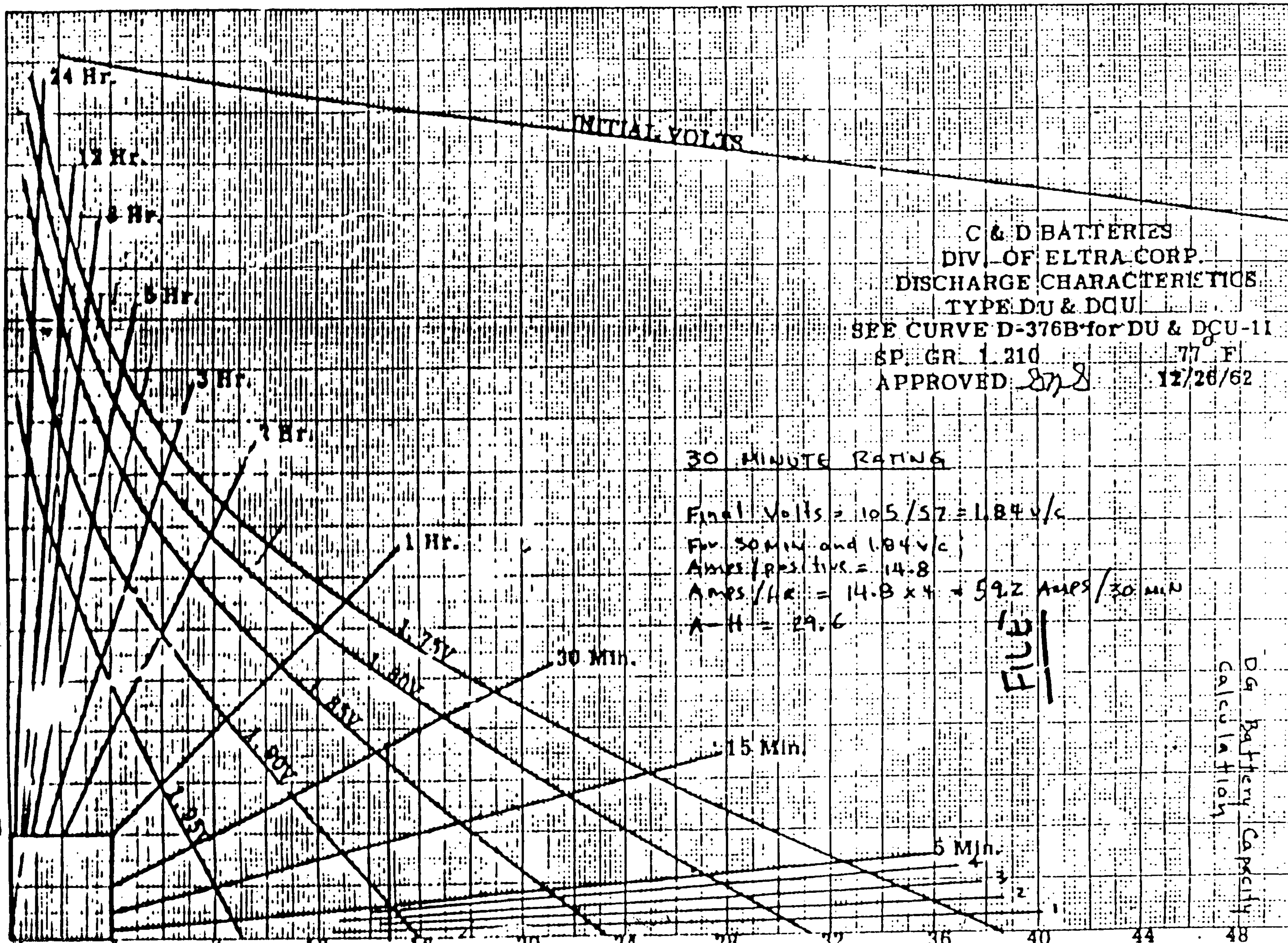
WADN ECD-170-7-11-0062

PAGE 5-37
6p 9/18/01



WBN EEB-MS-TI11-0062

PAGE 52 70



WBN EEB-MS-TI11-0062 Attachment 10.2

PAGE 39

WBN EEB-MS-TI11-0062 PAGE 54 [illegible]

ATTACHMENT 10.3

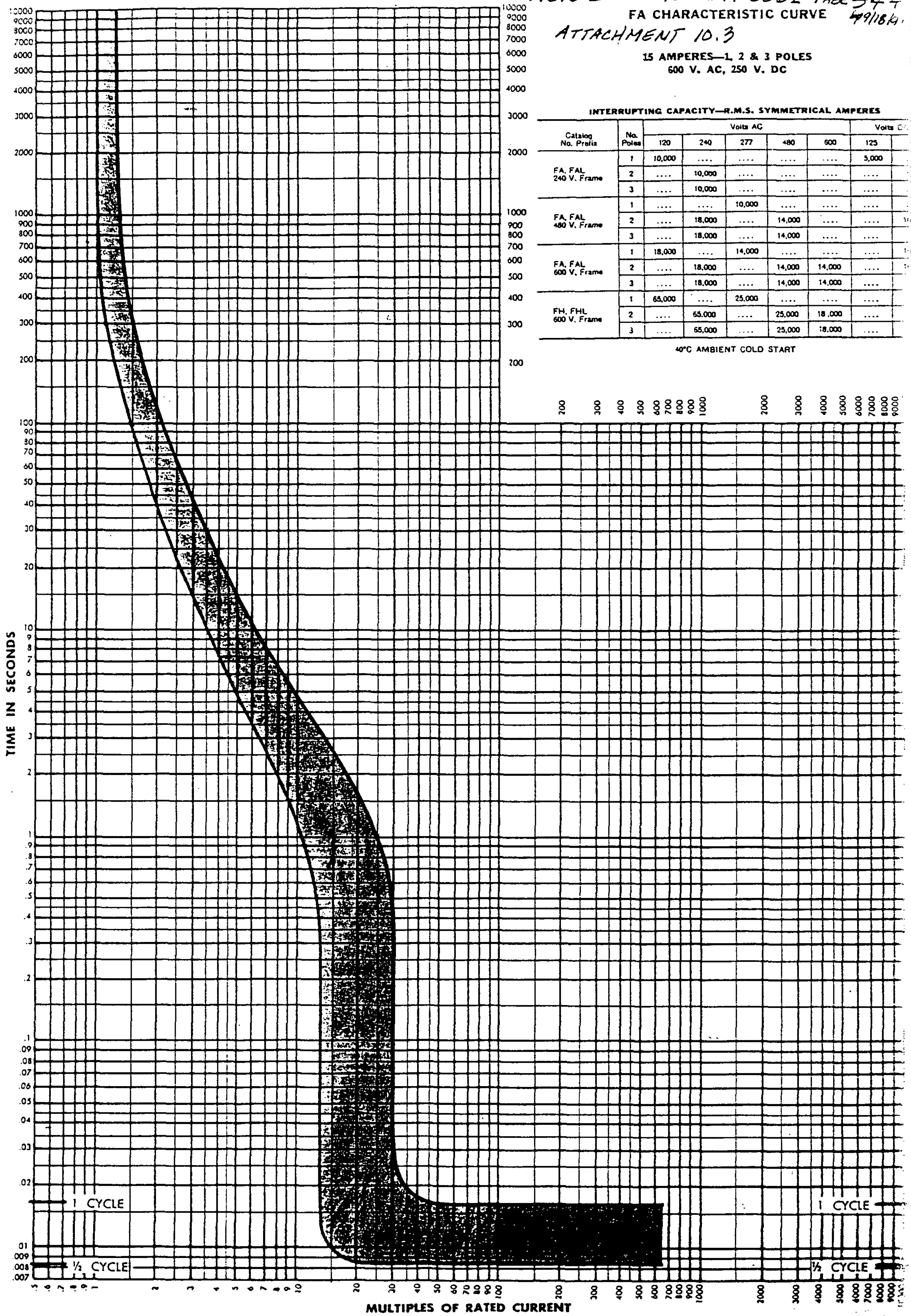
FA CHARACTERISTIC CURVE

15 AMPERES—1, 2 & 3 POLES
600 V. AC, 250 V. DC

INTERRUPTING CAPACITY—R.M.S. SYMMETRICAL AMPERES

Catalog No. Prefix	No. Poles	Volts AC					Volts DC
		120	240	277	480	600	125
FA, FAL 240 V. Frame	1	10,000	....	....	....	....	5,000
	2	....	10,000	....	....	....	....
	3	....	10,000	....	....	....	....
FA, FAL 480 V. Frame	1	....	....	10,000	....	....	....
	2	....	18,000	....	14,000	....	....
	3	....	18,000	....	14,000	....	....
FA, FAL 600 V. Frame	1	18,000	....	14,000	....	....	....
	2	....	18,000	....	14,000	14,000	....
	3	....	18,000	....	14,000	14,000	....
FH, FHL 600 V. Frame	1	65,000	....	25,000	....	....	....
	2	....	65,000	....	25,000	18,000	....
	3	....	65,000	....	25,000	18,000	....

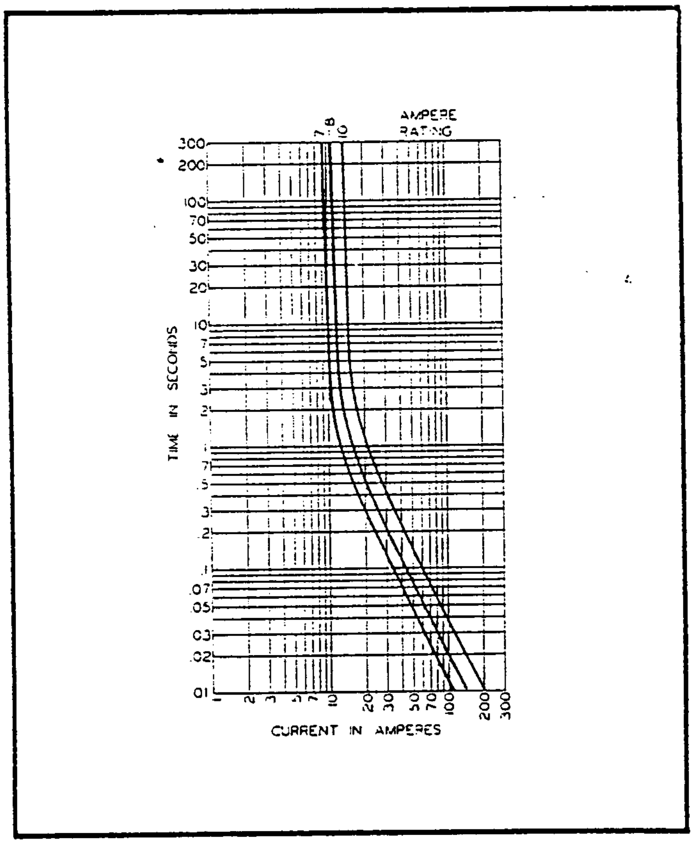
40°C AMBIENT COLD START



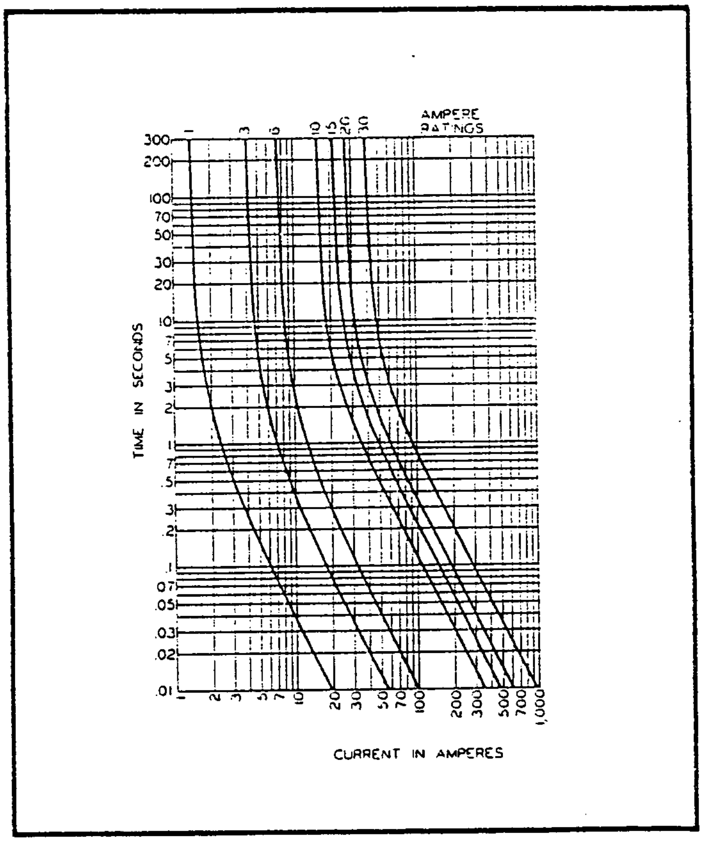
SQUARE D COMPANY

Time Current Characteristic Curves

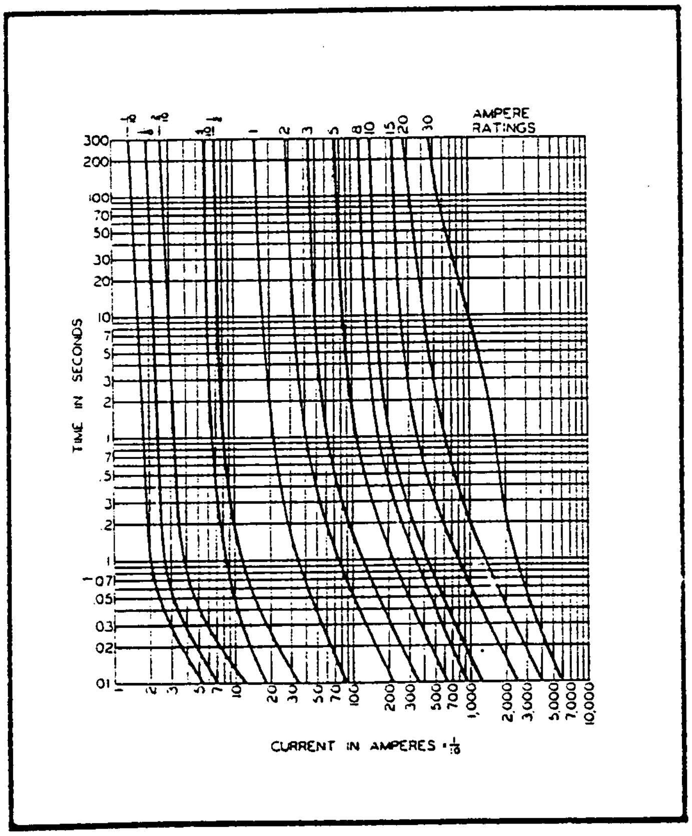
BUSS Fuses and FUSETRON dual-element Fuses



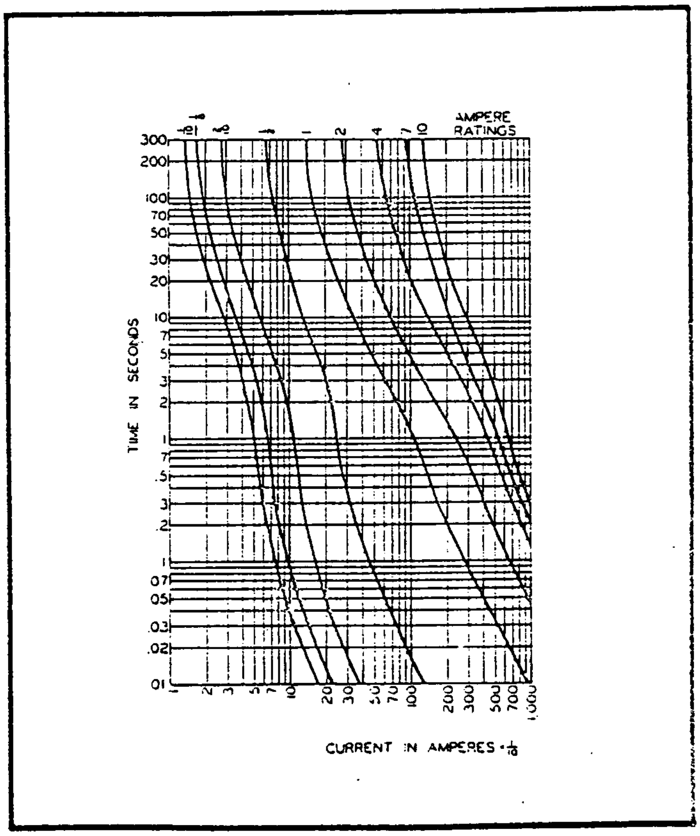
BUSS GLH Fuses ¼ x 1¼ inch.



BUSS BAF, BAN Fuses 13/32 x 1½ inch.



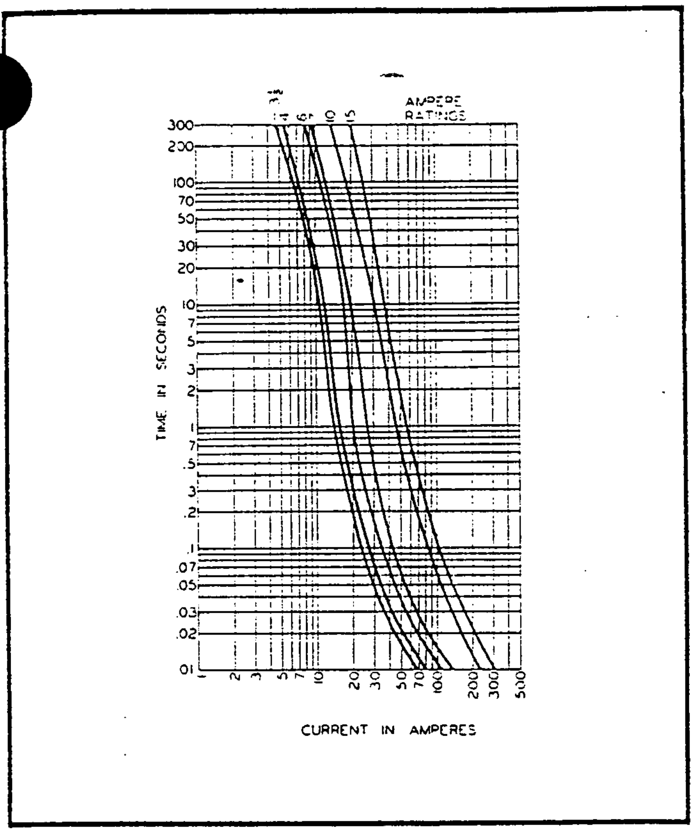
LIMITRON fast-acting KLM, KTK Fuses
13/32 x 1½ inch.



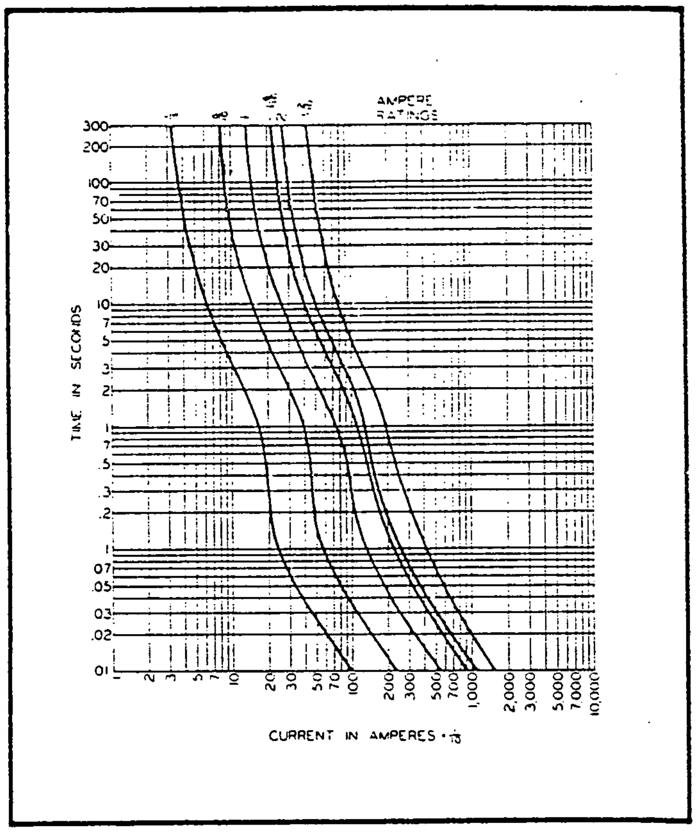
FUSETRON FNA dual-element, Indicating Fuses
13/32 x 1½ inch.

BUSS Fuses and FUSETRON dual-element Fuses

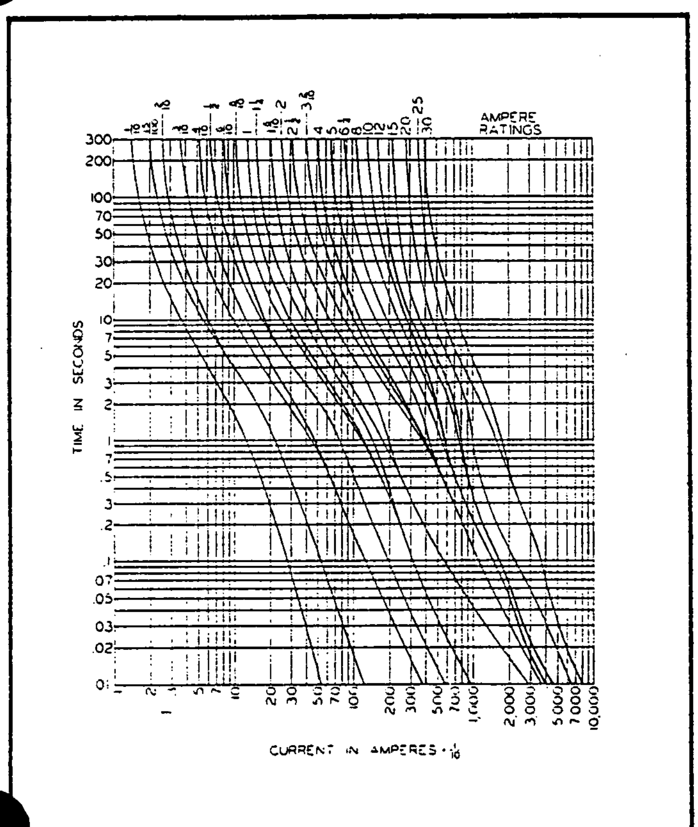
WBN EEB-MS-TI11-0062 PAGE 56 42
ATTACHMENT 10.5



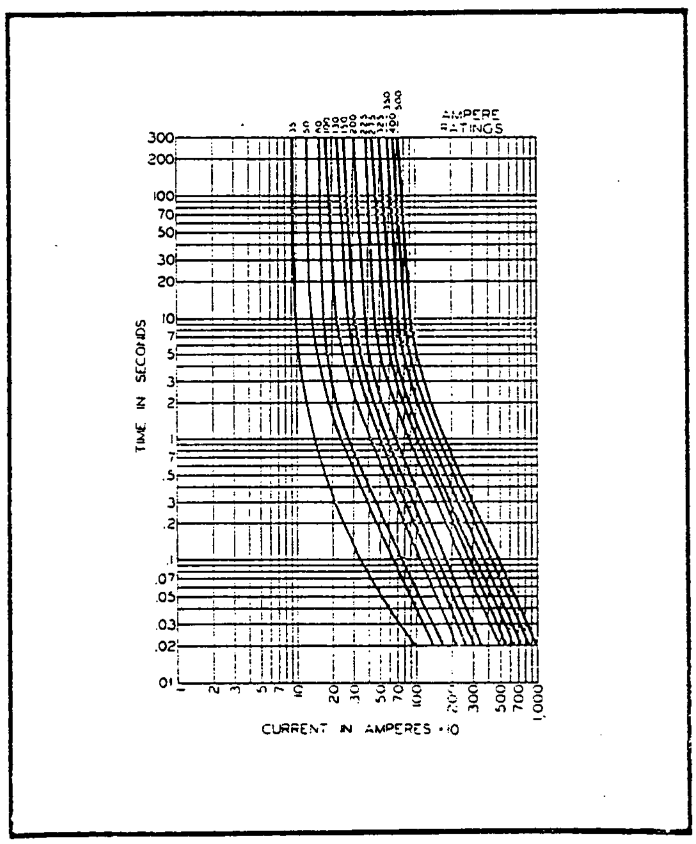
BUSS FNQ time-delay Fuses 13⁄32 x 1½ inch.



FUSETRON FNQ dual-element Fuses 13⁄32 x 1½ inch.



FUSETRON FNM dual-element Fuses 13⁄32 x 1½ inch.



BUSS ANL Limiters

WBN EEB-MS-TI11-0062
PAGE 57 43
ATTACHMENT 10.6

THERMAL-MAGNETIC MOLDED CASE CIRCUIT BREAKERS
UNIT BREAKER ONLY WITHOUT ENCLOSURES

Thermal-magnetic molded case circuit breakers shown on Pages 60-62 are UL listed, CSA certified, IEC rated, and also meet the requirements of Federal Specification W-C-375B/GEN as indicated on Page 54. For I-LINE molded case circuit breakers, see listings on Pages 102-105.

FA 100 AMPERE FRAME—PERMANENT TRIP

Ampere Rating	One Pole 120V. ac, 125V. dc		Two Pole 240V. ac, 250V. dc		Three Pole 240V. ac, 250V. dc		Terminal Lug Wire Size
	Catalog Number	Price	Catalog Number	Price	Catalog Number	Price	
15	FAL12015	$63.	FAL22015	$107.	FAL32015	$157.	#14-4 Cu #12-4 Al
20	FAL12020	63.	FAL22020	107.	FAL32020	157.	
25	FAL12025	63.	FAL22025	107.	FAL32025	157.	
30	FAL12030	63.	FAL22030	107.	FAL32030	157.	
35	FAL12035	63.	FAL22035	107.	FAL32035	157.	#14-1/0 Cu #12-1/0 Al
40	FAL12040	63.	FAL22040	107.	FAL32040	157.	
45	FAL12045	63.	FAL22045	107.	FAL32045	157.	
50	FAL12050	63.	FAL22050	107.	FAL32050	157.	
60	FAL12060	63.	FAL22060	107.	FAL32060	157.	
70	FAL12070	85.	FAL22070	173.	FAL32070	225.	
80	FAL12080	85.	FAL22080	173.	FAL32080	225.	
90	FAL12090	85.	FAL22090	173.	FAL32090	225.	
100	FAL12100	85.	FAL22100	173.	FAL32100	225.	


FA
One Pole
15-100 Amperes

FA 100 AMPERE FRAME—PERMANENT TRIP

Ampere Rating	One Pole 277V. ac, 125V. dc		Two Pole 480V. ac, 250V. dc		Three Pole 480V. ac, 250V. dc		Terminal Lug Wire Size
	Catalog Number	Price	Catalog Number	Price	Catalog Number	Price	
15	FAL14015	$80.	FAL24015	$194.	FAL34015	$249.	#14-4 Cu #12-4 Al
20	FAL14020	80.	FAL24020	194.	FAL34020	249.	
25	FAL14025	80.	FAL24025	194.	FAL34025	249.	
30	FAL14030	80.	FAL24030	194.	FAL34030	249.	
35	FAL14035	80.	FAL24035	194.	FAL34035	249.	#14-1/0 Cu #12-1/0 Al
40	FAL14040	80.	FAL24040	194.	FAL34040	249.	
45	FAL14045	80.	FAL24045	194.	FAL34045	249.	
50	FAL14050	80.	FAL24050	194.	FAL34050	249.	
60	FAL14060	80.	FAL24060	194.	FAL34060	249.	
70	FAL14070	100.	FAL24070	252.	FAL34070	295.	
80	FAL14080	100.	FAL24080	252.	FAL34080	295.	
90	FAL14090	100.	FAL24090	252.	FAL34090	295.	
100	FAL14100	100.	FAL24100	252.	FAL34100	295.	


FA
Two Pole
15-100 Amperes

FA 100 AMPERE FRAME—PERMANENT TRIP

Ampere Rating	One Pole		Two Pole 600V. ac, 250V. dc		Three Pole 600V. ac, 250V. dc		Terminal Lug Wire Size
	Catalog Number	Price	Catalog Number	Price	Catalog Number	Price	
15	....	..	FAL26015	$225.	FAL36015	$289.	#14-4 Cu #12-4 Al
20	....	..	FAL26020	225.	FAL36020	289.	
25	....	..	FAL26025	225.	FAL36025	289.	
30	....	..	FAL26030	225.	FAL36030	289.	
35	....	..	FAL26035	225.	FAL36035	289.	#14-1/0 Cu #12-1/0 Al
40	....	..	FAL26040	225.	FAL36040	289.	
45	....	..	FAL26045	225.	FAL36045	289.	
50	....	..	FAL26050	225.	FAL36050	289.	
60	....	..	FAL26060	225.	FAL36060	289.	
70	....	..	FAL26070	285.	FAL36070	355.	
80	....	..	FAL26080	285.	FAL36080	355.	
90	....	..	FAL26090	285.	FAL36090	355.	
100	....	..	FAL26100	285.	FAL36100	355.	


FA
Three Pole
15-100 Amperes

KA 225 AMPERE FRAME—600V. AC, 250V. DC PERMANENT TRIP

Ampere Rating	AC Magnetic* Trip Settings Amperes		Two Pole		Three Pole		Terminal Lug Wire Size
	Low	High	Catalog No.	Price	Catalog No.	Price	
70	350	700	KAL26070	$662.	KAL36070	$830.	One #4-300 MCM Cu or Al
80	400	800	KAL26080	662.	KAL36080	830.	
90	450	900	KAL26090	662.	KAL36090	830.	
100	500	1000	KAL26100	662.	KAL36100	830.	
110	550	1100	KAL26110	662.	KAL36110	830.	
125	625	1250	KAL26125	662.	KAL36125	830.	
150	750	1500	KAL26150	662.	KAL36150	830.	
175	875	1750	KAL26175	662.	KAL36175	830.	
200	1000	2000	KAL26200	662.	KAL36200	830.	
225	1125	2250	KAL26225	662.	KAL36225	830.	

*UL 489 magnetic trip setting tolerances are ±25% (Low) and ±20% (High) from the nominal values shown.


KA
70-225 Amperes

Additional Information

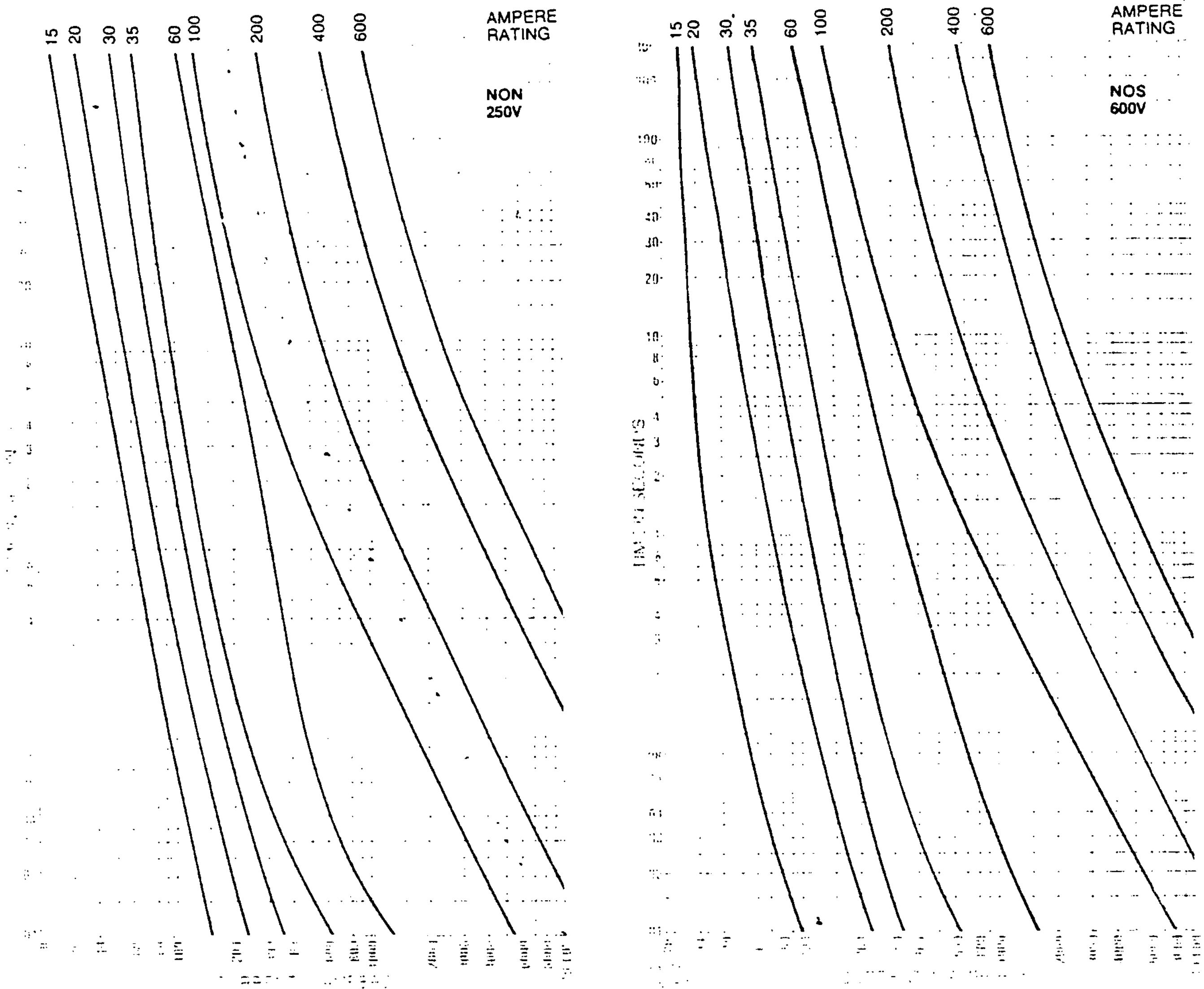
Accessories .... Pages 76-77
Lugs .... Pages 78-79
Dimensions .... Page 63
Interrupting Data .... Page 54

DP CATALOG REFERENCE FAL CLASS 650
KAL CLASS 655

WBN EEB-MS-TI11-0062 PAGE 58 4 9/18/91
ATTACHMENT 10.7

ONE-TIME General Purpose—NON And NOS

Time-Current Characteristic Curves—Average Melt



Note—Contact Bussmann for Latest Performance Data.

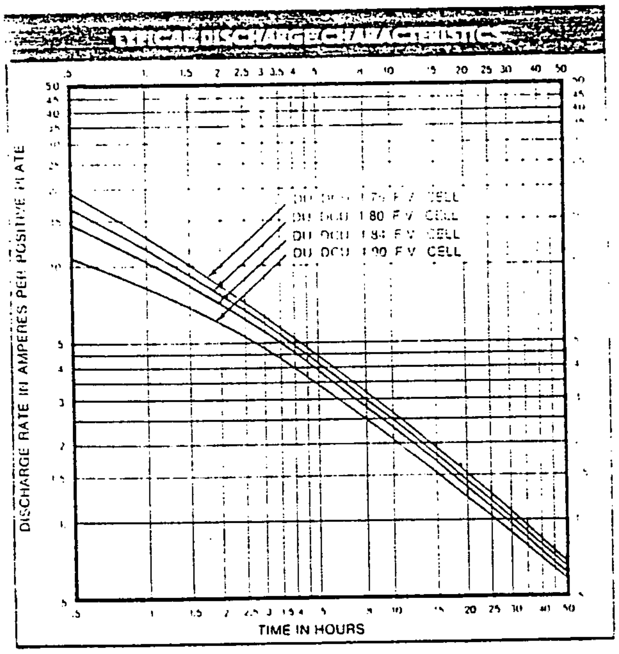
C&D
STATIONARY BATTERIES

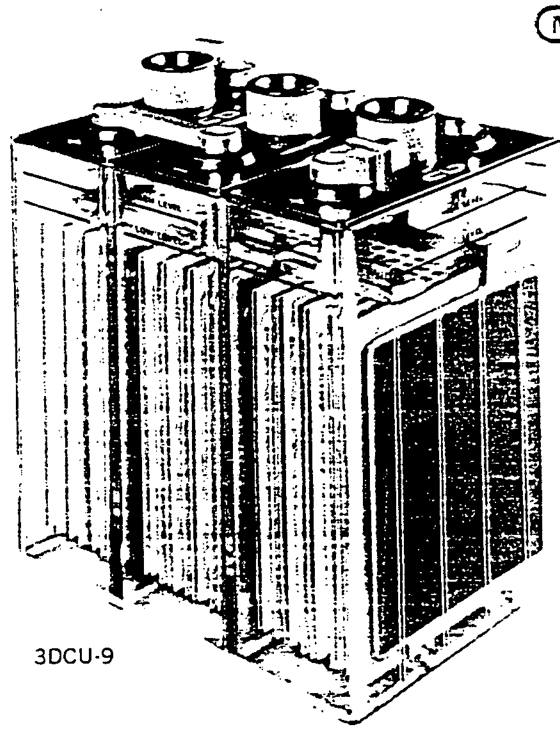
25 to 200 AMP. HOURS
DU - Lead Antimony
DCU - Lead Calcium

NEMA

SPECIFICATIONS

CAPACITY	25 to 200 Amp. Hrs. at 8 Hr. Rate to 1.75 F.V.		
PLATES	Height	Width	Thickness
Positive	5 7/8"	5 5/8"	.266"
Negative	5 7/8"	5 5/8"	.170"
Outside Neg.	5 7/8"	5 5/8"	.110"
SPECIFIC GRAVITY	1.210 @ 77° F.		
CONTAINERS	Thermoplastic		
CELL COVERS	Thermoplastic		
SEPARATORS	Microporous		
RETAINERS	Fibrous glass mats		
SEDIMENT SPACE	1/2" (9/16"—11 plate)		
ELECTROLYTE	Height above plate 1 3/4" (1 5/8"—11 plate)		





3DCU-9

1 **Saftee-Vent (optional)** — Prevents accidental spark or flame from entering cell. Water can be added without removing vent.

2 **Hi-Impac Cover** — Virtually eliminates cover breakage.

3 **Shock-Resistant, Transparent Container** — Thermoplastic containers have high impact resistance and virtually eliminate breakage.

4 **Close-Set Plates** — Reduce internal resistance. This design provides the high current rates needed for short term, high-draw loads.

Type of Cell		Cells Per Unit	Rated Capacities (Amp. Hrs. to 1.75 V. per Cell)			1 Minute Rate (Amperes)		Overall Dimensions (Inches)			Approx. Wt. (Pounds)		Elect. per Cell (Lbs.)
Calcium	Antimony		8 Hrs.	3 Hrs.	1 Hr.	To FV 1.75	To FV 1.50	L	W	H	Net Filled	Dom. Packed	
2DCU-3	2DU-3	2	25	19	12.5	37.5	71	3 19/32	7 3/8	10 5/16	18	22	3
3DCU-3	3DU-3	3	25	19	12.5	37.5	71	5 9/32	7 3/8	10 5/16	27	32	3
2DCU-5	2DU-5	2	50	38	25	75	142	3 19/32	7 3/8	10 5/16	22	26	2.8
3DCU-5	3DU-5	3	50	38	25	75	142	5 9/32	7 3/8	10 5/16	33	38	2.8
2DCU-7	2DU-7	2	75	57	38	111	212	6 3/8	7 1/8	10 5/16	36	40	5.8
3DCU-7	3DU-7	3	75	57	38	111	212	9 15/32	7 3/8	10 5/16	53	58	5.8
2DCU-9	2DU 9	2	100	76	50	148	282	6 3/8	7 3/8	10 5/16	40	44	5.3
3DCU-9	3DU-9	3	100	76	50	148	282	9 15/32	7 3/8	10 5/16	60	65	5.3
2DCU-11	2DU-11	2	120	90	60	184	342	7 1/2	7 3/16	10 1/4	48	55	5.8
3DCU-11	3DU-11	3	120	90	60	184	342	11 1/8	7 3/16	10 1/4	71	79	5.8
DCU-13	DU-13	1	150	114	75	220	405	6 3/8	7 3/8	10 3/4	38	44	12.5
DCU-15	DU-15	1	175	132	88	253	465	6 3/8	7 3/8	10 3/4	40	46	11.5
DCU-17	DU-17	1	200	150	100	288	524	6 3/8	7 3/8	10 3/4	42	48	10.5

Page

WBN EEB-MS-TI11-0062
~~WBPE0829104002~~ 6/9/18/91

ATTACHMENT
10.9
Page 1 of 1

MKW POWER SYSTEMS, Inc.

Post Office Box 1928
Rocky Mount, NC 27802-1928
Phone: (919) 977-2720
TWX: (510) 929-0725
FAX: (919) 446-1134

TELEFAX

DATE: 12/12/90

COMPANY:

FAX NUMBER: 615/365-1142

ATTENTION: JOHN MANNONE ~ EBASCO

REFERENCE: D.C. PUMPS

FROM: DON GALBREATH

[IF Y]OU DO NOT RECEIVE ALL PAGES LISTED, PLEASE CALL OUR WORD PROCESSING DEPARTMENT. (919) 977-2720, EXTENSION 212.

[PA]GES (INCLUDING COVER SHEET): 1

RESPONSE TO YOUR TELECON WITH OUR MILTON SHARPE THIS MORNING

UPON LOSS OF AC POWER, DC LUBE OIL PUMPS WILL COME ON IN APPROX. 1 MINUTE OR LESS.*

DC FUEL OIL PUMP COMES ON ONLY DURING ENGINE STARTING (UPON ACTIVATION OF START SIGNAL) AND TURNS OFF ONCE ENGINE FUEL PUMP PRESSURE BUILDS (10 SECS MAX). IF WHILE THE ENGINE IS RUNNING, THE ENGINE PUMP LOOSES PRESSURE, THE DC FUEL PUMP WILL START AS A BACKUP IN A MATTER OF A FEW SECONDS.

* 12-12-90 2:20 PM Telephone conversation w/ Don
Expounded on start times for dc lube oil pump motors depending on temperature, Typically min time 30 sec but not less than 10 sec

[signature]
12/12/90

MAINTENANCE REQUEST FORM — NON-NUCLEAR

1 MONTH 11 DAY 27 YEAR 90 TIME CST.	EQUIPMENT IDENTIFIER: UNIT / FUNCTION / SYSTEM / ADDRESS — N/A
2 EQUIPMENT NAME: REFER TO ACT 2A-A DC lube oil & DC fuel pump motors	UNIT/SYSTEM / COMPONENT / ADDRESS
3 LOCATION: BLDG DGB — ELEV N/A	5 ASSIGNED TO: MECH. ☐ ELEC. ☒ INSTRUMENT ☐ OUTAGE ☐ OTHER

6 DESCRIPTION/WORK REQUESTED: NEED STARTING CURRENTS FOR EACH DC LUBE OIL CIRC PUMP MOTOR & EACH DC FUEL PUMP ON DG 2A train A WITH HARD COPY (RECOMMEND VISICORDER). ORIGINATOR DESIRES TO BE PRESENT DURING DATA COLLECTION

7 ORIGINATOR: John C. Mannone — 8 EXT: 1096 — 9 SECTION: ELEC — 10 SUPV. INITIALS: Cel

11 PRIORITY: IM. ATTN. ☐ ROUTINE ☒ — 12 APPLICABLE LCO TECH. SPEC. TIME LIMIT: HRS — 13 EQUIPMENT CATEGORY: CSSC ☒ NON-CSSC ☐ CLASS IE YES ☐ NO ☐ NPRD/EQPT. HIST YES ☐ NO ☐

14 INSTRUCTIONS (INCLUDING APPLICABLE PLANT INSTRUCTIONS): See Att. I.

~~WBNEEBMSTI10062~~
CALC. ~~WBPE 08291-24002~~ 4/1/92
ATTACHMENT
10.10
Page ~~1 of 7~~ 47

15 PRECAUTIONS/POST MAINT. REQUIREMENTS: None

16 WORK/QE REVIEW (CSSC ONLY): Vaughan 11/27/90 — FOREMAN/SUPV. SIGNATURE / DATE — QE SIGNATURE 11-27-90 — DATE

17 WORK CREW SIZE: 2

18 TOTAL ESTIMATED MANHOURS: 4

19 PLANNER REVIEW: Guffey — PLANNING/DATE

20 JOB SAFETY PLANNING (SEE FORM TVA 6436D): Calvin Steele 11/29/90 — RESP. SUPV. SIGNATURE / DATE

21 WORK AUTHORIZATION: 11/29/90 — OPERATIONS SECT. SIGNATURE / DATE

22 CORRECTIVE ACTION/WORK PERFORMED: Assisted T&CS in obtaining start and run currents on motors listed. Starting amps obtained using T&CS recorder 561333 Due 9-25-91, 40 amp & 50 amp scale shunt 471567 Due 5-23-91 (TIF 1000 not quick enough for starting amps). See attachment I for start & run amp data

23 DELAYS: DELAY CODE | MANHOURS

24 CAUSE OF FAILURE: No failure

25 MATERIAL PROCUREMENT No's: (625, 4421, 4139, 209, 201, 144's) No material used

26 CRAFTSMEN'S: J. Boyd J. C. Watson K. Byers

27 MAINTENANCE WORK COMPLETE: S. Steele — FORE./SECT. REP. SIGNATURE 11/30/90

28 POST MAINTENANCE TEST(S) COMPLETE: NA RWB — FORE./SECT. REP. SIGNATURE — DATE 11/30/90

29 ALL WORK/TESTING COMPLETE: Benjamin F. McCoy — OPERATIONS SECT. SIGNATURE — DATE 12/3/90

30 MR COMPLETE-QE REVIEW (CSSC ONLY): QE SIGNATURE — DATE / /

AFFECTED EQUIPMENT LIST

MR No. A-1617680

Page 2 of 2

EQUIPMENT NAME/LOCATION	QA PROGRAM	LIMITED QA	NON-QA	ENVIR QUAL	EQUIPMENT IDENTIFICATION (U / FUNCTION / SYSTEM / ADDRESS)	S
D/G Aux DC Lube oil Circ Pmp Eng #1 LOCATION: BLDG D/G ELEV 742 COLUMN DGB-2AA	✓				2 MTR 0820 0PA	A
D/G Aux DC Lube oil Circ Pmp Eng #2 LOCATION: BLDG D/G ELEV 742 COLUMN DGB-2AA	✓				2 MTR 0820 0PA	A
Eng 2A1 MD Fuel oil pmp LOCATION: BLDG D/G ELEV 742 COLUMN DGB-2AA	✓				2 MTR 082005 4/3	
Eng 2A2 MD Fuel oil pmp LOCATION: BLDG D/G ELEV 742 COLUMN	✓				2 MTR 0820055 /3	
LOCATION: BLDG ____ ELEV ____ COLUMN ____						
LOCATION: BLDG ____ ELEV ____ COLUMN ____						
LOCATION: BLDG ____ ELEV ____ COLUMN ____						
LOCATION: BLDG ____ ELEV ____ COLUMN ____						

CALC. ~~WBPE-06910402~~ WBNEEBMSTI10062
ATTACHMENT 10.10
Page 2 of ~~7~~ 48

JUN 25 1990
issued [illegible]

CALC. ~~[illegible]~~ WBNEEBMSTI110062

ATTACHMENT 10.10

Page ~~3 of 7~~ 49

ATTACHMENT I
MR#A-617680
PAGE 1 OF 1

STANDARD PROCEDURES TO USE DURING MAINT. ACTIVITIES.

APP. B OF AI-9.2.3: Configuration control during maint activities.
AI-1.8: Housekeeping.

OBTAIN AMP READINGS
REFER TO A.E.L.

Reference drawings: 45W760-82-2; 45W760-82-6.

Extreme caution will need to be observed during performance of this task since it will require working close to energized equipment.

Contact MR originator prior to starting performance of this MR.

Assist TC&S personnel in connecting a visicorder to obtain amp readings on referenced motors as requested by MR originator. Also take amp readings using model TIF 1000 ampmeter and record data below.
NOTE: System Engineer John Tucker will be available for lending technical assistance if needed.

Motor ID# 2MTR-082-00PA-A Amp reading 53 / 4 Amp (start / run)

Motor ID# 2MTR-082-00PB-B Amp reading 53 / 5 Amp (start / run)

Motor ID# 2Mtr-082-0054/B Amp reading 36 / 1 Amp (start / run)

Motor ID# 2MTR-082-0055/B Amp reading 36 / 1 Amp (start / run)

MT&E ID# 542789 Due Date 3-6-91
TIF 1000 — RWB 11-29-90

Craft shall verify that the device/devices that has/have been worked upon is/are properly reinstalled after maintenance. By the installation of all bolts, screws, parts, covers, fastners, etc. and that they are snug tight.

"Snug tight"--The tightness that exists when all of the parts of the joint are in firm contact.

Jacquelyn M Boyd / 11-30-90
1st Craftsman / Date

Richard W. Byers / 11-30-90
2nd Craftsman / Date

APPENDIX E
Page 1 of 1

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MAINTENANCE REQUEST PLANNING CHECKLIST

MR NO. A 617680

ITEM	YES	NO		YES	NO
...Order/Clearance Needed ...2.12		✓	Confined Space Entry Permit AI-12.6.6		✓
...ioactive Sources ...2.17 (Series)		✓	Transient Fire Load Permit AI-12.3		✓
...rator Support Needed	✓		Fire Barrier Breaching Permit AI-12.3		✓
...RA Preplanning ...2.7.3, AI-2.7.11		✓	Removal of Fire Protection AI-12.3		✓
...er Craft Support Needed ...st Craft) TC&S	✓		Welding AI-9.4.2, AI-9.9, and AI-9.12		✓
...e Watch Needed		✓	Spray Painting, Cleaning, Sealing—AI-9.12		✓
...E Section XI (Repair/Replace-...t) AI-9.15		✓	Coating Service Level I AI-9.12 and AI-9.2.2		✓
...pendix R		✓	Grinding, Open Flame, Spark Producing AI-9.9		✓
...vironmental Qualification (EQ)		✓	Drilling and Chipping Concrete AI-9.8		✓
...-keeping	✓		Excavating Earth and Backfill AI-9.8		✓
...mmon Mode Failure Potential		✓	Scaffold & Temp Platform AI-12.8.2		✓
...vironmental Review ...-1.34		✓	Open Reactor Coolant System AI-2.6		✓
...pecial Tools/Equipment Required		✓	Open Piping Systems/ Cleanliness TI-27 Part III		✓
...TE Required	✓		Torch Cutting AI-9.9 and AI-9.12		✓
...ot Temperature Work ...CI-914		✓	Ice Condenser Access AI-2.6		✓
...espiratory Protection Needed ...I-12.6.5		✓	Post Maintenance Test or Inspection		✓
...igging ...I-6.4		✓	Radiation Work Permit (RWP) RCI-13		✓
...hemical Use ...aterial Safety Data Sheets		✓	NDE AI-9.7		✓
			QA Hold Points AI-7.1		✓
			Pre Maint Test of Containment Isol Valve TI-31.4		✓

REMARKS:

Planner John Quigley

Date 11/26/90

CALL. WBNEEBMSTI10062 ~~WBFE0824104002~~ GP 4/1/92

ATTACHMENT 10.10

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INSTRUCTIONS: For each wire lifted, record the applicable data and provide a second-party verification the data is correct.
For the Return-To-Normal, ensure each wire is correctly reterminated and provide second-party verification the retermination is correctly performed.

AFFECTED DEVICE	WIRE NUMBER	WIRE COLOR	WIRING — DATA: PANEL or BOX NUMBER	TERMINAL or BLOCK NUMBER	VERIFICATIONS: CONFIGURATION - CHANGE: 1st Party /date	CONFIGURATION - CHANGE: 2nd Party /date	RETURN - TO - NORMAL: 1st Party /date	RETURN - TO - NORMAL: 2nd Party /date
2-FU-082-AAV/1-B	2 wires #3	Grey	2-50-256-4596-A	JCW 11-29-90 ~~T-50~~ [illegible]	J.C.W. 11-29-90	JMB 11-29-90	JCW. 11-29-90	JMB 11-29-90
CONTACTOR FPA	(2) Top LEFT #12	GREY	DG Control panel	N/A RWB 11-29-90	J.C.W. 11-29-90	JMB 11-29-90	J.C.W. 11-29-90	JMB 11-29-90
CONTACTOR FPB	(2) Top Left #12	GREY	DG Control panel	N/A RWB 11-29-90	JCW 11-29-90	JMB 11-29-90	J.C.W. 11-29-90	JMB 11-29-90
2-FU-082-DA1/1A	2 wires #3	GRAY	JB 4996A	+ fuse	RWB 90 11-29-90	JMB 11-29-90	RWB 11-29-90	JMB 11-29-90
2-FU-082-DA1/2A	2 wires #3	GRAY	JB 5001 RWB 11-29-90	+ fuse	RWB 11-29-90	JMB. 11-29-90	RWB 11-29-90	JMB 11-29-90

WBPER910062 ~~WBPER910...~~
CAL. ATTACHMENT 10.10
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CONFIGURATION CONTROL LOG
WIRE LIFTS

MR NO. A-617690

PAGE __ OF __

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second-party verification the change description ... correct.

2. For the Return-To-Normal, ensure each change ... ectly restored and provide a second-party verification the restoration is correctly performed.

CONFIGURATION CONTROL LOG
CONFIGURATION CHANGES

MR NO. A1-G17C80

PAGE __ OF __

Page 6 of 7

AFFECTED DEVICE	CONFIGURATION CHANGE DESCRIPTION	VERIFICATIONS CONFIGURATION - CHANGE 1st Party /date	2nd Party /date	RETURN - TO - NORMAL 1st Party /date	2nd Party /date
2-JB-256-4556-A	Removed cover	JCL 11-29-90	JMB 11-29-90	RWB 11-29-90	JMB 11-29-90
2-JB-256-5001A	Removed cover	JCL 11-29-90	JMB 11-29-90	RWB 11-29-90	JMB 11-29-90
2-FU-082-DA1/1A	Removed fuse	JCL 11-29-90	JMB 11-29-90	RWB 11-29-90	JMB 11-29-90
2-FU-082-A2/1A	Removed fuse	JCL 11-29-90	JMB 11-29-90	RWB 11-29-90	JMB 11-29-90
2-FU-082-A2/4P-A	Removed fuse	JCL 11-29-90	JMB 11-29-90	RWB 11-29-90	RAL 11-29-90
2-FU-082-DA1/1A	Remove fuses	RWB 11-29-90	JMB 11-29-90	RWB 11-29-90	JMB 11-29-90
2-FU-082-DA1/2A	Remove fuses	RWB 11-29-90	JMB 11-29-90	RWB 11-29-90	JMB 11-29-90

CALC. WBNEEMS1100G2
ATTACHMENT 10.10
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APPENDIX B
Page 2 of 2
CONFIGURATION CONTROL LOG
CONFIGURATIONS CHANGES

WBNEEBMSTI110062
ATTACHMENT
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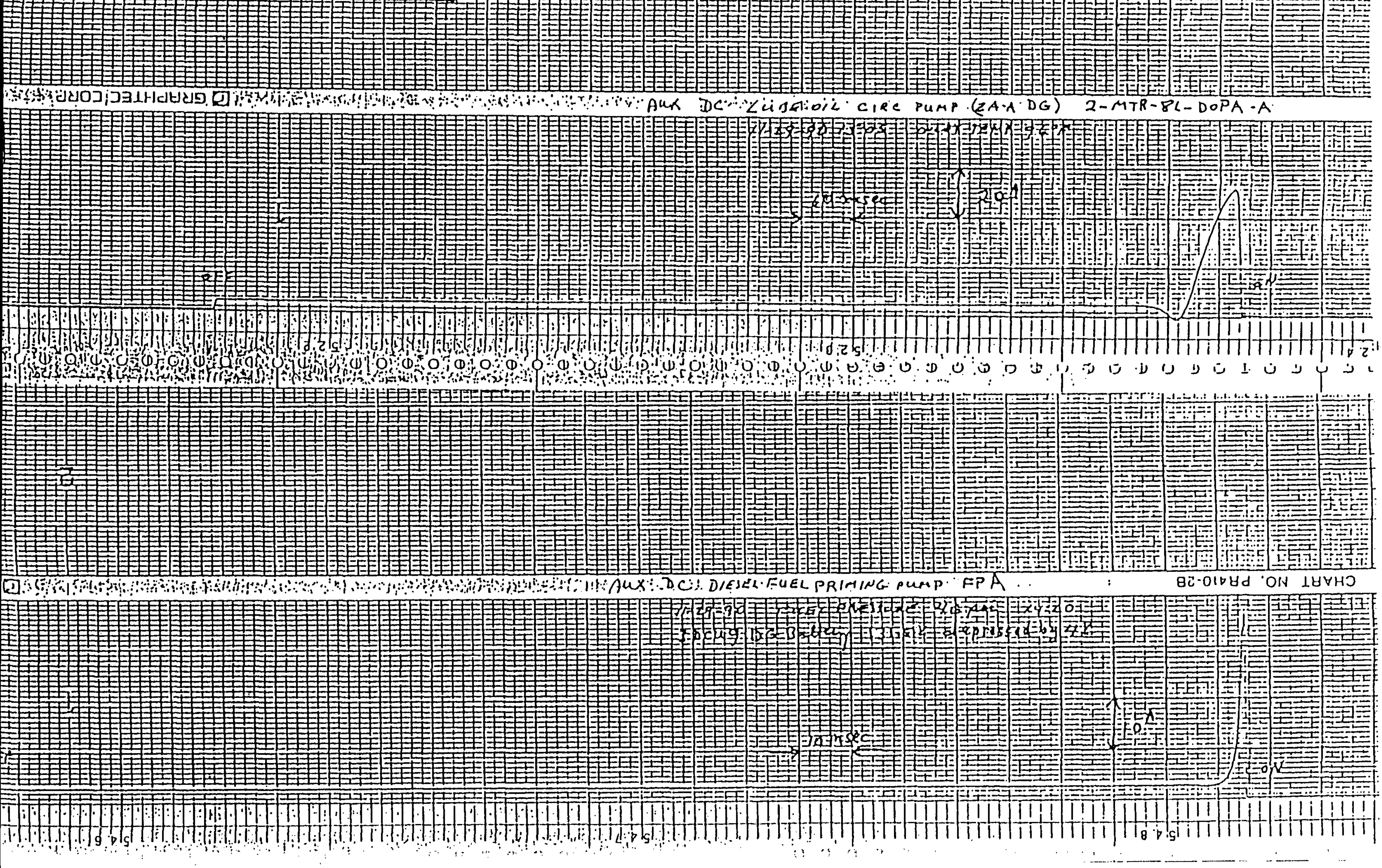


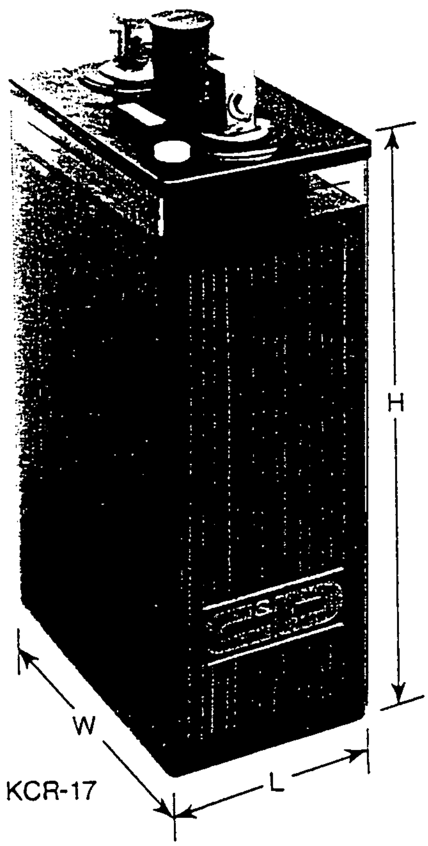
C&D®

CHARTER POWER SYSTEMS

WBNEEBMSTI10062 Attachment 10.11 Page 54

KCR LEAD-CALCIUM
Standby Batteries

- 20-year environmental and seismic qualified
- 100 percent capacity on delivery



KCR-17

Specifications

PLATES	Height	Width	Thickness
• Positive	11.38 in (289 mm)	8.75 in (222 mm)	0.312 in (7.9 mm)
• Negative	11.38 in (289 mm)	8.75 in (222 mm)	0.210 in (5.3 mm)
• Outside negative	11.38 in (289 mm)	8.75 in (222 mm)	0.130 in (3.3 mm)

SPECIFIC GRAVITY.......... 1.215 nominal @77 F (25 C)

CONTAINER †............... Transparent thermoplastic

CELL COVER................ High-impact, flame-retardant thermoplastic with tongue-and-groove seal; flammability ratings: UL 94-VO, ASTM D-635 self-extinguishing

SEPARATORS............... Microporous

RETAINERS................. Fibrous glass mats

ELECTROLYTE HEIGHT ABOVE PLATES............. 2.06 in (52 mm)

WITHDRAWAL TUBES....... Two per cell

SEDIMENT SPACE........... 0.75 in (19.1 mm)

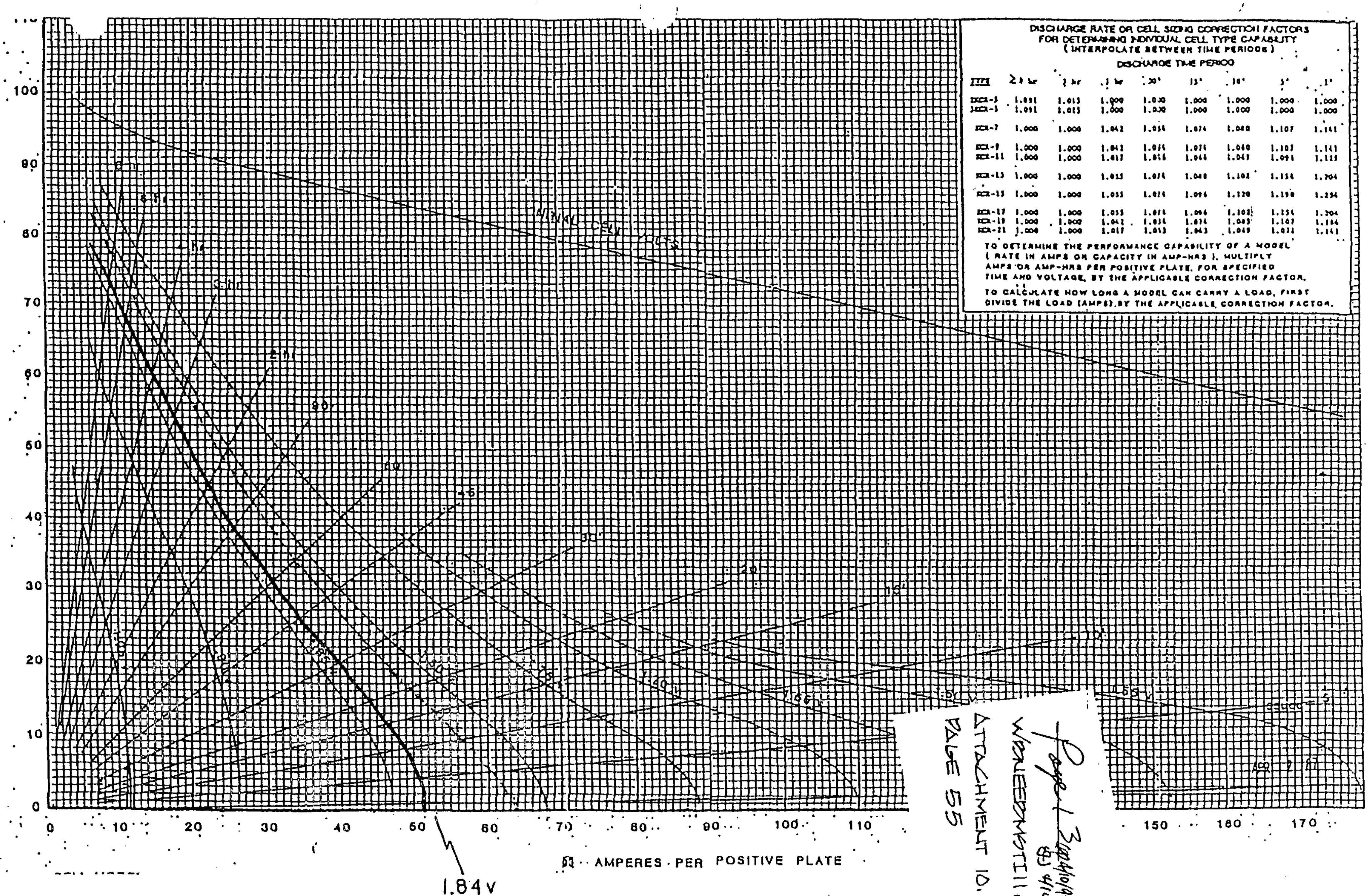
TERMINALS................. 3KCR-5: two 0.5 in x 1.38 in (12.7 mm x 35 mm) cast lead terminals; KCR-7 through 21: two 1 in (25 mm) square posts per cell (Copper inserts are used with 15 through 21 plates.)

VENT CAPS................. Flame arrester type with dust cap

†OPTIONAL CONTAINER............... Transparent, flame-retardent polycarbonate; flammability ratings: UL 94-V2, ASTM D-635, self-extinguishing

Type of Cell	Nominal capacities to 1.75 average VPC @ 77 F (25 C) (includes connector voltage drop)*						Overall dimensions			Approx wt. (lbs) (kgs)		Electrolyte per cell
	Ampere-hours			Amperes			L (in) (mm)	W (in) (mm)	H (in) (mm)	Net filled	Dom. packed	(lbs) (kgs)
Calcium	8 hrs	3 hrs	1 hr	30 min	15 min	1 min						
3KCR-5	180	132	81	109	134	177	8.53 217			122 55.3	135 61.2	13 5.9
KCR-7	250	195	126	172	219	303	3.63 92.2			56 25.4	61 27.7	15 6.8
KCR-9	330	260	168	230	292	404	4.63 118			73 33.1	80 36.3	20 9.1
KCR-11	410	326	204	285	362	500	4.63 118	10.44 265	18.25 464	82 37.2	89 40.4	19 8.6
KCR-13	495	390	255	351	444	639	5.59 142			97 44.0	105 47.6	23 10.4
KCR-15	577	456	298	410	522	777	6.59 167			114 51.7	124 56.2	28 12.7
KCR-17	660	521	340	468	596	852	8.53 217			134 60.8	145 65.8	39 17.7
KCR-19	742	586	378	517	657	929	8.53 217			143 64.9	155 70.3	38 17.2
KCR-21	825	650	410	568	723	1010	8.53 217			152 68.9	165 74.8	36 16.3

Note: Electrolyte weights approximately 10 lbs per gallon (1.210 kgs per liter).
*Data based on discharge directly from a 72-hour float condition, 60-cell battery discharged to 105 terminal volts.
IEEE-450 acceptance testing – optional, 100 percent testing of all cells at name plate rating (1 hour).



DISCHARGE RATE OR CELL SIZING CORRECTION FACTORS
FOR DETERMINING INDIVIDUAL CELL TYPE CAPABILITY
(INTERPOLATE BETWEEN TIME PERIODS)

DISCHARGE TIME PERIOD

TYPE	≥ 3 hr	2 hr	1 hr	30'	15'	10'	5'	1'
[illegible]-5	1.091	1.013	1.000	1.030	1.000	1.000	1.000	1.000
[illegible]-5	1.011	1.013	1.000	1.030	1.000	1.000	1.000	1.000
ECR-7	1.000	1.000	1.042	1.034	1.074	1.040	1.107	1.141
ECR-9	1.000	1.000	1.042	1.034	1.074	1.040	1.107	1.141
ECR-11	1.000	1.000	1.017	1.036	1.044	1.049	1.091	1.123
ECR-13	1.000	1.000	1.033	1.074	1.048	1.102	1.154	1.204
ECR-15	1.000	1.000	1.033	1.074	1.096	1.120	1.190	1.254
ECR-17	1.000	1.000	1.033	1.074	1.096	1.102	1.154	1.204
ECR-19	1.000	1.000	1.042	1.034	1.074	1.045	1.107	1.166
ECR-21	1.000	1.000	1.017	1.013	1.043	1.049	1.071	1.141

TO DETERMINE THE PERFORMANCE CAPABILITY OF A MODEL (RATE IN AMPS OR CAPACITY IN AMP-HRS), MULTIPLY AMPS OR AMP-HRS PER POSITIVE PLATE, FOR SPECIFIED TIME AND VOLTAGE, BY THE APPLICABLE CORRECTION FACTOR.

TO CALCULATE HOW LONG A MODEL CAN CARRY A LOAD, FIRST DIVIDE THE LOAD (AMPS) BY THE APPLICABLE CORRECTION FACTOR.

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BJ 4/10/92
WOLEEDMSTII0062
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Calculation No. WBN EEB-MS-TI11-0062

Prepared by LWH Date 12-17-91

Checked by [signature] Date 12-19-91

Sheet 1

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THIS SHEET ADDED BY REV 3

9069x

Attachment No. P-04575-A
Calculation No. WBN EEB-MS-TI11-0062

Prepared by ____ Date 12-19-91

Checked by ____ Date 12-19-91

Sheet 2

TABLE OF CONTENTS

This Attachment Package contains 26 total pages.

THIS SHEET ADDED BY REV. 3

9069x

1.0 PURPOSE AND SCOPE

1.1 Purpose

- The purpose of this attachment is to evaluate and support the modifications to be implemented under DCN P-04575-A.

This attachment documents the roll-up of mini-calculation No. WBPE 0828905039.

The attachment affects the following baseline calculation:

Baseline Calculation	Calculation No.
125V DC Diesel Generator (DG) Control Power System Evaluation	WBN EEB-MS-TI11-0062

THIS SHEET ADDED BY REV 3

1.2 Scope

The scope of this calculation is to Verify and document the adequacy of the size and types of fuses installed in circuits for the diesel generator priming fuel pumps and air start solenoid valves. The fuses in the C-S engine control panels are Bussmann KLM-10 installed to implement the corrective action for NCR W-326-P R0 (Ref. 5.6) per ECN 6180 (Ref. 5.7).

2.0 CRITERIA

Each protective device (fuse) shall have a continuous rating greater than the circuit load current but less than or equal to the allowable circuit ampacity. The current interrupting capacity (AIC) shall be greater than the maximum credible fault current. The melting times must be less than the upstream breaker trip initiation time during fault conditions to assure adequate fuse-breaker coordination..

3.0 APPLICABLE CODES AND STANDARDS

3.1 Electrical Design Standard DS-E12.6.3, R2.

3.2 Electrical Design Guide DG-E2.4.6, R0.

3.3 National Fire Protection Association, NFPA 70, National Electrical Code, 1990 Edition, Articles 210-22, 240-3 (Exception No. 1) and 240-6.

4.0 ASSUMPTIONS

4.1 Justified Assumptions

The Gould Shawmut TRM-1 fuse has not been tested for maximum DC current interrupting capacity (AIC), however, typical DC ratings range from 10 to 50 percent of the AC ratings. This calculation demonstrates that the maximum SC current to which the TRM-1 would be subjected is 137 amperes (Section 7.3.2) which is less than 1.5 percent of the AC rating of 10 K AIC. Based on the above, it is assumed that the fuse will safely interrupt this small SC current.

There are no unverified assumptions.

5.0 REFERENCES

5.1 TVA Drawings - 1-45W760-82-2 (R1) and -4 (R1), Wiring Diagrams - Standby Diesel Generator System - Schematic Diagrams.

5.2 TVA Drawings - 1-45W760-82-12 (R1) and -14 (R0), Wiring Diagrams - Standby Diesel Generator SC-S - Schematic Diagrams.

5.3 Vendor Drawings - Power Systems Division Morrison-Knudsen Company, Inc. Contract 83090 - 6036F02501 Sheet 1 (R905, C) and Sheet 7 (R904, C) - Schematic Diagram - Engine Controls and Alarms.

THIS SHEET ADDED BY REV 3

5.0 REFERENCES (Continued)

5.4 Vendor Drawings - Power Systems Division Bruse GM Diesel, Inc. - Contract 83090 - D379F02501 Sheet 1 (R904, C) and Sheet 7 (R902, E) - Schematic Diagram - Engine Controls and Alarms.

5.5 WBNP Computerized Cable Routing System, CCRS - WBNP Cable Schedule Complete Summary.

5.6 Nonconforming Condition Report NCR W-326-P R0.

5.7 Engineering Change Notice ECN 6180.

5.8 Field Verification of priming fuel pump motor and air-start solenoid valves.

5.9 TVA Drawings - Diesel Generator Connection Diagrams

45W1780-1 RG
45W1781-1 NN
45W1782-1 RE
45W2780-1 RK
45W2781-1 RL

(TVA Contract No. 74C63-83090)

5.10 TVA Drawings - Environmental Data - Mild

47E235-29 R2
47E235-29 R2

5.11 Departmental Guidelines for Electrical Mini Calculation Roll-Up ELEC-004 of 4-30-91.

6.0 DESIGN INPUT DATA

6.1 Cable Data (See Appendix I)

6.2 Priming Fuel Pump Motor, (Appendix F and B)

Manufacturer: Honeywell
Model: BA36-40-1524-48BP (Nameplate)
Size: 1/2 hp
Voltage: 90VDC
FLA: 4.7 Amp
LRA: 75.0 Max

6.3 Air-Start Solenoid Valves, (Appendix G & B)

Manufacturer: Graham-White Mfg Co.
Type: Salem Model 712-051
Coil: 3160-020
I Holding: 0.094 Amps
I Inrush: 0.131 Amps

THIS SHEET ADDED BY REV 3

6.0 DESIGN INPUT DATA (Continued)

6.4 Relay (Blown Fuse), (Ref. 5.9 & Appendix H)

- Mfr/Model: Square D/KPD13
  Voltage Rating: 125VDC
  Power: 1.2 watt standard; 3 watt maximum
  I(MAX) = 3w/125 VDC = 0.024 Amp

6.5 Fuse: Bussmann FNM-10, (Appendix D)

AIC: 10 K AIC @ 125 VDC

6.6 Fuse: Gould Shawmut TRM-1, (Ref. 4.0 & Appendix E)

Resistance Range: 0.690 - 0.795 ohm
AIC: (see 4.0)

6.7 Circuit Breaker, Molded Case (Ref. 5.9)

Mfr/Model: Square D/FAL 22015
Rating: 15 Amp, 125 VDC

7.0 ANALYSIS/COMPUTATION

7.1 Priming Fuel Pump Motor Circuits

The simplified control circuit schematic for this calculation is shown in Appendix A (Sh. 2). These circuits are identical to the similar circuits in the other DG sets; the following calculation will be generic for all circuits.

7.1.1 The fuse protecting a combination motor circuit must be greater than 125% of the motor load (4.7 Amps) plus 100% of the relay load (0.024 Amps)(reference 3.3), or Minimum fuse rating = F_R

$$F_R \geq 1.25 \times 4.7 + 0.024 \geq 5.9 \text{ Amps}$$

Because the ambient temperature within the diesel engine rooms can reach 120°F (reference 5.10), fuse derating is required. Adding an estimated 30°F panel internal temperature for conservatism, the derating factor of 0.85 (Appendix D) yields minimum fuse size of;

$$F_R \geq \frac{5.9}{0.85} \text{ Amp} \geq 6.94 \text{ Amp}$$

THIS SHEET ADDED BY REV 3

7.0 ANALYSIS/COMPUTATION (Continued)

All conductors listed in Appendix I table 1 are #14 AWG routed in V3 (Ref. 5.5) and rated 6 amp per DS-E12.6.3 (Ref. 3.1). Therefore, per NEC section 240-6 and 240-3 exception 1, a 10 amp fuse will provide protection to the conductors and meet the above minimum requirements.

Use Bussmann style FNM or similar 10 amp dual-element, time delay fuse due to DC motor inrush. The FNM-10 is a standard stores stock item at Watts Bar Nuclear Plant.

7.2 Air Start Solenoid Valves

The simplified control circuit schematic for this calculation is shown in Appendix A (sh. 3). The other air start solenoid circuits may be treated generically for all diesel engine control panels.

The holding current for each valve coil is 0.094 Amps (Reference 6.3). The blown fuse relay current is 0.024 Amps (Refernce 6.4). The load current, I_L, is

$$I_L = 2 \times 0.094 + 0.024 = 0.212 \text{ Amps}$$

$$F_R \geq 1.25 \times 0.212 \geq 0.31 \text{ Amp}$$

Again applying temperature effect fuse derating

$$\text{Min FR} \geq 0.265/0.85 \geq 0.31 \text{ Amp}$$

The next NEC standard fuse rating above this value is 1 amp (reference 3.3). The Gould Shawmut dual-element, TRM-1 would satisfy the above criteria. The TRM-1 is a standard stores stock item at Watts Bar Nuclear Plant.

7.3 Short Circuit Coordination

7.3.1 Fuel pump motor circuits:

A review of all feeder and end device cable combinations resulted in a worst case (minimum resistance) for fuel pump FPA circuit for the 1B-B diesel generator. The resistance of Bussmann fuse FNM-10 is negligible (See Appendix D).

$$R_{PP628B} = 2 \times \frac{1.04}{1000} \times 58 = 0.12 \text{ Ohm (Appendix I)}$$

$$R_{PP527B} = 2 \times \frac{2.62}{1000} \times 58 = 0.30 \text{ Ohm (Appendix I)}$$

THIS SHEET ADDED BY REV 3

$R_{CKT} = Z_S* + R_{PP628B} + R_{PP527B}$ ohm LWH 12-19-91 J.H. 12-19-91
(ref. baseline calculation, 6.5 and Appendix I)

= (0.0682 + 0.12 + 0.30) Ohm = 0.49 Ohms

This resistance represents a SC current of

$I_{SC} = 117.4V^*/R_{CKT} = 117.4/0.49 = 239$ Amps

7.0 ANALYSIS/COMPUTATION (Continued)

For this SC value, the minimum breaker trip initiation time would be approximately 0.4 seconds. The fuse melting time would be approximately 0.025 seconds and coordination is assured for a solid short circuit near the end device and the FNM has adequate current interrupting capacity of 10KAIC (reference 6.5).

Based on motor manufacturer's recommendation (Appendix E) diesel operating experience, the dual-element fuse will permit proper motor operation.

7.3.2 Air start solenoid circuits:

A short circuit at the load side of the fuse, assuming the worst case cable lengths, would involve cable PP508A (or PP748B, both are of equal length, Appendix I Table II).

$$R_{PP508A} = 2 \times \frac{1.04}{1000} \times 48 = 0.100 \text{ Ohm}$$

Per reference 6.6, the minimum resistance of a TRM-1 fuse is 0.690 ohm. The circuit resistance is

$R_{CKT} = Z_S* + R_{PP508A} + R_{TRM-1}$ ohm LWH 12-19-91 J.H. 12-19-91

$R_{CKT} = (0.0682 + 0.100 + 0.690)$ ohm = 0.86 Ohm

$I_{SC} = 117.4$ VDC*/0.86 = 137 Amps

For this SC value, this minimum breaker trip initiator time would be approximately 0.95 seconds. The fuse melting time would be less than 0.01 seconds, thus coordination is assured.

* Z_S (0.0682 Ohms) and source voltage (117.4V) from Section 6.4.7 of base calculation. Z_S is the equivalent source impedence of the battery, battery changers, fuel oil pump motors and lube oil pump motors.

THIS SHEET ADDED BY REV 3

Attachment No. P-04575-A
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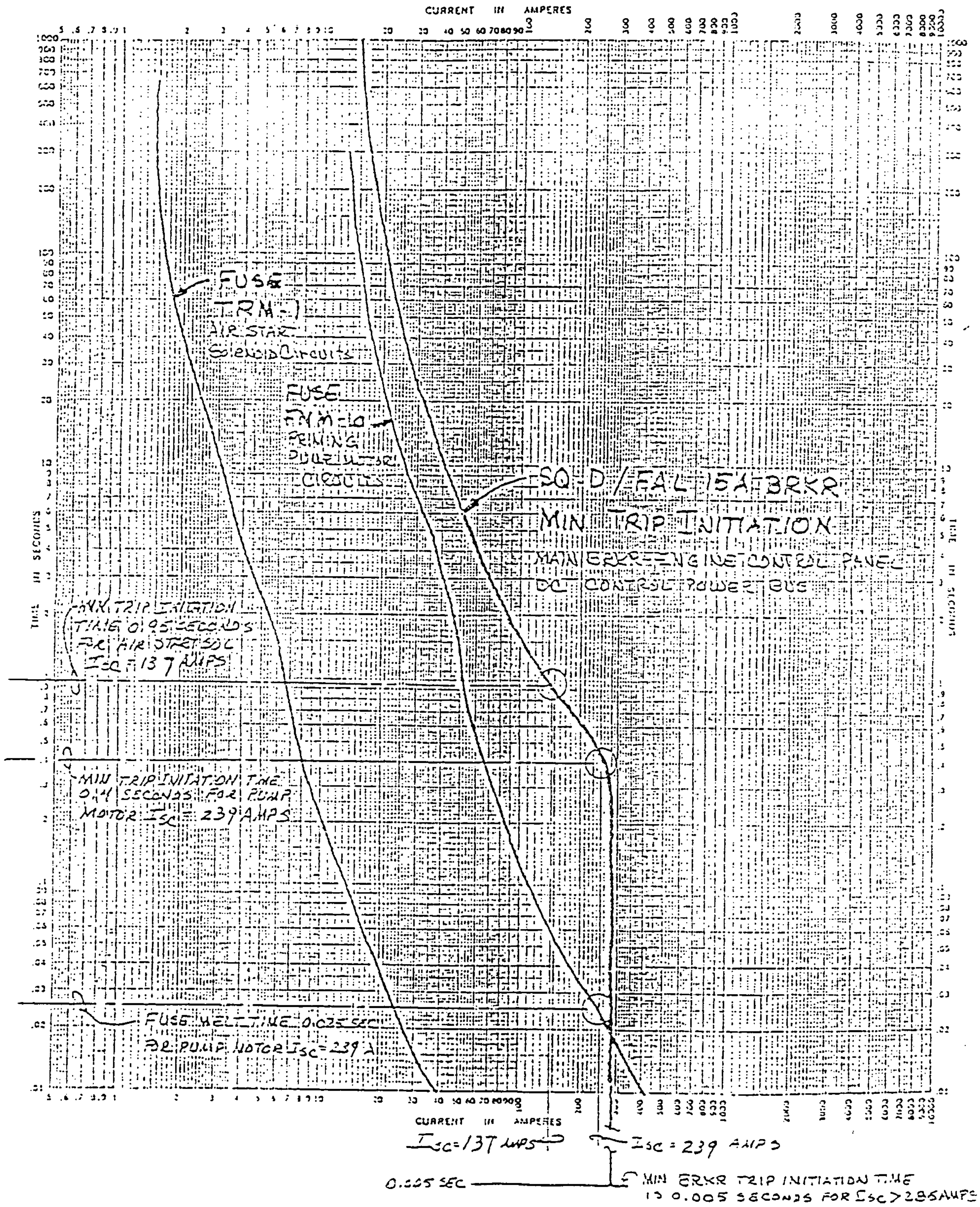
Prepared by ________ Date 12-19-91

Checked by ________ Date 12-19-91

Sheet 9

7.3.3 Superimposed time-current characteristics curves for square D, 15 Amp FAL breaker and fuses.



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THIS SHEET ADDED BY REV 3

8.0 SUMMARY OF RESULTS

8.1 The optimum fuse size/type for the priming fuel pump circuits, incorporating a derating factor due to high ambient temperature, should be a dual element, 10 Amp Bussmann FNM-10 or equivalent.

8.2 The load current for the air start solenoid circuits is 0.212 Amps. Application of temperature effect derating requires a dual element 1 Amp fuse Gould Shawmut TRM-1 or equivalent.

8.3 The coordination of fuse TRM-1 and FNM-10 with SQ-D FAL 15A breaker is shown in sheet 9.

9.0 CONCLUSION

9.1 The fuses presently installed in the fuel pump motor circuits in the C-S diesel generator control panels should be changed to dual element 10A fuses, Bussmann type FNM-10.

9.2 The fuses presently installed in the air start solenoid circuits for all diesels should be changed to 1 Amp dual element, Gould Shawmut type TRM-1.

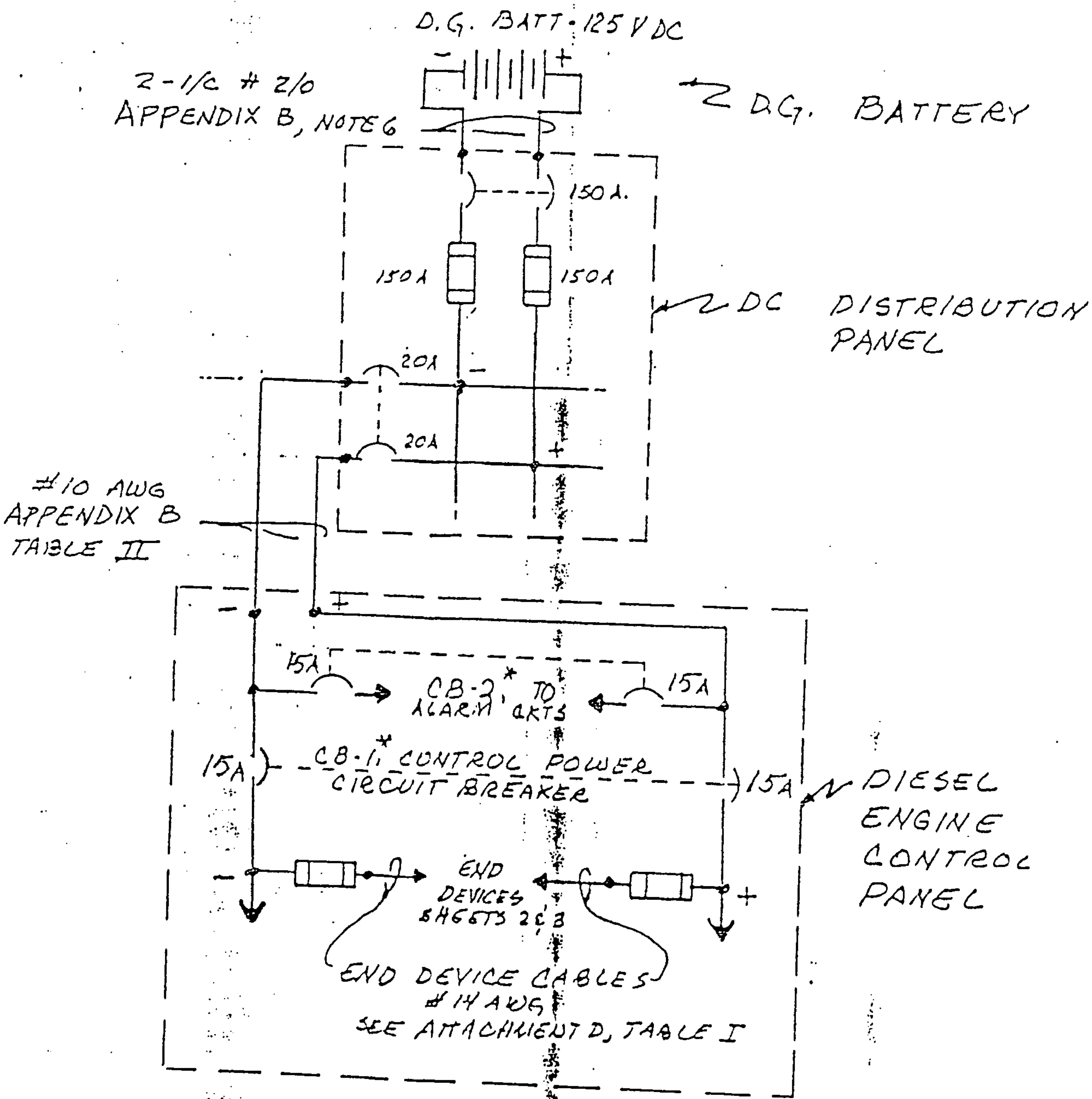
9.3 These fuses will allow the circuit devices to perform their design functions. The fuses coordinate with the breakers.

THIS SHEET ADDED BY REV 3

Attachment No. P-04575-A
Calculation No. WBN EEB-MS-TI11-0062

Appendix A
Sh. 1

SKETCH- TYPICAL SCHEMATIC
DIESEL GENERATOR DC CONTROL POWER (REF 5.1 & 5.2)



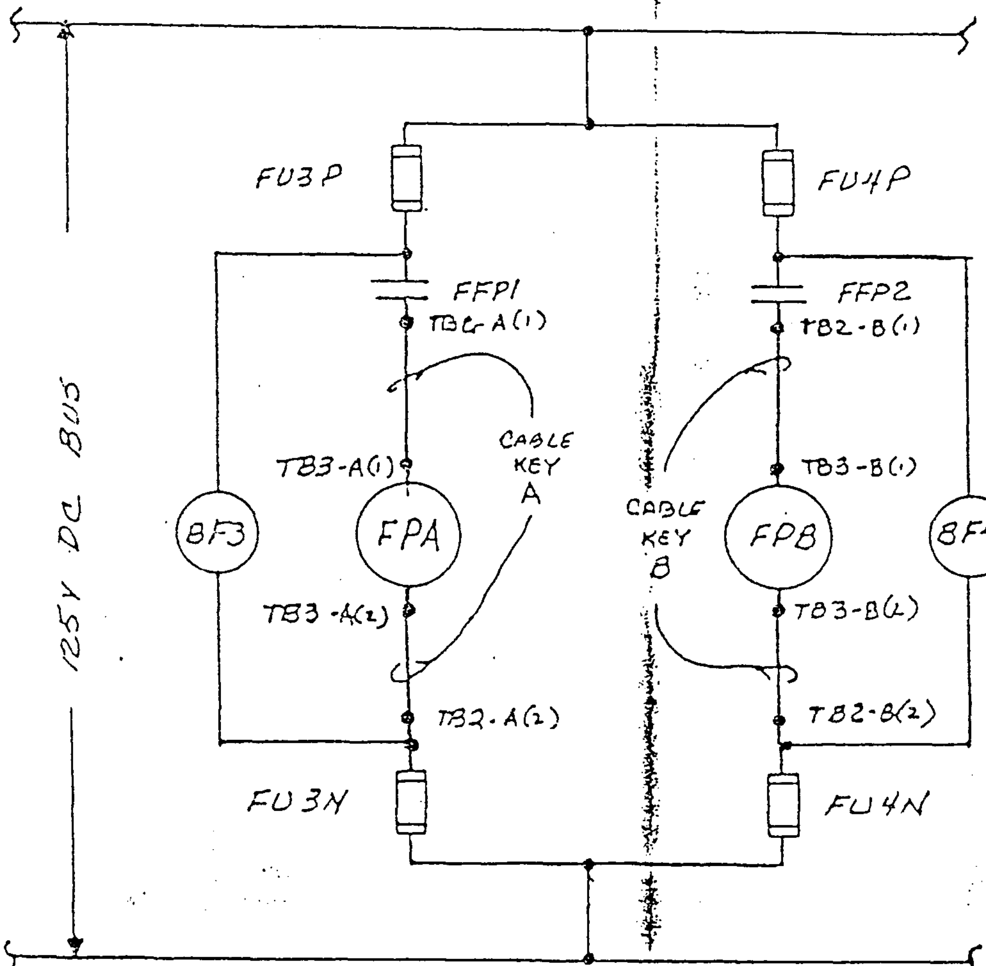
* 15A, SQUARE D, FAL 22015, 2P, 125VDC

THIS SHEET ADDED BY REV 3

Attachment No. P-04575-A
Calculation No. WBN EEB-MS-TI11-0062

Appendix A
Sh. 2

SKETCH - TYPICAL SCHEMATIC
CONTROL CIRCUIT FOR DIESEL
GENERATOR PRIMING FUEL PUMPS
(REF. 5.1 & 5.2)



FPA, B : PRIMING FUEL PUMP MTRS
BF3, 4 : BLOWN FUSE RELAYS
FU3 P, N : FUSES
FU4P, N : FUSES

NOTE: SEE SCTN. 6.1 FOR CABLE KEY/IDENTIFIERS

THIS SHEET ADDED BY REV 3

J. PARRISH
8/1/89

Attachment No. P-04575-A
Calculation No. WBN EEB-MS-TI11-0062

SKETCH- TYPICAL SCHEMATIC CONTROL CIRCUIT FOR DIESEL GENERATOR START SOLENOIDS (REF. 5.1 & 5.2)

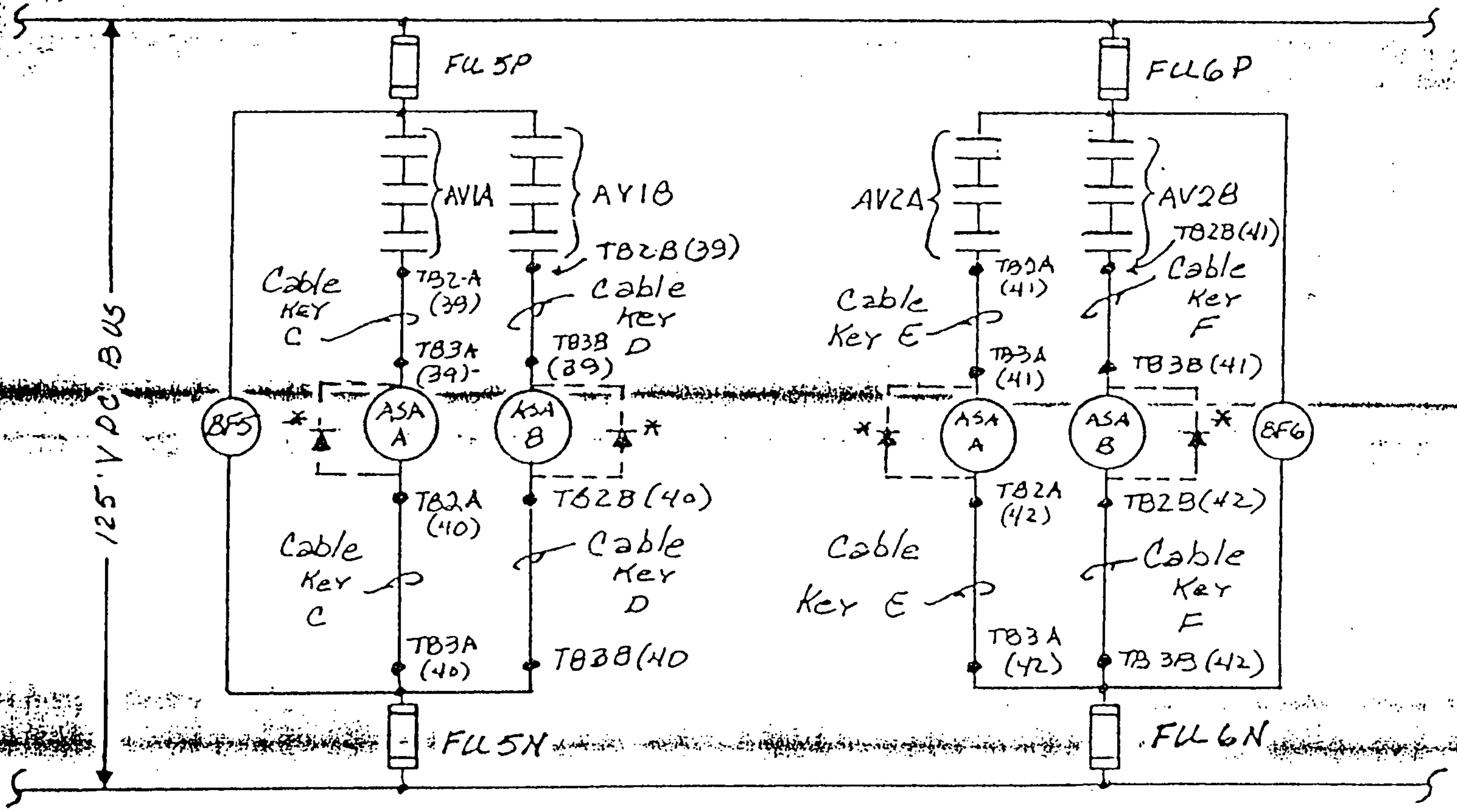
LEDGEND:

ASA-A,B: AIR START SOLENOID VALVES A & B

BF5,6: BLOWN FUSE RELAYS

FU5(N&P) : FUSES
FU6(N&P)

* DIESEL GEN. 1A-A, 1B-B, 2A-A, & 2B-B ONLY



NOTE; SEE ATTACHMENT D FOR CABLE KEYS VERSUS CABLE IDENTIFIERS

THIS SHEET ADDED BY REV 3

Appendix A
Sh. 3

Attachment No. P-04575-A

CALCULATION NO. WBN EEB-MS-TI11-0062

APPENDIX NO. B

FIELD VERIFICATION

Priming Fuel Pump Motor

1. Manufacturer: Honeywell

   Model: BA36-46-1524-48BP (Nameplate)

   Size: $\frac{1}{2}$ HP

   FLA: 4.7 Amp

2. Manufacturer: Applied Motor

   FLA: 4.0 Amp

   Other details not visible on nameplate

   Honeywell motor has higher FLA of 4.7 Amp is worst case.

RECORDED BY [signature] DATE 12-16-91

VERIFIED BY [signature] DATE 12-16-91

1346x

THIS SHEET ADDED BY REV. 3

Attachment No. P-04575-A

CALCULATION NO. WBN EEB-MS-TI11-0062 APPENDIX NO. B

FIELD VERIFICATION

·Air-Start Solenoid Valve

Manufacturer: Graham-White Mfg. Co.

Type: Salem Model 712-50

RECORDED BY [signature] DATE 12-16-91

VERIFIED BY [signature] DATE 12-16-91

THIS SHEET ADDED BY REV 3

1346x

Appendix C

RECORD OF TELEPHONE CONVERSATION

Attachment No. P-04575-A
Calculation No. WBN-EEB-MS-TI11-0062

DATE July 24, 1989

TO : Files: Calc WBPE0828905039
Name/File No.

FROM : James G. Parrish, ESI

CLIENT/PROJECT: TVA - WBNP

SUBJECT: DG Primer Fuel Pump Motors - OL's

CHARGE : DEPT. NO.________ CLIENT SYMBOL________ OFS NO.________

DISCUSSION WITH

James Dunka
Pacific Scientific
(815) 226-3100

Requested whether subject pump motors had internal overload protection, and their recommendations for adequate protection.

(Reference record of tele. conversation between J. Dunka and D. Martin dated May 12, 1989)

COMMENTS

Dunka confirmed the motors did not contain OL's and their "maintenance bulletins" recommended 115% of FLA for adequate OL protection in branch circuit using dual-element, time-delay fuses.

BY: James G. Parrish Sr. Engr.
NAME TITLE DEPT. NO.

cc:

5755e

Attachment No. P-04575-A
Calculation No. WBN EEB-MS-TI11-0042

Appendix D
Sh. 1

Fuse Time-Current Characteristic Curves * and Temperature Effects

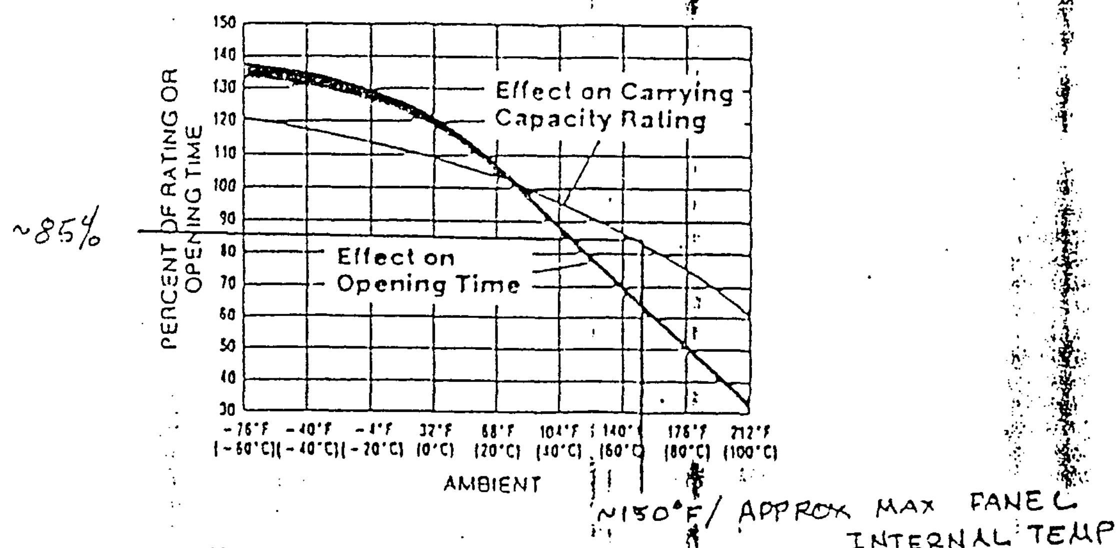
*Average Total Clearing Time

Effects of Ambient Temperatures

The operating characteristics of fuses are based on a nominal ambient temperature level. Higher ambients will, to some extent, reduce the current carrying compacity and the fuse opening time. Conversely, lower ambients result in a somewhat increased current carrying capacity and opening time.

As indicated in the Fusetron graph below, for example, an ambient of 100°F (40°C) reduces the current carrying capacity of this type of fuse by 5%.

The graphs below show the effects of ambient temperatures for Fusetron and "Non-Time-Delay" fuses.



Effects of Ambient Temperature on the Operating Characteristics of Fusetron Dual-Element Fuses. Nominal Fuse Ratings Based on Ambient Temperatures in the Range of 70°F (21.0°C) thru 80°F (26.7°C). Change in Opening Time Occurs with Loads of 500% (or less) of the Nominal Current Rating of the Fuse.

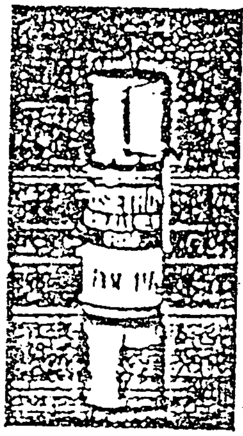
THIS SHEET ADDED BY REV 3

Attachment No. P-04575-A
Calculation No. WBN-EEB-MS-TI11-0062

Appendix D
Sh. 2

Type FNM

13/32" × 1½" (10.3mm × 38.1mm)
Time-Delay



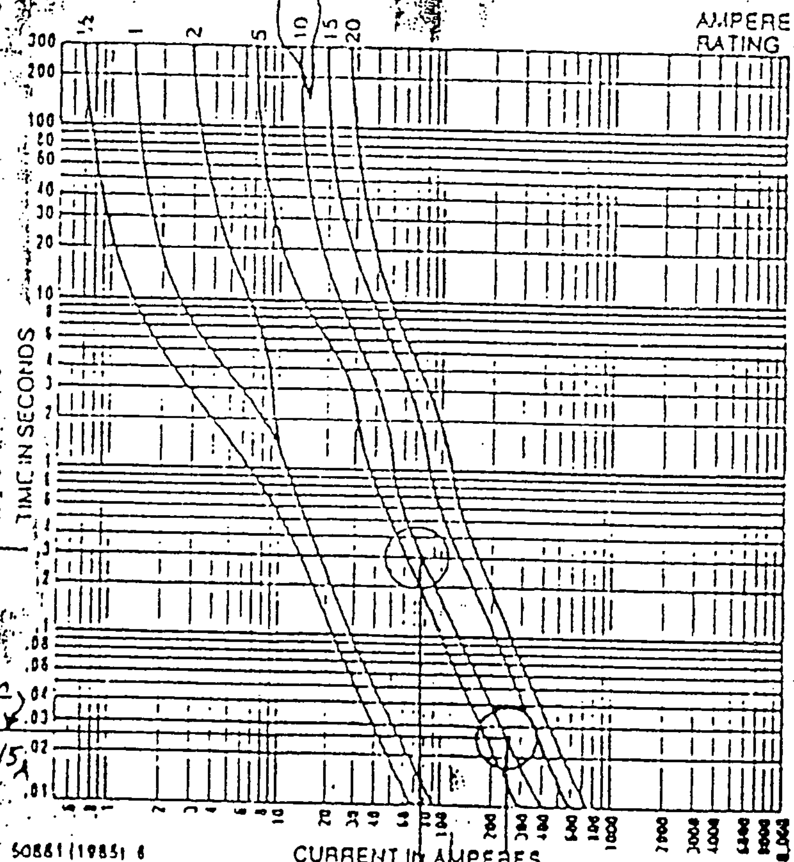
Fibre. Formerly designated SA8. A dual-element Fusetron® fuse. For circuits with high inrush currents. Mount in Buss fuseholders, fuseblocks, and clips. Shipping weight per 100—1.5 lbs. (680g). U.L. File E19180; Guide JDYX. CSA File 53787; Class 1422-01.

Electrical Ratings (Catalog Symbol and Amperes)

250 Volts		250 Volts		250 Volts		250 Volts	
FNM-1/10	U.L. Listed & CSA	FNM-1 1/8	U.L. Listed & CSA	FNM-3	U.L. Listed & CSA	FNM-8	U.L. Listed & CSA
FNM-15/100		FNM-1 1/4		FNM-3 2/10		FNM-9	
FNM-2/10		FNM-1 4/10		FNM-3 1/2		FNM-10	
FNM-1/4		FNM-1 1/2		FNM-4		125 Volts	
FNM-3/10		FNM-1 6/10		FNM-4 1/2		FNM-12	
FNM-4/10		FNM-1 8/10		FNM-5		FNM-15	
FNM-1/2		FNM-2		FNM-5 6/10		32 Volts	
FNM-6/10		FNM-2 1/4		FNM-6		FNM-20	
FNM-8/10		FNM-2 1/2		FNM-6 1/4		FNM-25	
FNM-1		FNM-2 8/10		FNM-7		FNM-30	

LEGIBILITY EVALUATED and
ACCEPTED for issue

[signature] 10/11/89
Signature Date



50881 (1985) 6
Time-Current Curves – Typical

U.L. File E19180; CSA File 53787

THIS SHEET ADDED BY REV 3

Attachment No. P-04575-A
Calculation No. WBN EEB-MS-TI11-0062

Appendix D
Sh. 3

RECORD OF TELEPHONE CONVERSATION

DATE 7/20/89
9/20/89 (supplement)

TO : Files: CALC
Name/File No.

FROM : JIM PARRISH, ESI

CLIENT/PROJECT: TVA WBN

SUBJECT: AIC for Bussman FNM fuses

CHARGE : DEPT. NO. ________ CLIENT SYMBOL ________ OFS NO. ________

DISCUSSION WITH Jim Calzona
Bussman Fuses
(314)-394-2877

Per Jim, the AIC for the FNM is 10 KAIC @ 125VDC.

9/20/89 - Supplementary
Contacted Jim again requesting FNM resistances with following results:

	OHMS RESISTANCE RANGE (COLD)
FNM-1	0.650 - 0.750
FNM-8	0.011 - 0.0135
FNM-10	0.0072 - 0.00730

COMMENTS

BY: [signature] NAME Sr. Engr TITLE EE DEPT. NO.

cc:

5755e

THIS SHEET ADDED BY REV. 3

Attachment No. P-04575-A
Calculation No. WBN EEB-MS-TI11-0062

Appendix E

RECORD OF TELEPHONE CONVERSATION

DATE 8/23/89

TO CINDY CLINE - GOULD SHAWMUT
NAME/FILE NO.

FROM BRIAN FORTENBERY - EBASCO SERVICES, INC.

CLIENT/PROJECT TVA / WATTS BAR NUCLEAR PLANT

SUBJECT FUSE RESISTANCE

CHARGE: DEPT. NO ______ CLIENT SYMBOL ______ OFS NO ______

DISCUSSION WITH

CINDY CLINE OF GOULD-SHAWMUT REVEALED THAT THE COLD RESISTANCE OF TRM-1 FUSES IS 0.690 - 0.795 OHMS.

The above info is correct.
H. Cynthia Cline
Applications Engineer

COMMENTS:

BY Brian Fortenbery (NAME) ENGR. (TITLE) ELEC. (DEPT. NO.)

THIS SHEET ADDED BY REV 3

Attachment No. P-04575-A
Calculation No. WBN EEB-MS-TI11-0062

RECORD OF TELEPHONE CONVERSATION

Appendix F

DATE May 12, 1989

TO Pacific Scientific (815) 226-3100
NAME/FILE NO

FROM David Martin NE-EBASCO WBNP

CLIENT/PROJECT TVA/WBNP

SUBJECT Disel Generator Primer Fuel Pump

CHARGE: DEPT. NO. ______ CLIENT SYMBOL ______ OFS NO. ______

DISCUSSION WITH

James Dunlea referred by John Tucker TVA/WBNP maintenance Ext. 8591

Honeywell sold this motor division to Pacific Scientific

Base on information given to Pacific Scientific:
see Appendix B. [initials] 12-17-91

~~90VDC, 4.7 Amp 12~~ DM 5/12/89

(1) Replacement motor in TVA shop Honeywell Model BA36-40-1524-48BD 1/2 HP 125VDC 2300RPM FL

(2) Motor in service Honeywell 90VDC, 4.7 Amp

(3) Pump supplied to Morrison Knudsen Co for TVA contract # 74C63-834

COMMENTS

James Dunlea provide the following information

Honeywell 90VDC
FLA 4.7 Amp
LRA 75.0 max
RPM 1750
1/2 H.P.

LEGIBILITY EVALUATED and ACCEPTED for issue

[signature] 10/11/89
Signature Date

CC:

BY [signature: David D Martin] EE NE-EBASCO
NAME TITLE DEPT. NO

Ext 1788

THIS SHEET ADDED BY REV 3

Attachment No. P 04575-A
Calculation No. WBN EEB-MS-TI11-0062

Appendix G

The SALEM Line

Graham-White Sales DIVISION

GRAHAM-WHITE MANUFACTURING COMPANY

Pneumatic and Electro-Pneumatic Devices

FAX NO.: 615/365-1142

TO: Mr. David Martin
Tennessee Valley Authority

DATE: 6/12/89

SUBJECT: Salem 3160-020 Coil Electrical Information

MESSAGE: Dear Mr. Martin,

With reference to our conversation this morning, I am pleased to furnish the following information on the Salem 3160-020 coil:

in rush current	131 milliamps
holding current	94 milliamps

Should you require additional information, please advise.

Mike Cromer

Mike Cromer

THIS SHEET ADDED BY REV. 3

1242 COLORADO STREET P.O. BOX 1099 SALEM, VA 24153-1099 PHONE (703) 387-5020 FAX (703) 387-5639

Attachment No. P-04575-A
Calculation No. WBN EEB-MS-TI11-0062

Appendix H

GENERAL PURPOSE CONTROL RELAYS

TYPE K

8501

APPLICATION DATA — TYPE K

CONTACT RATINGS

AC						DC		
Volts	Amperes				HP	Volts	Amperes	
	Inductive 35% PF			Resistive 75% PF				
	Make	Break	Continuous	Make, Break & Continuous			Make Break	Continuous
120	30	3	10	10	1/3 Δ	8-120	60 VA	10 A
240	15	1.5	10*	10*	1/2			

* 3 pole devices have 6¾ Amps max. continuous rating.
Δ Type KP rated ¼ HP.

OPERATING DATA

Pick-Up Time:
Types KF, KP, KU — Approximately 15 ms
Type KL — Approximately 25 ms

Drop-Out Time:
Types KF, KP, KU — Approximately 10 ms
Type KL — Approximately 25 ms

Operating Temperature Range:
Types KF, KP, KU
AC: 2 pole: −45°C to +55°C (−49°F to +131°F)
3 pole: −45°C to +45°C (−49°F to +113°F)
DC: −45°C to +70°C (−49°F to +158°F)
Type KL
AC/DC: −45°C to +70°C (−49°F to +158°F)

CONTACTS

Configuration: 2 or 3PDT (2 or 3 Form C)
Material: Silver cadmium oxide
Ratings: See table above

UL/CSA

UL Component Recognized and CSA Certified

UL listed with appropriate Class 8501 Types NR-51, NR-52, NR-61, NR-62 and NR-82 sockets.

COILS

Duty: Continuous rated coils

Standard Voltages:

	Type KP	Types KU, KF	Type KL
[illegible]	[illegible]	6,12,24,48,120,240	24,120,240
DC	6,12,24,48,110,125,130	6,12,24,48,110	12,24

Operate:
[illegible]
DC: 75% of Nominal Voltage at 25°C (77°F)

Burden:
Type KP:
[illegible]
DC: 1.2 watts standard
3 watts maximum

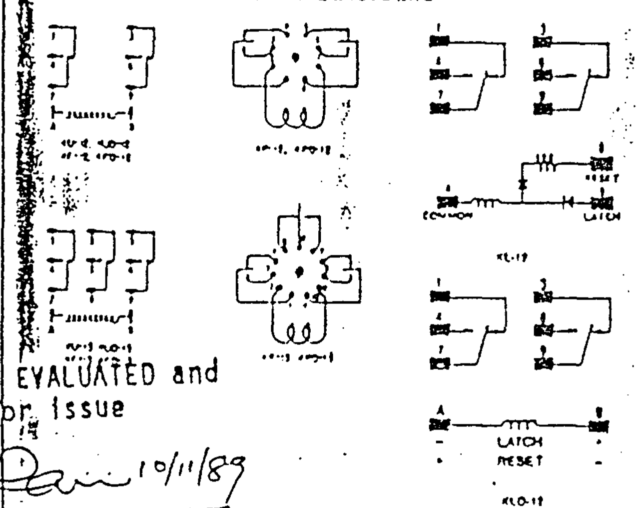
Types [illegible]
AC: 2 pole — 3 VA inrush,
2 VA sealed
3 pole — 5.4 VA inrush,
2.7 VA sealed
DC: 1.2 watts standard
3 watts maximum

Type KL:
AC: 2.0 VA latch, 0.6 VA unlatch
DC: 1.22 watts

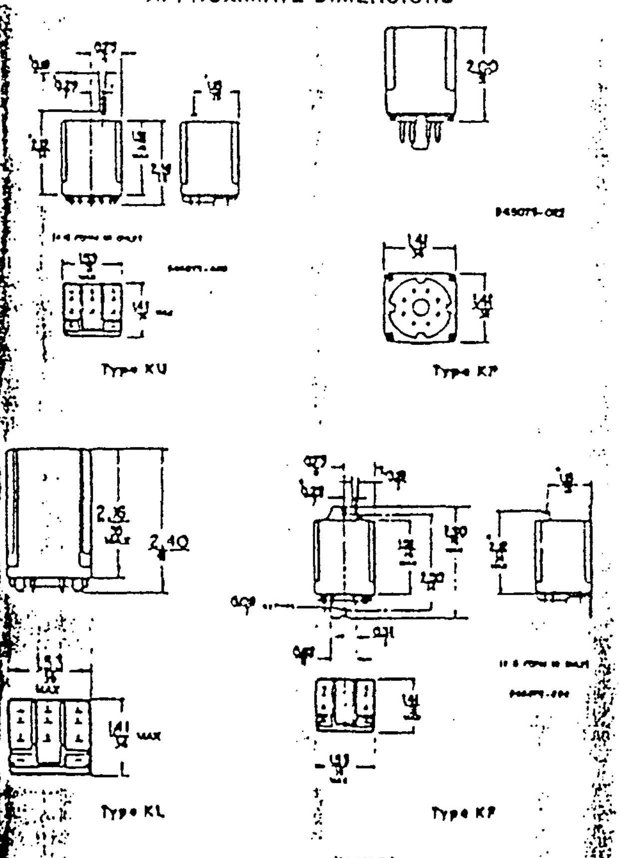
LEGIBILITY EVALUATED and ACCEPTED for Issue

Signature: [signature] Date: 10/11/89

WIRING DIAGRAMS



APPROXIMATE DIMENSIONS



THIS SHEET ADDED BY REV 3

Appendix *I*

TABLE I
END DEVICE BRANCH CABLES

KEY (1) LETTER	CABLE I.D. (2)	FUSE	DG (3)	CIRCUIT	LENGTH (5)
A	PP1646-S	FU3P, N	C-S	FPA	74
B	PP1651-S	FU4P, N	C-S	FPB	96
C	PP1648-S	FU5P, N	C-S	ASSA	74
D	PP1653-S	FU5P, N	C-S	ASSB	96
E	PP1649-S	FU6P, N	C-S	ASSA	74
F	PP1654-S	FU6P, N	C-S	ASSB	96
A	PP287-A	FU3P, N	1A-A	FPA	53
B	PP288-A	FU4P, N	1A-A	APB	75
C	PP284-A	FU5P, N	1A-A	ASSA	53
D	PP285-A	FU5P, N	1A-A	ASSB	75
E	PP281-A	FU6P, N	1A-A	ASSA	53
F	PP282-A	FU6P, N	1A-A	ASSB	75
A	PP527-B	FU3P, N	1B-B	FPA	58
B	PP528-B	FU4P, N	1B-B	FPB	70
C	PP524-B	FU5P, N	1B-B	ASSA	58
D	PP525-B	FU5P, N	1B-B	ASSB	70
E	PP521-B	FU6P, N	1B-B	ASSA	58
F	PP522-B	FU6P, N	1B-B	ASSB	70
A	PP407-A	FU3P, N	2A-A	FPA	68
B	PP408-A	FU4P, N	2A-A	FPB	80
C	PP404-A	FU5P, N	2A-A	ASSA	68
D	PP405-A	FU5P, N	2A-A	ASSB	80
E	PP401-A	FU6P, N	2A-A	ASSA	68
F	PP402-A	FU6P, N	2A-A	ASSB	85
A	PP647-B	FU3P, N	2B-B	FPA	68
B	PP648-B	FU4P, N	2B-B	FPB	80
C	PP644-B	FU5P, N	2B-B	ASSA	68
D	PP645-B	FU5P, N	2B-B	ASSB	80
E	PP641-B	FU6P, N	2B-B	ASSA	68
F	PP642-B	FU6P, N	2B-B	ASSB	80

THIS SHEET ADDED BY REV 3

Appendix I (continued)

TABLE II

ENGINE CONTROL PANEL FEEDERS

Cable I.D. (4)	Length (5)	DG
PP388A	53	1A-A
PP508A	48	2A-A
PP628B	58	1B-B
PP748B	48	2B-B
PP1640S	59	C-S

NOTES:

1. Refer to Appendix A for key letter vs. cable identifier
2. Cable identifiers obtained from Diesel Generator Connection Diagrams (Reference 5.9).
3. Cables are type WHB or WHB-1, No. 14 AWG (reference 5.5). Resistance (min) @ 25°C = 2.62 ohm/1000 ft (ref. 3.2).
4. All feeder cables are #10 AWG per CCRS (reference 5.5). Resistance (min) @ 25°C = 1.04 ohm/1000 ft (ref. 3.2)
5. CCRS design lengths (reference 5.5)
6. Vendor supplied feeder cables from battery to DC distribution panels are 2-1/C #2/0; field estimated at approximately 8 to 10 feet. The resistance (min) @ 25°C is

$$2 \times \frac{0.0812}{1000} \times 8 = 0.0013 \text{ ohm (reference 3.2)}$$

THIS SHEET ADDED BY REV 3.

Attachment No. P-04575-A
Calculation No. WBN EEB-MS-TI11-0062

Appendix J

FA/FH FAMILY MOLDED CASE CIRCUIT BREAKERS
CHARACTERISTIC TRIP CURVE NO. 650-1

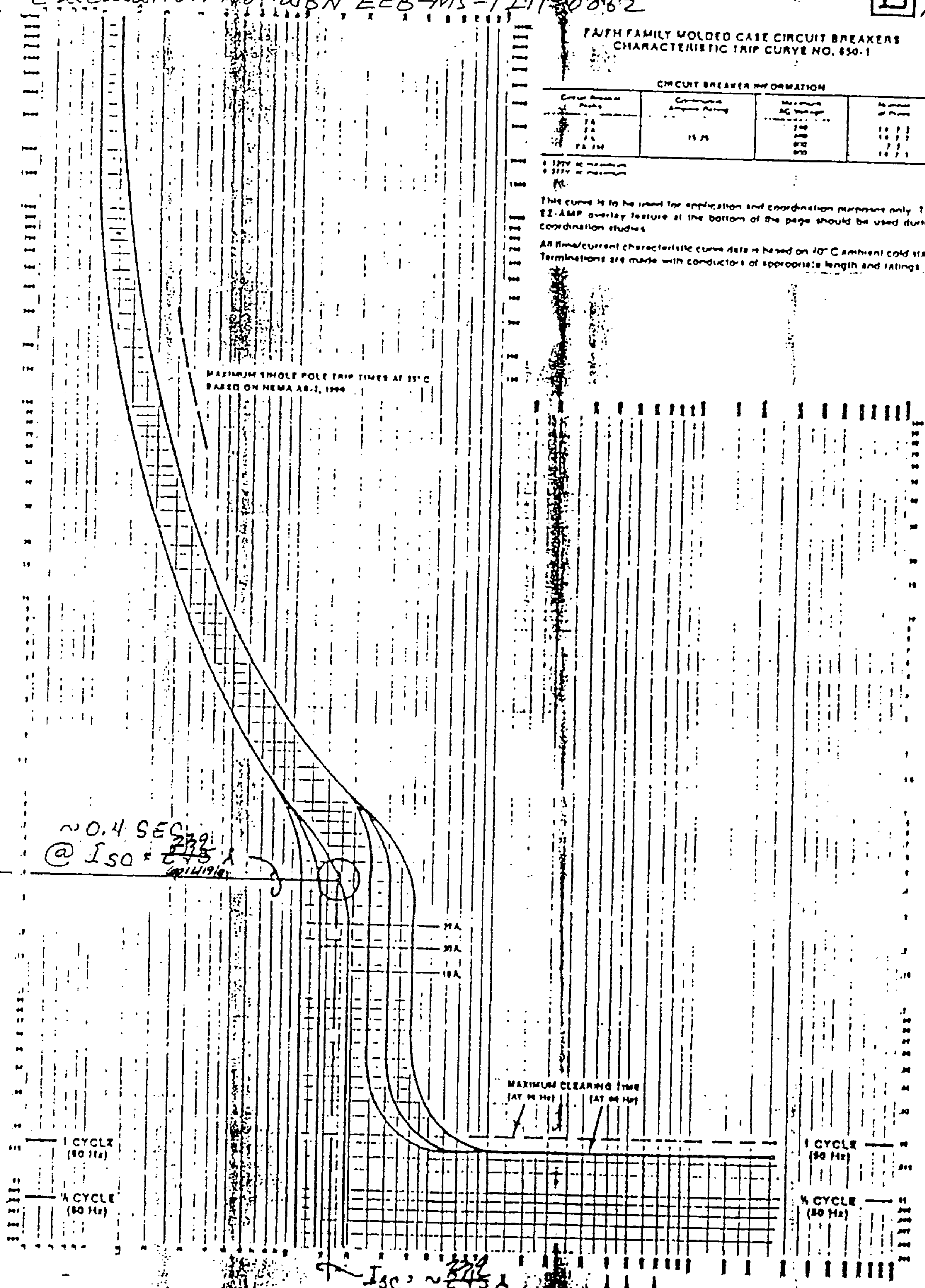
CIRCUIT BREAKER INFORMATION

Circuit Breaker Prefix	Continuous Ampere Rating	Maximum AC Voltage	Number of Poles
FA	[illegible]	240	[illegible]
FA	[illegible]	480	[illegible]
FA	[illegible]	600	[illegible]
FA [illegible]	[illegible]	600	[illegible]

[illegible]

This curve is to be used for application and coordination purposes only. The EZ-AMP overlay feature at the bottom of the page should be used during coordination studies.

All time/current characteristic curve data is based on 40° C ambient cold start. Terminations are made with conductors of appropriate length and ratings.



SQUARE D

MULTIPLES OF RATED CURRENT

Calcualtion No. WBN EEB-MS-TI11-0062
Attachment No. S-15660-A
125V DC Diesel Generator
Control Power System Evaluation

Prepared by m.l. Madua Date 3-25-92

Checked by [signature] Date 3-26-92

Sheet 1

TABLE OF CONTENTS

This attachment contains 7 pages.

THIS SHEET ADDED BY REV 4

1445x

1.0 PURPOSE AND SCOPE

1.1 Purpose

The purpose of this attachment is to evaluate the modification to be implemented under Design Change Notice (DCN) S-15660-A. This DCN was issued to document the replacement of fuses "MIS 1". As referenced in DCN S-15660-A the replacement of fuses "MIS 1" will be for the standby diesel generator system (system 82) fuses as follows:

a. 0-FU-82-DC3-S
b. 1-FU-82-DA3
c. 1-FU-82-DB3
d. 2-FU-82-DA3
e. 2-FU-82-DB3

1.2 Scope

The following problem and its corresponding resolution are addressed by this calculation.

"MIS-1" is being used as a blown fuse indicator. This is a misapplication (Appendix "A") and a replacement actuator must be selected.

2.0 CRITERIA

2.1 The "MIS 1" replacement must meet the following criteria:

A. Have an operating voltage rating which equals or exceeds the circuit voltage.
B. Have a fault current interrupting capacity rating greater than 1721A (Ref. 5.2 Pg 16).
C. Is physically interchangeable with the original fuse.
D. Must meet performance requirements necessary to be an actuating device.

THIS SHEET ADDED BY REV. 4

3.0 APPLICABLE CODES AND STANDARDS

See Baseline Calculation. (Section 3.3)

4.0 ASSUMPTIONS

JUSIFIED
See assumptions identified in the Baseline Calculation (Section 2.0 & 5.0).

UNVERIFIED
None per this attachment (see baseline for existing UVA's)

5.0 REFERENCES

5.1 DCN S-15660-A substitute fuses

5.2 TVA Baseline Calculation WBN EEB-MS-TI11-0062 R3, 125C DC, Diesel Generator (DG) Control Power System Evaluation.

5.3 1-45W703-1, R1 Wiring Diagrams 125V Vital Battery Board I, Single Line Sheet 1.

5.4 TVA Electrical Design Standard "DS-E8.1.1" R7 fuses

6.0 DESIGN INPUT DATA

See Design Input Data identified in Baseline calculation (Section 4.0).

THIS SHEET ADDED BY REV 4

Calcualtion No. WBN EEB-MS-TI11-0062
Attachment No. S-15660-A
125V DC Diesel Generator
Control Power System Evaluation

Prepared by *M. L. Madun* Date *3-26-92*

Checked by *[signature]* Date *3-26-92*

Sheet 4

7.0 COMPUTATION/ANALYSIS

7.1 "MIS 1" replacement (Section 1.2 & 2.1), analysis will be done with a KAZ Actuator.

7.1.1 The circuit nominal voltage is 125V DC with a range of 135V DC to 105V DC (Ref. 5.3). The KAZ Actuator rating is 150V (Ref. 5.4).

7.1.2 The fault current rating of the KAZ Actuator is 10,000 A (Ref. 5.4).

7.1.3 The "MIS 1" and the KAZ Actuator are both 13/32" x 2" in dimension (Appendix "B").

7.1.4 The KAZ Actuator is a device that provides blown fuse indication. (Appendix "B")

8.0 <u>SUMMARY OF RESULTS</u>

8.1 An acceptable qualified replacement for the "MIS 1" is the KAZ Actuator.

8.1.1 The circuit nominal voltage is 125V DC with a range of 135V DC to 105V DC (Ref. 5.3). The KAZ Actuator rating is 150V (Ref. 5.4).

8.1.2 The fault current rating of the KAZ Actuator is 10,000 A (Ref. 5.4).

8.1.3 The "MIS 1" and the KAZ Actuator are both 13/32" x 2" in dimension (Appendix "B").

8.1.4 The KAZ is an actuator device to provide blown fuse indication (Appendix "B").

9.0 <u>CONCLUSIONS</u>

9.1 The KAZ Actuator performs the required functions of a blown fuse indicator and should be used as a replacement for the "MIS-1" fuse.

THIS SHEET ADDED BY REV *1*

CALCULATION: WBN EEB-MS-TI11-006
APPENDIX 'A' Sh 1 of

TELEPHONE CALL AND VISIT REPORT

ATTACHMENT B (Page 1 of 2)

TV[redacted] (OS-3-80)

✓ [redacted]t / Telephone Call	✓ To / From	Telephone Number	Date 9/27/90	Time

Name George Martzin - CEG, Aaron Lambert, Ed Igahorts Elec, Cedric Graham - EQ

Title

Company or Organization

Location

Subject(s) Watts Bar Nuclear Plant.
Fuse Procurement, EQ review JBOX 001.

Follow-Up	By Letter	By Telephone	Other

Remarks

1) Met with Geo. Martzin. He is requested to buy class IE MIS-5, MIN-3, and MIS-1 fuses. Fuse list shows few applications. The MIS-5 has in the past failed seismic tests and is not really suitable for IE applications. R[redacted]mendation is that MIS-5 be replaced with FLAS-5 which is a qualified fuse which can be bought and dedicated by TVA.

MIN-3 is a pin indicating type fuse and is not a class IE fuse; it can be bought as QA III ~~[illegible]~~ and seismic provided by TVA for IE if necessary.
and is a misapplication as a blown fuse indicator.

The MIS-1 is being used as a KAZ actuator.
This fuse should be replaced with a KAZ. Also need DCN

Recommend DCN to replace the MIS-1 with a KAZ. Also need DCN to replace MIS-5 with Flas-5 and correct the use of FRN 15 in one MIS-5 slot (Incorrect fuse list).
Fuse info. coordinated with Aaron Lambert & Ed. I

The MIN-3 is non IE application.

2) Fuse list and PR's show Federal Pacific fuses which field apparently used to replace Bussman & Shawmut fuses originally furnished. These FPE cannot be bought as commercial grade and dedicated, need to be replaced with Bussman or Gould-Shawmut. Geo. has written DCN requesting this. I agree it should be done to make procurement easier and reduce different types of fuses stocked.

3) [redacted]t with Cedric Graham & signed JBOX 001 binder per telecon with JKG.

[redacted] Material Given

(OVER)

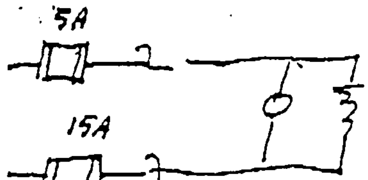
THIS SHEET ADDED BY REV 4

Signed J.R. Ourtt, Eng. Specialist

APPENDIX 'A' Sheet 2 OF

ATTACHMENT B
(Page 2 of 2)

4. Item I above indicates problem with the fuse list. The list is based on field walkdown data for "as constructed" configuration. This represents a snapshot at the time of the walkdown. Certain fuse changes were reviewed and calculations verified acceptability of installed fuses. This was not done for all fuses as is evident in the situation where we had a control circuit fused in both legs. One fuse was a 5A MIS-5 fuse. The other fuse is shown to be a 15A FRN installed by mistake.



Also the "as constructed" configuration showed a MIS-1 installed where you would expect to find a KAZ actuator.

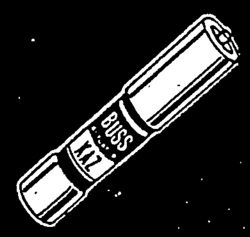
The FPE fuses are apparently replacements for the fuse originally qualified with the equipment. Since Civil agrees that the non-indicating type fuses are not seismically sensitive this is not a real problem other that the difficulty in procuring the FPE fuses for 1E applications. From a procurement prospective it is to TVA's advantage to use Bussman or Gould-Shawmut fuses to replace the FPE's.

THIS SHEET ADDED BY REV 4

Pin Indicating, Ferrule Fuses and Devices

Arranged by physical size, and grouped by non-time-delay and delay (dual-element) types

13/32" x 2" (10.3mm x 50.8mm)



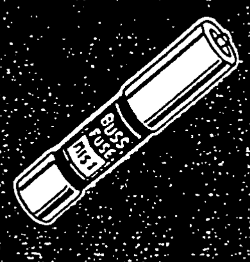
For mounting in signal blocks 2778, 2788-2 thru -5, 2838, and 2837 (page 50) for signal activation.

- Non-Time-Delay Device to call attention to the opening of a paralleled 50 ampere or larger fuse.
- Opens at 10 amperes or more.
- Interrupting Rating of 200,000A.
- Only to be used in parallel with a fuse—KAZ is an actuating device, not a fuse.

Device Symbol	Current Rating (Amperes)	Voltage Rating (Volts or Less)
*KAZ	—	600ac

*UL listed as "Fuse Accessory."

Request Form KAFS for more information.



For mounting in signal block mounts in all KAZ blocks (page 34) for signal activation.

- Non-Time-Delay Fuse
- Interrupting Rating of 200,000A.
- MIS is an indicating fuse—can be used as fuse or in parallel with larger fuses to indicate open fuse.

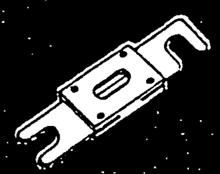
Fuse Symbol	Current Rating (Amps)	Voltage Rating (Volts or Less)
MIS	1	600ac, 250dc
MIS	2	600ac, 250dc
MIS	3	600ac, 250dc
MIS	4	600ac, 250dc
MIS	5	600ac, 250dc
MIS	6	600ac, 250dc
MIS	8	600ac, 250dc
MIS	10	600ac, 250dc
MIS	12	600ac, 250dc

Test Specifications	
Load	Opening Time
100%	Indefinitely
MIS 1 to MIS 5	
150%	6 Minutes, Max.
MIS 6 to MIS 12	
150%	12 Minutes, Max.

Special Fuses and Devices

Arranged by similar body and terminal configurations

Low Voltage Limiters



For mounting in block 4164 (page 50).

- ANL is Non-Time-Delay limiter to isolate faults in equipment systems such as lift trucks or batteries.
- Visual indication of link element.

Time Current Curve on pages 53 to 57.

Note: Silver-plated copper link
Mica window
Slot width: ⅛"
Distance between slot centers: 2⅞"

Fuse Symbol	Current Rating (Amps)	Voltage Rating (Volts or less)
ANL	35	32
ANL	40	32
ANL	50	32
ANL	80	32
ANL	100	32
ANL	130	32
ANL	150	32
ANL	175	32
ANL	200	32

Fuse Symbol	Current Rating (Amps)	Voltage Rating (Volts or less)
ANL	225	32
ANL	250	32
ANL	275	32
ANL	325	32
ANL	350	32
ANL	400	32
ANL	500	32

THIS SHEET ADDED BY REV 4