CALC[illegible]TIONS
ED-Q0[illegible]-88139
250V DC REACTOR MOV BOARD 2A, 2B, 2C

TVA 10697 (NE 6-86) 72164A TSD-[illegible]044 EBASCO SERVICES INC CALCULATION COVER SHEET Q.A. Record Sheet 1 of 84

TITLE: FUSE PROGR[illegible] 250V. DC R[illegible]OR MOV BOARDS 2A, 2B, 2C	PLANT: BFN[illegible] IT 2
PREPARING ORGANIZATION: EEB/EBASCO	KEY NOUNS (Consult RIMS DESCRIPTORS LIST): FUSE PROGRAM
BRANCH/PROJECT IDENTIFIERS: ED-Q0281-88139	Each time these calculations are issued, preparers must ensure that the original (RO) RIMS accession number is filled in.

Rev	(for RIMS' use)	(88) RIMS accession number
RO	880525C0010	B22 '880520 162
R__		
R__		
R__		

APPLICABLE DESIGN DOCUMENT(S): AS REFERENCED

SAR SECTION(S): N/A

UNID SYSTEM(S): 281

	Revision 0	R1	R2	R3
ECN No. (or indicate Not Applicable)	NOT APPLICABLE			
Prepared	[illegible] (BHATT) 5-13-88 DMS			
Checked	[illegible] 5/18/88 Charles Omeara 5-18-88			
Reviewed	B. W. Gilbert 5-18-88			
Approved	J. Conilla			
Date	5/19/88			
Use form TVA 10834 if more space required. List all pages added by this revision.				-
List all pages deleted by this revision.				
List all pages changed by this revision.				

Safety-related? Yes ☒ No ☐

Statement of Problem

EVALUATE FUSE TYPES INSTALLED AT BROWNS FERRY NUCLEAR PLANT (BFN) TO DETERMINE WHETHER THESE FUSE TYPES ARE ACCEPTABLE OR SHALL BE REPLACED WITH ACCEPTABLE FUSE TYPES.

Abstract

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

THIS CALCULATION DOCUMENTS ADHERENCE TO THE FOLLOWING STANDARDS:

IEEE:	ANSI:	ANSI/UL:	ANSI/[illegible]	FEDERAL CODE AND STANDARD:
242-1986	C37.27-72	198B-82	70-1987	10CFR50 APP. B
323-1974	C37.46-81	198C-81		10CFR50 APP. R
344-1975	C37.48A-80	198D-82		10CFR PART 50.49
384-1981	C37.47-81	198L-82		
		198M-82		

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☐ Microfilm and store calculations in RIMS Service Center

☐ Microfilm and return calculations to CALCULATION LIBRARY EDB F3 BFN

Microfilm and destroy ☐

Approved

ec: RIMS, SL 26 C/K

CHKD CCO/DB: DATE 5/18/88

TVA

ED-Q028. :39

Title: FUSE PROGRAM — 250V. DC REACTOR MOV BOARDS 2A, 2B, 2C

F SION LOG

Revision No.	DESCRIPTION OF REVISION	Date Approved
0	Initial Issue	

TVA 10534 (EN DES-4-78)

EBASCO SERVICES INCORPORATED

[ED-20281-88139]

BY THB DMS DATE 05-18-88

CHKD. BY CCO DATE 5/18/88

SHEET 3 OF 84

CLIENT TVA

OFS NO. _____ DEPT. NO. _____

PROJECT BFNP UNIT 2

SUBJECT FUSE PROGRAM [250V REACTOR MOV BOARDS 2A, 2B, 2C]

TABLE OF CONTENTS

1.0 PURPOSE

THE PURPOSE OF THIS CALCULATION IS TO DETERMINE THE PROPER FUSE SIZE AND TYPE FOR 250V REACTOR MOV BOARDS (SYSTEM #281) WHICH ARE REQUIRED FOR UNIT 2 RESTART.

SPECIFICALLY, PROPER FUSE APPLICATIONS ARE SELECTED FOR THE DIRECT CURRENT CIRCUITS OF THE FOLLOWING 250V D.C. REACTOR MOV BOARDS.

1.1 250V D.C. REACTOR MOV BOARD 2A
1.2 250V D.C. REACTOR MOV BOARD 2B
1.3 250V D.C. REACTOR MOV BOARD 2C

2.0 CRITERIA

THE CRITERIA FOR EVALUATING AND SELECTING PROPER FUSE TYPE FOR 250V D.C. REACTOR MOV BOARDS IS AS FOLLOWS.

2.1 FUSE CIRCUITS WERE CATEGORIZED BY CIRCUIT CONFIGURATION. THE WORST CASE LOAD FOR EACH CIRCUIT WAS ANALYZED FOR FUSE SIZING.

2.2 FUSE SIZING IS BASED ON MAXIMUM CIRCUIT LOAD CALCULATION AND/OR ENGINEERING ANALYSIS. A BRIEF STATEMENT FOR BASIS OF ANALYSIS MUST BE DEFINED AND ENTITLED "TECHNICAL JUSTIFICATION" FOR FUSES EVALUATED BY ENGINEERING ANALYSIS.

2.3 THE FUSE SELECTION CRITERIA FOR NON-EQ AND NON-APPENDIX R FUSES IS PERFORMED IN ACCORDANCE WITH REF. (5.9)

2.0 CRITERIA (CONT)

2.4 FUSE SELECTION SHALL BE BASED ON APPLICATION, VOLTAGE RATING, CURRENT CARRYING AND INTERRUPTING CAPACITY.
FUSE COORDINATION IS NOT A PART OF THIS EFFORT.

2.5 FUSES INSTALLED IN CLASS 1E BOARDS LOCATED OUTSIDE THE HARSH ENVIRONMENTAL ZONES SHALL BE CLASSIFIED AS CLASS 1E FUSES REGARDLESS OF CIRCUIT FUNCTION/SERVICE. (NON-1E OR CLASS 1E END DEVICE/EQUIPMENT).

2.6 FUSES INSTALLED IN CLASS 1E BOARDS LOCATED IN A HARSH ENVIRONMENT (REFERENCE DWGS. 47W229-102 THRU' 124, REV. 2) SHALL BE CLASSIFIED AS CLASS 1E-EQ FUSES PER 10CFR 50.49, REGARDLESS OF END DEVICE/EQUIPMENT CLASSIFICATION (NON-1E OR CLASS 1E)

2.7 FUSES SHALL BE ANALYZED FOR PROPER FUSE SIZE TO PROVIDE FAULT CLEARING TIME LESS THAN THE I^2t RATING OF THE CABLE PROTECTED. CABLE SCALED LENGTHS ARE OBTAINED FROM DRAWINGS AND ADJUSTED BY ≈ 400% TO ENSURE CLEARING OF MINIMUM FAULT CURRENT AT DEVICE END OF CABLE

2.8 GUIDE FOR APPLICATION

2.8.1 THE FOLLOWING CALCULATIONS AND DRAWINGS SHALL BE UTILIZED TO DETERMINE THE FUSES USED IN THE APPENDIX 'R' RELATED CIRCUITS.

CALCULATION NO.	RIMS NO.
BFEP-E1-86041 REV.0	B22861112201
BFEP-E1-86019 REV.4	B30870903003

E.0 CRITERIA (CONT)

2.8.1 (CONT)

DWG. NO.	DESCRIPTION
45B900 SERIES	CABLE LIST
45B901 SERIES	EQUIPMENT LIST

2.8.2 THE FOLLOWING CALCULATIONS SHALL BE UTILIZED TO DETERMINE THE FUSES USED FOR PENETRATION PROTECTION

CALCULATION NO	RIMS NO.
• ED-Q2000-87068 (2-E9-403, REV. 1)	B43870805942
• ED-Q2000-87070 (2-E9-405, REV. 2)	B43870805944
• ED-Q2000-87067 (2-E9-402, REV. 2)	B43870805941

2.9 • TABLE 'A' CONTAINS DESIGN INPUT DATA/CALCULATION AND DRAWING CROSS REFERENCES
• TABLE 'B' CONTAINS SUMMARY OF RESULTS
• TABLE 'C' CONTAINS CONCLUSION & RECOMMENDATIONS.

2.0 FORMULAE USED IN CALCULATION:

- ALLOWABLE SHORT CIRCUIT CURRENT FOR INSULATED COPPER CONDUCTORS IS CALCULATED FROM THE FOLLOWING FORMULA

$$\left[\frac{I}{A}\right]^2 \cdot t = 0.0297 \log\left[\frac{T_2+234}{T_1+234}\right] \quad \text{(REF 5.7)} \qquad (1)$$

WHERE, I = SHORT CURRENT - AMPERES

A = CONDUCTOR AREA - CIRCULAR MILS

t = TIME OF SHORT CIRCUIT - SECONDS

T_1 = OPERATING TEMPERATURE - 90°C

T_2 = MAXIMUM SHORT CIRCUIT TEMPERATURE - 250°C

- FIND DEVICE/COMPONENT RESISTANCE RATED 250V D.C.

$$P_{250} = E_{250} \times I_{250} \qquad (2)$$

OR $$P_{250} = I^2_{250} \times R \qquad (3)$$

$$I_{250} = E_{250}/R \qquad (4)$$

SUBSTITUTING (4) INTO (3)

$$P_{250} = \left[\frac{E_{250}}{R}\right]^2 \times R \qquad (5)$$

$$P_{250} = \frac{E^2_{250}}{R} \qquad (6)$$

$$\therefore R = \frac{E^2_{250}}{P_{250}} \qquad (7)$$

2.0 - FORMULAE USED IN CALCULATION (CON

- FIND CURRENT OF DEVICE/COMPON 280V D.C. (EQUALIZATION VOLTAGE. BASED ON TACHMENT 15)

$$P_{280} = \frac{E^2_{280}}{R} \quad (8)$$

$$P_{280} = I^2_{280} \times R \quad (9)$$

$$I^2_{280} = \frac{P_{280}}{R} \quad (10)$$

- FIND FUSE DERATING FACTOR (REF. 5.23)

FUSE DERATING FACTOR $D_f = \sqrt{\frac{150 - T_a}{125}}$ (11)

∴ CURRENT AFTER TEMP. DERATING. $I_N = I_{280} \times \frac{1.25}{D.F}$ (12)

2.0 FORMULAE USED IN CALCULATION (CONT)

WHERE,

P_{250} = DEVICE/COMPONENT CAPACITY, RATED 250V D.C
E_{250} = DEVICE/COMPONENT VOLTAGE RATING, RATED 250V D.C.
I_{250} = FULL LOAD CURRENT OF DEVICE, RATED 250V D.C.
R = RESISTANCE OF DEVICE VENDOR RATED 250V D.C.
P_{280} = CALCULATED DEVICE COLD CAPACITY @ 280V D.C. IN VOLT AMP.
E_{280} = VOLTAGE BASED ON 280V D.C (EQUALIZATION) - IN VOLT
I_{280} = CALCULATED FULL LOAD CURRENT BASED ON 280V D.C - AMPS.
DF = FUSE DERATING FACTOR
Ta = AMBIENT TEMPERATURE IN °C
I_N = NEW CURRENT RATING

3.0 APPLICABLE CODES AND STANDARDS:

CODE OR STANDARD	TITLE
3.1 IEEE 242-1986	RECOMMENDED PRACTICE FOR PROTECTION AND COORDINATION OF INDUSTRIAL AND COMMERCIAL POWER SYSTEMS.
3.2 IEEE 323-1974	STANDARD FOR QUALIFYING CLASS 1E EQUIP. FOR NUCLEAR POWER GENERATING STATION.
3.3 IEEE 344-1975	RECOMMENDED PRACTICES FOR SEISMIC QUALIFICATION OF CLASS 1E EQUIPMENT FOR NUCLEAR GENERATING STATION.
3.4 IEEE 384-1981	STANDARD CRITERIA FOR INDEPENDENCE OF CLASS 1E EQUIPMENT AND CIRCUIT.
3.5 ANSI-C37.46-81	SPECIFICATION FOR POWER FUSE AND FUSE DISCONNECTING SWITCHES.
3.6 ANSI-C37.48-69	GUIDE FOR APPLICATION, OPERATION AND MAINTENANCE OF DISTRIBUTION CUTOUTS AND FUSE LINKS; SECONDARY FUSES, DISTRIBUTION ENCLOSED SINGLE-POLE AIR SWITCHES, POWER FUSES, FUSE DISCONNECTING SWITCHES AND ACCESSORIES.
3.7 ANSI-C37.48A-80	GUIDE FOR APPLICATION OF CURRENT LIMITING FUSES IN ENCLOSURES.

BY THB DCL DATE 5-18-88 [ED-Q0281-88139]

CHKD. BY CCO/SO DATE 5/18/88 SHEET 11 OF 34

CLIENT TVA OFS NO. DEPT. NO.

PROJECT BFNP UNIT 2

SUBJECT FUSE PROGRAM [250V REACTOR MOV BOARDS 2A, 2B, 2C]

3.0 APPLICABLE CODES AND STANDARDS (CONT)

	CODE OR STANDARD	TITLE
3.8	ANSI-C37.47-1981	AMERICAN NATIONAL STANDARD SPECIFICATIONS FOR FUSES AND FUSE DISCONNECTING SWITCHES.
3.9	ANSI/NFPA 70-1987	NATIONAL ELECTRICAL CODE.
	ANSI/UL 198B-1982	SAFETY STANDARD FOR CLASS 'H' FUSES.
3.10	ANSI/UL 198C-1981	SAFETY STANDARD FOR HIGH-INTERRUPTING CAPACITY FUSES, CURRENT LIMITING TYPE.
3.11	ANSI/UL 198D-1982	SAFETY STANDARD FOR CLASS 'K' FUSES
3.12	ANSI/UL 198E-1982	SAFETY STANDARD FOR CLASS 'R' FUSES
3.13	ANSI/UL 198L-1982	D.C. FUSE FOR INDUSTRIAL USE
3.14	ANSI/UL 198M-1982	SAFETY STANDARD FOR CLASS 'K, R, H' FUSES
3.15	10CFR50 APPENDIX 'R'	FIRE PROTECTION PROGRAM FOR NUCLEAR POWER FACILITIES OPERATING PRIOR TO JAN. 1, 1979.
3.16	10 CFR 50, APPENDIX 'B'	QUALITY ASSURANCE PROGRAM
3.17	10 CFR PART 50.49	ENVIRONMENTAL QUALIFICATION OF ELECTRIC EQUIPMENT IMPORTANT TO SAFETY FOR NUCLEAR POWER PLANT

581 9-87

4.0 REFERENCE DRAWINGS

ITEM	TVA SCHEMATIC		TVA SINGLE LINE	
	DIAGRAM No.	REV.	DIAGRAM No.	REV.
101	45N714-2	10	45N712-1	16
102	45N714-3	7	45N712-1	16
103	45N714-4	8	45N712-2	20
104	45N714-5	9	45N712-3	17
105	45N714-6	6	45N712-3	17
106	45N714-7	5	45N712-1	16
			45N712-2	20
			45N712-3	17
107	45N626-4	4	45N712-3	17

SUPPLEMENTAL DRAWINGS:

DIAGRAM No.	REV.
45N802-7	58
45N810-2	G
47W225-112	2

5.0 REFERENCES

	DOCUMENT No.	TITLE
5.1	DS-E1.2.3 (REV. 5)	MASTER FUSE LIST AND FUSE LABELLING.
5.2	DS-E8.1.1 (REV. 7)	SUBSTITUTION STANDARD FOR LOW-VOLTAGE POWER AND CONTROL FUSES (600V OR LESS).
5.3	DS-E8.1.2 (REV. 4)	SUBSTITUTION STANDARD FOR MIDGET AND SMALL DIMENSION FUSES.
5.4	BFN-50-728 (REV. 0)	PHYSICAL INDEPENDENCE OF SAFETY RELATED SYSTEM.
5.5	BFN-50-727 (REV. 0)	ENVIRONMENTAL QUALIFICATION TO 10CFR50.49.
5.6	SS-E18.12.01	ENVIRONMENTAL QUALIFICATION REQUIREMENTS FOR SAFETY-RELATED ELECTRICAL EQUIPMENT.
5.7	BULLETIN EHB-81	ENGINEERING DATA - ELECTRICAL CABLES (COPPER & ALUMINIUM CONDUCTORS - THE OKONITE COMPANY
5.8	EQUIS MANUAL 1986	EQUIPMENT INFORMATION SYSTEM MANUAL (ONE LINE USER TRANSACTION MANUAL)
5.9	SPD 87	ELECTRICAL PROTECTION HANDBOOK, BUSSMAN DIV., McGRAW-EDISON COMPANY

5-9 REFERENCES (CONT)

	DOCUMENT No.	TITLE
5-10	ISNB07-606693-2	OVERCURRENT PROTECTION, ELECTRICAL CONSTRUCTION & MAINTENANCE BY ARTHUR FREUND, McGRAW-HILL, INC.
5-11	ED-Q2000-87068 (2-E9-403, REV.1)	FAULT CURRENT IN THE INSTRUMENT CIRCUITS PENETRATING BFNP CONTAINMENT THROUGH INSTRUMENT PENETRATION.
5-12	ED-Q2000-87070 (2-E9-405, REV.2)	EVALUATION OF PROTECTION PROVIDED FOR BFNP CONTAINMENT ELEC. PENETRATIONS 'EB' & 'EE'
5-13	ED-Q2000-87067 (2-E9-402, REV.2)	EVALUATION OF PROTECTION PROVIDED FOR BFNP CONTAINMENT ELECTRICAL PENETRATIONS, EA, ED, EF, FA, AA, AB, AC, AD, AE, AF.
5-14	QIREEB88035 (RIMS# B22880308002)	WALKDOWN INFORMATION REQUIRED FOR BFNP FUSE PROGRAM DEVELOPMENT.
5-15	CAT# 4900, 6700 {CONTRACT # 66C60 - 90744}	POWER MASTER AKD-5 LOW VOLTAGE SWITCHGEAR, GENERAL ELECTRIC CO.
5-16	RIMS# B22870304002	ELECTRICAL ISSUES - UNAVAILABLE WALKDOWN DATA
5-17	CP-50-M-1085 (REV. 11/86)	SHAWMUT ADVISOR - GOULD ELECTRONICS
5-18	RIMS# 2433600206912 (REV.1)	ELECTRICAL EQUIPMENT REQUIRED TO SUPPORT UNIT 2 RESTART

5.0 REFERENCES (CONT.)

5.19	BFEP-EI-86041 (RIMS# B22861112201)	APPENDIX 'R'-TABULATION OF EQUIPMENT POWER SUPPLIES AND DETAILING CRITERIA FOR THE AUXILIARY POWER SYSTEM (APS)
5.20	BFEP.EI-86019 (RIMS# B30870903003)	ELECTRICAL MODIFICATIONS REQUIRED FOR 10CFR 50 APPENDIX 'R'
5.21	GE; REQN# 366-87013 (CONTRACT# 66C60-90744)	GE INSTRUCTION MANUAL
5.22	RIMS# B22871201303	DOCUMENT TRANSMITTAL (WALKDOWN DATA)
5.23	AMP-TRAP FORM-101 (1981)	SEMI-CONDUCTOR FUSE APPLICATIONS. GOULD ELECTRONICS
5.24	47W225 SERIES DRAWINGS	BFNP HARSH ENVIRONMENTAL DATA DRAWINGS.
5.25	BIREQP87049 (RIMS# B22870302003)	ENVIRONMENTAL PARAMETERS FOR SAFETY-RELATED MCC'S IN UNIT 2
5.26	RIMS# R01870427449	CONTROL CIRCUIT VOLTAGE DROP CALCULATION - D.C. CIRCUITS
5.27	EQ. PACKAGE NO. U2-SYS.71-FOLDER 5	ENVIRONMENTAL QUALIFICATION FIELD VERIFICATION DATA

EBASCO SERVICES INCORPORATED

BY THB DATE 10-88 [ED-Q0281-85.29]

CHKD. BY [illegible] DATE 3/18/88

CLIENT TVA

PROJECT BFNP UNIT 2

SUBJECT FUSE PROGRAM [250V REACTOR MOV BOARDS 2A, 2B, 2C]

OFS NO. _____ DEPT. NO. _____

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60 DESIGN INPUT DATA / CALC. AND DWG. CROSS REF.

ITEM	FUSE UNID	FUSE TYPE	NUMBER UNIT	NUMBER FIG.	NUMBER CALC	NUMBER ATT.	REF. DWG. ITEM NO.	REMARKS
1	2-FU2-73 - 40A	A6Y6-11	2	1.0	1.0	12	101	250V. D.C. RX MOV BD 2A: RUN LIGHTS
2	- 16A	A6Y6-11		1.0	1.0		101	
3	- 47A	A6Y6-11		1.0	1.0		102	
4	- 26A	A6Y6-11		1.0	1.0		101	
5	- 34A	A6Y6-11		1.0	1.0		102	
6	- 35A	A6Y6-11		1.0	1.0		102	
7	- 44A	A6Y6-11		1.0	1.0		101	
8	- 10A	A6Y6-11		1.0	1.0		102	
9	- 30A	A6Y6-11		1.0	1.0		102	
10	- 10C	A6Y6-11		1.0	1.0		102	
11	- 27A	A6Y6-11		1.0	1.0		101	
12	- 3A	A6Y6-11		1.0	1.0		101	
13	2-FU2-96 - 48AA	A6Y6-11		1.0	1.0		101	CONTROL CIRCUIT
14	2-FU2-73 - 40B	A6Y15-11		2.0	2.0		101	
15	- 16B	A6Y15-11		2.0	2.0		101	
16	- 16C	A6Y15-11		2.0	2.0		101	
17	- 47B	A6Y15-11		2.0	2.0		102	
18	- 26B	A6Y15-11		2.0	2.0		101	
19	- 34B	A6Y15-11		2.0	2.0		102	
20	- 35B	A6Y15-11		2.0	2.0		102	
21	- 44B	A6Y15-11		2.0	2.0		101	

DESIGN INPUT FOR FUSE UNID # TYPE PER DIREES BB025 (REF. 5.14) (TYP. FOR TABLE 'A')

TABLE A (TYP. FOR TABLE 'A')

REF. 4.0

EBASCO SERVICES INCORPORATED

BY THS DATE 1/18/88 CHK'D. BY CCO/EB DATE 1/18/88 CLIENT TVA PROJECT BFNP UNIT 2 SUBJECT FUSE PROGRAM [250V REACTOR MOV BOARDS 2A, 2B, 2C]

[ED-Q0281-880139]

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OFS NO. DEPT. NO.

60 DESIGN INPUT DATA/CALC. AND DWG. CROSS REF.

ITEM	FUSE UNID	FUSE TYPE	NUMBER UNIT	FIG.	CALC	ATT.	REF. DWG. ITEM NO.	REMARKS
22	2-FU2-73-10B	A6Y15-11	2	2.0	2.0	12	102	250V D.C. RX MOV BD. 2A CONTROL CIRCUIT
23	-30B	A6Y15-11		2.0	2.0		102	
24	-10D	A6Y15-11		2.0	2.0		102	
25	-27B	A6Y15-11		2.0	2.0		101	
26	-3B	A6Y15-11		2.0	2.0		101	
27	2-FU2-96-48AB	A6Y15-11		2.0	2.0		101	
28	2-FU2-281-2AB	A6Y6-11		3.0	3.0		106	BREAKER CLOSE CIRCUIT
29	-2AD	A6Y6-11		3.0	3.0		106	
30	-2AH	A6Y6-11		3.0	3.0		106	
31	-2AK	A6Y6-11		3.0	3.0		106	
32	2-FU2-281-2AC	A6Y30-11		4.0	4.0		106	BREAKER TRIP CIRCUIT
33	-2AE	A6Y30-11		4.0	4.0		106	
34	-2AJ	A6Y30-11		4.0	4.0		106	
35	-2AL	A6Y30-11		4.0	4.0		106	
36	2-FU2-281-2AA	A6Y6-11		5.0	5.0		106	VM & UV CKT
37	-2AG	A6Y6-11		5.0	5.0		106	
38	2-FU2-281-2AF	A6Y6-11		6.0	6.0		106	BUS UV ANN
39	2-FU2-69-2A	A6Y6-11		1.0	1.0		103	250V D.C. RX MOV BD. 2B
40	-73-36A	A6Y6-11		1.0	1.0		103	RUN LIGHTS
41	-74-108A	A6Y6-11		1.0	1.0		103	
42	-74-47A	A6Y6-11		1.0	1.0		103	

TABLE A

EBASCO SERVICES INCORPORATED

[ED-Q0281-88139]

BY THB DMS DATE [illegible]18-88
CHKD. BY CCO/CB: DATE 3/18/88

OFS NO. ______ DEPT. NO. ______

CLIENT TVA

PROJECT BFNP UNIT 2

SUBJECT FUSE PROGRAM [250V REACTOR MOV BOARDS 2A, 2B, 2C]

6.0 DESIGN INPUT DATA / CALC. AND DWG CROSS REF

ITEM	FUSE UNID	FUSE TYPE	NUMBER UNIT	NUMBER FIG.	NUMBER CALC	NUMBER ATT.	REF. DWG. ITEM No.	REMARKS
43	SPARE	NONE	—	—	—	—	—	—
44	2-FU2-96-48BA	A6Y 6-11	2	1.0	1.0	12	103	250V D-C RX MOV BD 2B RUN LIGHT
45	-1-56A	A6Y 6-11		1.0	1.0		103	
46	-69-28	A6Y 15-11		2.0	2.0		103	CONTROL CIRCUIT
47	-73-36B	A6Y 15-11		2.0	2.0		103	
48	-74-108B	A6Y 15-11		2.0	2.0		103	
49	-74-47B	A6Y 15-11		2.0	2.0		103	
50	-74-47C	A6Y 15-11		2.0	2.0		103	
51	SPARE	NONE	—	—	—	—	—	
52	SPARE	NONE	—	—	—	—	—	
53	2-FU2-96-48BB	A6Y 15-11	2	2.0	2.0	12	103	
54	-1-56B	A6Y 15-11		2.0	2.0		103	
55	-1-56C	A6Y 15-11		2.0	2.0		103	
56	-281-28B	A6Y 6-11		3.0	3.0		106	BREAKER CLOSE CIRCUIT
57	-281-28D	A6Y 6-11		3.0	3.0		106	
58	-281-28H	A6Y 6-11		3.0	3.0		106	
59	-281-28K	A6Y 6-11		3.0	3.0		106	
60	-281-28C	A6Y 30-11		4.0	4.0		106	BREAKER TRIP CIRCUIT
61	-281-28E	A6Y 30-11		4.0	4.0		106	
62	-281-28J	A6Y 30-11		4.0	4.0		106	
63	-281-28L	A6Y 30-11		4.0	4.0		106	

TABLE A

EBASCO SERVICES INCORPORATED

BY: TMG DATE: 5-18-88 [ED-Q0281-88139]

CHKD. BY: CCO/BO DATE: 5/18/88

CLIENT TVA

PROJECT BFNP UNITS 2

SUBJECT FUSE PROGRAM [250V REACTOR MOV BOARDS 2A, 2B, 2C]

SHEET 12 OF 24

OFS NO.

60 DESIGN INPUT DATA / CALC. AND DWG. CROSS REF.

ITEM	FUSE UNID	FUSE TYPE	NUMBER UNIT	NUMBER FIG.	NUMBER CALC	NUMBER ATT.	REF. DWGS. ITEM NO.	REMARKS
64	2-FU2-281-2BA	A6Y6-11	2	5.0	5.0	12	106	VM BUS UV CKT
65	-281-2BG	A6Y6-11		5.0	5.0		106	
66	-281-2BF	A6Y6-11		6.0	6.0		106	BUS UV ANN
67	2-FU2-71-29A	A6Y6-11		1.0	1.0		105	250V DC RX MOV BD. 2C
68	-71-37A	A6Y6-11		1.0	1.0		104	RUN LIGHTS
69	-71-39A	A6Y6-11		1.0	1.0		104	
70	-71-8A	A6Y6-11		1.0	1.0		104	
71	-71-34A	A6Y6-11		1.0	1.0		105	
72	-71-9A	A6Y6-11		1.0	1.0		105	
73	-71-3A	A6Y6-11		1.0	1.0		104	
74	-71-19A	A6Y6-11		1.0	1.0		104	
75	-71-38A	A6Y6-11		1.0	1.0		105	
76	-71-18A	A6Y6-11		1.0	1.0		104	
77	-71-17A	A6Y6-11		1.0	1.0		104	
78	-71-25A	A6Y6-11		1.0	1.0		104	
79	-71-31A	A6Y6-11		1.0	1.0		105	CONTROL CIRCUIT
80	-71-29B	A6Y15-11		2.0	2.0		105	
81	-71-29C	A6Y15-11		2.0	2.0		105	
82	-71-37B	A6Y15-11		2.0	2.0		104	
83	-71-37C	A6Y15-11		2.0	2.0		104	
84	-71-39B	A6Y15-11		2.0	2.0		104	

TABLE A

EBASCO SERVICES INCORPORATED

BY THS DWL CHKD BY CCP/JB DATE 5/18/88

[ED - 4028 - 68159]

CLIENT TVA

PROJECT BFNP UNITS 2

SUBJECT FUSE PROGRAM [250V REACTOR MOV BOARDS 2A, 2B, 2C]

SHT 20 OF 24

OFS NO. DEPT NO.

60 DESIGN INPUT DATA / CALC. AND DWG CROSS REF.

ITEM	FUSE UNID	FUSE TYPE	NUMBER UNIT	NUMBER FIG.	NUMBER CALC	NUMBER ATT.	REF. DWG. ITEM NO.	REMARKS 250V MOV CONTROL CIRCUIT	REMARKS D.C BD CIRCUIT	REMARKS RX 20
85	2-FU2-71-39C	A6Y15-11	2	2.0	2.0	12	104			
86	-71-88	A6Y15-11		2.0	2.0		104			
87	-71-8C	A6Y15-11		2.0	2.0		104			
88	-71-34B	A6Y15-11		2.0	2.0		105			
89	-71-34C	A6Y15-11		2.0	2.0		105			
90	-71-9B	A6Y15-11		2.0	2.0		105			
91	-71-9C	A6Y15-11		2.0	2.0		105			
92	-71-3B	A6Y15-11		2.0	2.0		104			
93	-71-3C	A6Y15-11		2.0	2.0		104			
94	-71-19B	A6Y15-11		2.0	2.0		104			
95	-71-19C	A6Y15-11		2.0	2.0		104			
96	-71-38B	A6Y15-11		2.0	2.0		105			
97	-71-38C	A6Y15-11		2.0	2.0		105			
98	-71-18B	A6Y15-11		2.0	2.0		104			
99	-71-18C	A6Y15-11		2.0	2.0		104			
100	-71-17B	A6Y15-11		2.0	2.0		104			
101	-71-17C	A6Y15-11		2.0	2.0		104			
102	-71-25B	A6Y15-11		2.0	2.0		104			
103	-71-25C	A6Y15-11		2.0	2.0		104			
104	-71-31B	A6Y15-11		2.0	2.0		105			
105	-71-31C	A6Y15-11		2.0	2.0		105			

TABLE A

EBASCO SERVICES INCORPORATED

[EJ-Q0281-88159]

BY THB DATE 5-18-88 · 21 OF 34

CHKD. BY CCO/… DATE …/18/88 · OFS NO. ____ DEPT. NO. ____

CLIENT TVA

PROJECT BFNP UNIT 2

SUBJECT FUSE PROGRAM [250V REACTOR MOV BOARDS 2A, 2B, 2C]

6.0 DESIGN INPUT DATA / CALC. AND DWG. CROSS REF.

ITEM	FUSE UNID	FUSE TYPE	NUMBER UNIT	NUMBER FIG.	NUMBER CALC	NUMBER ATT.	REF. DWG. ITEM NO.	REMARKS
106	2-FU2-281-2CB	A6Y 6-11	2	3.0	3.0	12	106	250V D.C. RX MOV BD.
107	-2CD	A6Y 6-11		3.0	3.0		106	BREAKER CLOSING CIRCUIT
108	-2CH	A6Y 6-11		3.0	3.0		106	
109	-2CK	A6Y 6-11		3.0	3.0		106	
110	-2CC	A6Y 30-11		4.0	4.0		106	BREAKER TRIP CIRCUIT
111	-2CE	A6Y 30-11		4.0	4.0		106	
112	-2CJ	A6Y 30-11		4.0	4.0		106	
113	-2CL	A6Y 30-11		4.0	4.0		106	
114	-2CA	A6Y 6-11		5.0	5.0		106	VM & UV CKT
115	-2CG	A6Y 6-11		5.0	5.0		106	
116	-2CF	A6Y 6-11		6.0	6.0		106	BUS UV ANN
117	2-FU2-71-9D	A6Y 10-11		7.0	7.0		107	TRIP SOL.
118	-9E	A6Y 10-11		7.0	7.0		107	

TABLE A

7.0 D.C. LOAD CALCULATIONS AND FUSE SIZING

70 Typ 250V D.C. CONTROL CIRCUIT - INDICATING LIGHT

* - FOR UNIQUE IDENTIFICATION No. (UNID) SEE TABLE "A" (TYP)

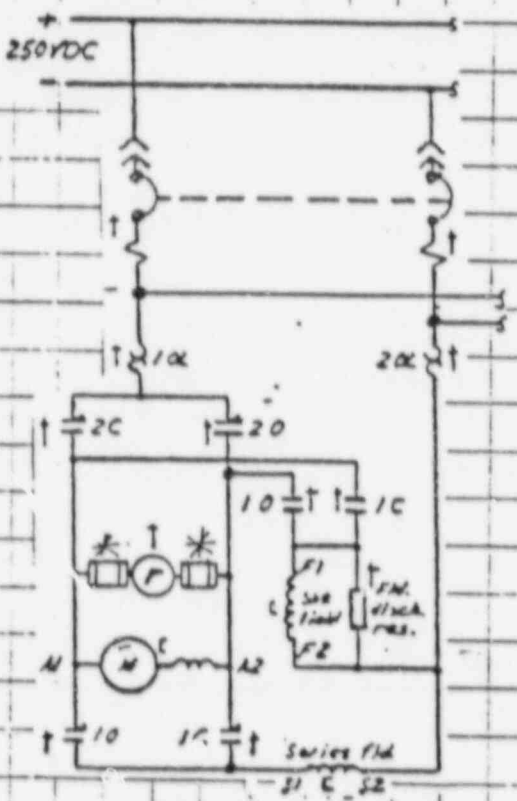


FIGURE 1-0

NOTE: THE ABOVE CIRCUIT IS USED FOR INDICATING LIGHT FUSE ANALYSIS ONLY.

FOR CALCULATION No. 1

EBASCO SERVICES INCORPORATED

BY TAB DHL DATE 5-18-88 [ED-Q0281-88139] SHEET 24 OF 34

CHKD. BY CLD/DC DATE 5/18/88 OFS NO. DEPT NO.

CLIENT TVA

PROJECT BELP UNIT 2

SUBJECT FUSE PROGRAM [250V REACTOR MOV BOARDS 2A, 2B, 2C]

7.0 CALC. #1 - CONT. CKT. INDICATING LIGHT

250V DC SUPPLY EQUIVALENT CIRCUIT FIGURE 1.

CONNECTED LOAD: INDICATING LIGHT (L) AND 3500Ω RESISTOR (R)

MANUFACTURER: GE

CAT. No.: LIGHT - CR2940UD212A3 (ATTACH. 2)

RESISTOR - 541A224-1, 3500Ω (REF. 6.27)

BASIS: • FUSE SIZES ARE DERATED FOR 250V Rx MOV BD 2C (REF 6.25 & DWG No. 47W225-112 REV. 2)

• RESIS. OF IND. LIGHT IS NEGLIGIBLE

CALCULATION:

(1) CURRENT ACROSS RESISTOR R, AT 250V $I_{250} = \frac{250}{3500} = 0.071$ AMPS.

(2) CURRENT ACROSS RESISTOR R AT 280V (EQUALISATION VOLTAGE - ATTACH. 15), $I_{280} = \frac{280}{3500} = 0.08$ AMPS.

FUSE SIZING CURRENT = 0.08 × 1.25 = 0.10 AMPS.

(REQUIRED FUSE SIZE 6 AMPS, GOULD SHAWMUT TYPE A2Y6-1 - ATTACH. 12)

(3) CALC. FOR 250V Rx MOV. BD 2C [HARSH ENVIRONMENT]

WORST TEMP. = 202°F (+15°F MARGIN) = 217°F. ≡ 102.8°C

FUSE DERATING FACTOR, $D_F = \sqrt{\frac{150 - T_a}{125}} = \sqrt{\frac{150 - 102.8}{125}} = 0.615$ (REF. 6.23)

LOAD CURRENT AFTER TEMP. DERATING, $I_N = I_{100} \times \frac{1.25}{D_F} = 1.63$ AMPS.

(REQUIRED FUSE SIZE 6 AMPS, GOULD SHAWMUT TYPE A2Y6-1 - ATTACH. 12)

TECHNICAL JUSTIFICATION:

REFER TO CALCULATION NO. 2, ITEM 12 - "TECHNICAL JUSTIFICATION" - FOR JUSTIFICATION OF USING 6 AMP FUSE

7.0 250V DC CONTROL CKT - TYP FOR CONT DUTY MOTORS & MOVS.

FOR UNIQUE IDENTIFICATION No. (UNID)
SEE TABLE "A" (TYP)

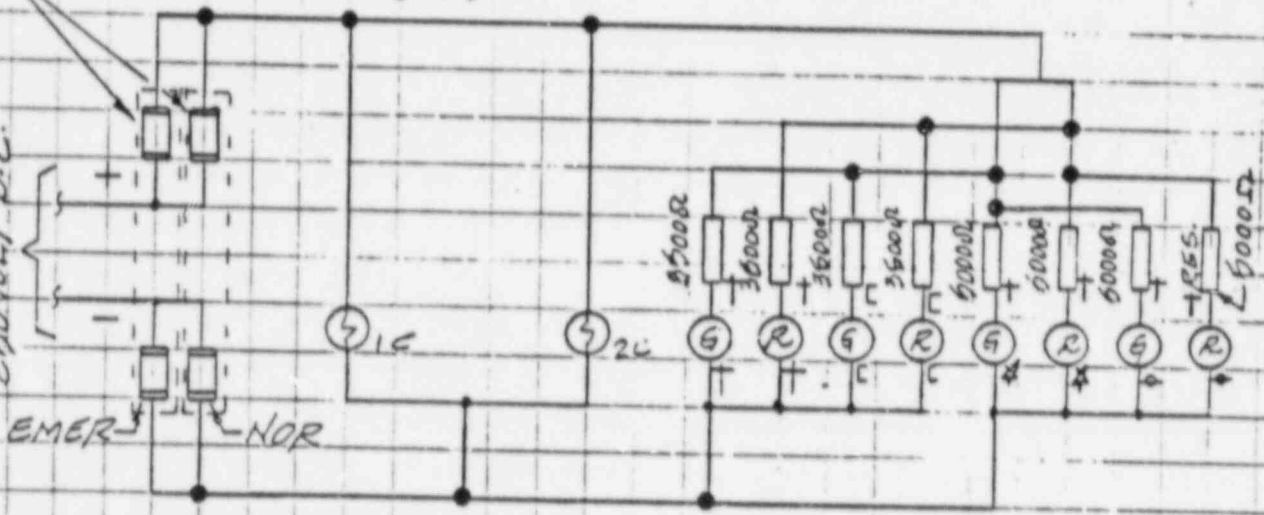


FIGURE 2.0

FOR CALCULATION-2

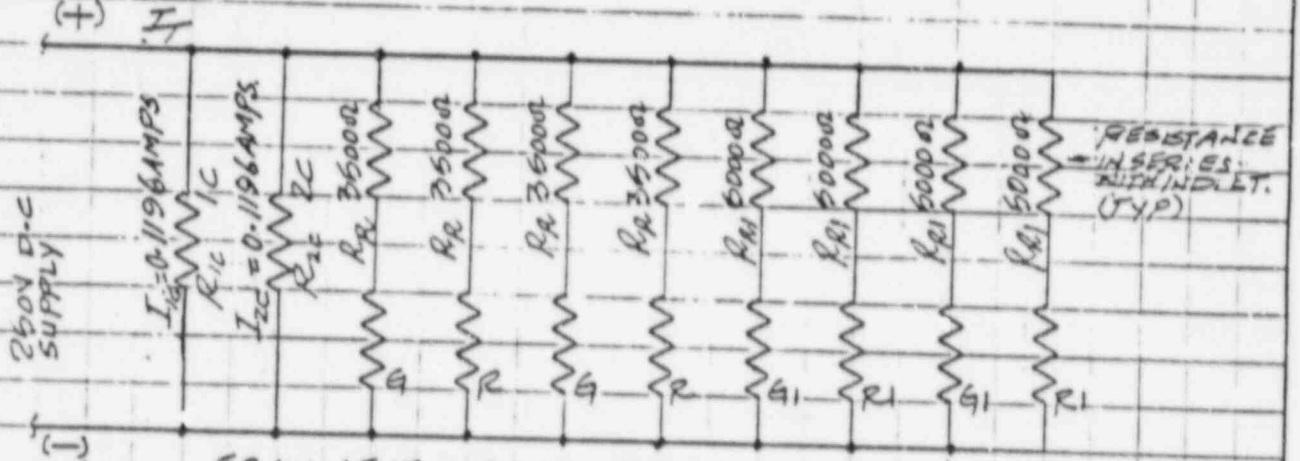
NOTE: FOR CLARITY, CONTACTS, AND OTHER NON-CONTRIBUTING LOADS NOT SHOWN

1C - CONTACTOR 1
2C - CONTACTOR 2
G - GREEN LIGHT
R - RED LIGHT

† - COMPONENTS ON 250V. DC SWITCHGEAR
C - COMPONENTS MTD. LOCALLY AT EQUIPMENT
✡ - COMPONENTS ON UNIT CONT. BD IN MAIN CONTROL ROOM
⊕ - COMPONENTS ON GRAPHIC DISPLAY PANEL IN MAIN CONTROL ROOM

70 CALC #2 - CONT. CKT. - TYP. FOR CONT. DUTY MOTORS & MOVS.

- TO FIND FULL LOAD CURRENT OF CIRCUIT.
- CIRCUIT LOAD: INDICATOR LIGHTS, RESISTORS AND CONTACTORS.
- CIRCUIT FUNCTION: MOV CONTROL CIRCUIT.



EQUIVALENT CIRCUIT - FIG. 2

- DEVICE LIST, MANUFACTURER & CAT. No.

1C, 2C	- GE D.C. CONTACTOR CAT. NO. IC2800 (ATTACH. 2)
3500Ω	- GE RESISTOR CAT. NO. 541A2241, 3500Ω (REF. 5.16)
5000Ω	- GE RESISTOR CAT. NO. A250DA, 5000Ω (REF. 5.16)
G, R	- GE IND. LT. CAT. NO. CR2940UR212A3 (C3) (ATTACH. 1)
G1, R1	- G.E. IND. LT. CAT NO. 0116B6708G4 (ATTACH. 3)

BASIS OF CALCULATION: INTERNAL RESISTANCE OF G, R INDICATING LTS. CONSIDERED NEGLIGIBLE IN THE CALC.

CALCULATION AT 250V.

1. $I_K = I_{2C} = 0.110$ AMPS @ 230V

RESISTANCE R_{1C} (R_{2C}) $= \frac{E_{230}}{I_{1C}} = \frac{230}{0.110} = 2091\Omega$

$\frac{I_{1C} \text{ @ } 250V}{(TYP.\ I_{2C})} = \frac{E_{250}}{R} = \frac{250}{2091} = 0.1196$ AMPS (1)

2. CURRENT THRU R_R (TYP FOR 4) $= \frac{E_{250}}{R_R} = \frac{250}{3500} = 0.0714$ AMPS. (2)

10 CALC. #2 (CONT)

3 CURRENT THRU' R_{R1} (TYP FOR 4) $= \frac{E_{250}}{R_{R1}} = \frac{250}{5000} = 0.05$ AMPS. (3)

4 TOTAL CURRENT I_T AT 250V $= 2\times(1) + 4\times(2) + 4\times(3)$

$= (2\times 0.1196) + (4\times 0.0714) + (4\times 0.05)$ AMPS

$= 0.2392 + 0.2856 + 0.20 = 0.7248$ AMPS (A)

CALCULATION AT E_{280}

5 ∴ CURRENT $I_{1C} = \frac{E_{280}}{R_{1C}} = \frac{280}{2091} = 0.1339$ AMPS (4)
(TYP FOR I_{2C})

6 CURRENT THRU $R_R = \frac{E_{280}}{R_R} = \frac{280}{3500} = 0.08$ AMPS (5)
(TYP FOR 4)

7 CURRENT THRU $R_{R1} = \frac{E_{280}}{R_{R1}} = \frac{280}{5000} = 0.056$ AMPS (6)
(TYP FOR 4)

8 TOTAL CURRENT $I_T = 2\times(4) + 4\times(5) + 4\times(6)$
AT 280V $= (2\times 0.1339) + (4\times 0.08) + (4\times 0.056)$
$= 0.2678 + 0.32 + 0.224 = 0.8118$ AMPS. (B)

9 FUSE STRING CURRENT $= 0.8118 \times 1.25 = 1.015$ AMPS.

REQUIRED FUSE SIZE = 15 AMPS.

[GOULD SHAWMUT FUSE TYPE A2Y15-1
SEE ATTACH. 12]

10 SEE ITEM 12 OF THIS CALCULATION FOR TECH. JUSTIFICATION FOR USING 15 AMP FUSE

7.0 CALCULATION #2 (CONT.)

11. CALC FOR 250V RX MOV BD 2C [HARSH ENVIRONMENT - REF. 5.25 AND DWG NO. 47W225-12 REV. 2]

WORST CASE TEMP. = 202°F (+15°F MARGIN) = 217°F = 102.8°C

FUSE DERATING FACTOR, DF $= \sqrt{\frac{150 - T_a}{125}} = \sqrt{\frac{150 - 102.8}{125}} = 0.615$

LOAD CURRENT AFTER TEMP. DERATING, $I_N = \frac{I_{T(CKT)} \times 1.25}{DF}$ { I_T = TOTAL CURRENT @ 250V SEE (B), THIS CALC. }

$\therefore \quad I_N = \frac{0.8118 \times 1.25}{0.615}$ AMPS

$I_N = 1.65$ AMPS

REQUIRED FUSE SIZE = 15 AMPS
(GOULD SHAWMUT FUSE TYPE A2Y15-1 SEE ATTACH. 12)

TECHNICAL JUSTIFICATION:
REFER TO ITEM 12 OF THIS CALCULATION FOR TECHNICAL JUSTIFICATION FOR USING 15 AMP FUSE

7.0 CALC #2 (CONT)

12. TECHNICAL JUSTIFICATION:

OBJECT: TO JUSTIFY THAT ≤15AMP FUSE WILL PROTECT THE #14 AWG IN THE CONTROL CIRCUIT. (ALLOWABLE AMPACITY FOR #14 AWG = 15 AMPS - REF. 3.9)

INPUT: WIRE: #14 AWG @ 90°C (T_1)

SYSTEM VOLTAGE: 250V D.C.

CABLE LENGTH: 1000FT, WORST CASE (SEE * BELOW)

CONDUCTOR AREA: 4110 CIRC. MILS (REF. 5.7) = A

RESISTANCE OF WIRE = 2.62 Ω/1000FT. @ 25°C (REF 5.7)

MAXIMUM SHORT CKT. TEMP. (T_2) = 250°C

* REF. DRAWINGS: 45N802-7, REV. 58 - RB/PQ - 250V RX MOV BD. 2C, 45N810-2, REV. 6, CONTROL RM. PNL 9.3

CALCULATION:

A. FIND RESISTANCE OF #14 AWG CABLE AT 90°C

RESISTANCE @ 90°C = 2.62 × 1.25 = 3.275 (REF 5.7)

TOTAL RESISTANCE R_T = 3.275 × 2 (2 × 1000FT)

= 6.55 Ω

B. MAXIMUM AVAILABLE SHORT CIRCUIT CURRENT $I_M = \frac{E}{R_T} = \frac{250}{6.55} = 38.17$ AMPS.

C. FIND CABLE SHORT CIRCUIT WITHSTANDABILITY FOR #14 AWG CABLE USING FORMULA AT $t = 0.01$ SECS.

$$\left[\frac{I}{A}\right]^2 \cdot t = 0.0297 \log\left[\frac{T_2 + 234}{T_1 + 234}\right]$$

$$\left[\frac{I}{A}\right]^2 t = 0.0297 \log\left[\frac{250+234}{90+234}\right] = 0.00517$$

$$I = \sqrt{0.00517/t} \times A = \sqrt{0.00517/0.01} \times 4110 = 2955 \text{ AMPS.}$$

7Q CALC#2 (CONT) - TECHNICAL JUSTIFICATION

12 (CONT)

D FROM THE CALCULATION, #14 AWG CAN WITHSTAND A SHORT CIRCUIT CURRENT OF 2955 AMPS @ 0.01 SECS.

E TO FIND PERIOD OF TIME THE #14 AWG CAN WITHSTAND SHORT CIRCUIT CURRENT OF 28.17 AMPS @ 1000 FT.

APPLYING THE FORMULA $\left[\frac{I}{A}\right]^2 . t = 0.0297 \log \left[\frac{T_2+234}{T_1+234}\right]$

$$t = 0.0297 \log \left[\frac{T_2+234}{T_1+234}\right]\left\{\left[\frac{I}{A}\right]^2\right\}^{-1} = 0.0297 \log \left[\frac{250+234}{90+234}\right]\left[\left\{\frac{28.17}{4110}\right\}^2\right]^{-1}$$

$$t = (0.00617)(11594.16) = \underline{59.94 \text{ SECS.}}$$

F FROM GOULD SHAWMUT MELTING TIME-CURRENT CURVE (ATTACHMENT 12)

15 AMP FUSE (TYPE A2Y) WILL MELT IN ≃ 5 CYCLES. WHEN SHORT CIRCUIT CURRENT OF 28.17 AMPS IS APPLIED. ALL OTHER FUSES LESS THAN 15 AMPS WILL MELT IN LESS THAN 5 SECS.

THE #14 AWG WIRE CAN WITHSTAND SHORT CIRCUIT CURRENT OF 28.17 AMPS FOR 59.94 SECS. ALSO, #14 AWG WIRE CAN WITHSTAND SHORT CIRCUIT CURRENT OF 2955 AMPS, WITHOUT DAMAGE TO THE CABLE DURING SHORT CIRCUIT, FOR 0.01 SECS.

G BASED ON THE ABOVE DISCUSSION, FUSE SIZES UP TO AND INCLUDING 15 AMPS WILL ADEQUATELY PROTECT #14 AWG WIRE.

70 250V D.C. CLOSING CIRCUIT

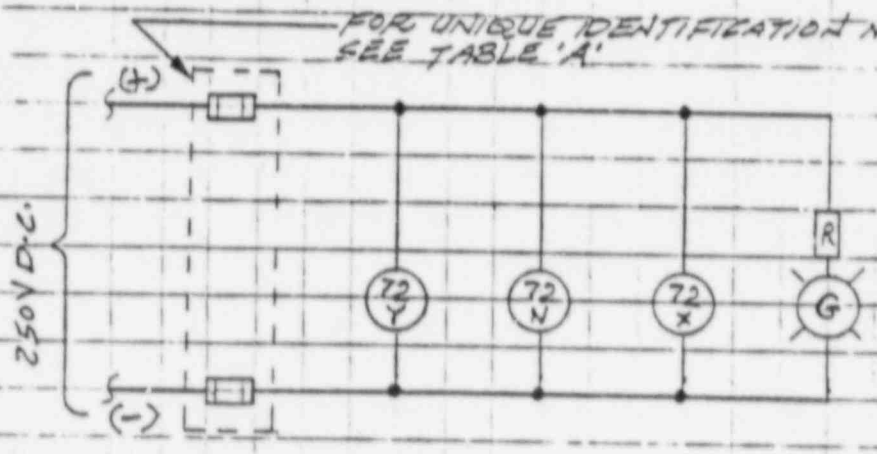


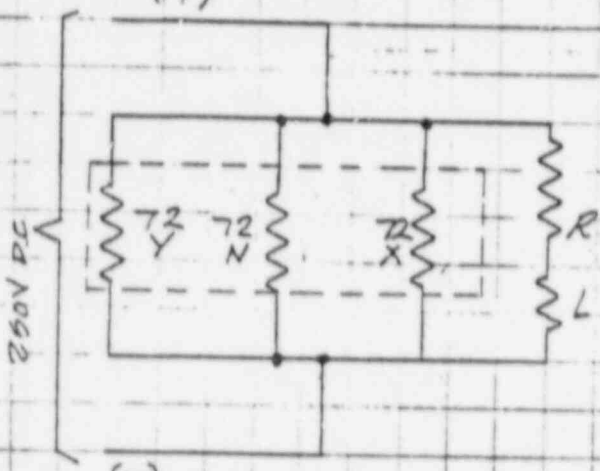
FIGURE 3.0

FOR CALCULATION - 3

NOTE: NORMAL CLOSE CIRCUIT SHOWN. EMERGENCY CLOSE CIRCUIT IS SIMILAR.

7Q CALC #3 - 250V D.C. CLOSING CIRCUIT

EQUIVALENT CIRCUIT OF FIG. 3



- TO FIND FULL LOAD CURRENT OF CLOSING CIRCUIT
- DEVICE LIST

72X - CKT BRKR CLOSING RELAY
72Y - CKT BRKR ANTI-PUMP RELAY
72N - CKT BRKR CLOSING COIL SOL.
L - INDICATING LIGHT RESISTANCE
R - RESISTOR-3500Ω (REF 5.16)

X, Y, CC - (ATTACH. 10 & 7)

BASIS OF CALCULATION: SINCE THE SERIES RESISTANCES OF INDICATING LIGHT L & RESISTOR R ARE TOO LARGE COMPARED TO RESISTANCE OF CLOSING COIL 72N, THEY ARE CONSIDERED NEGLIGIBLE IN THIS CALCULATION.

CALCULATION: THE SUSTAINED CURRENT OF CLOSING MECHANISM IS 24 AMPS FOR 5 CYCLES FOR GE TYPE AK-25 BREAKERS (ATTACH. 7 & 4)

REQUIRED FUSE SIZE = 6 AMPS.
(GOULD SHAWMUT FUSE TYPE A2Y6-1)
SEE ATTACHMENT 12

TECHNICAL JUSTIFICATION:

1. CLOSING TIME OF CIRCUIT BREAKER = 5 CYCLES

7.0 CALC. #3 (CONT)

OPERATING FREQUENCY = 60 CYC./SEC.

∴ TIME FOR 1 CYCLE = $\frac{1}{60}$ SECS.

TIME FOR 5 CYCLES = $\frac{1}{60} \times 5 = 0.083$ SECS.

2. CALCULATION @ 250V D.C.

PER GOULD SHAWMUT MELTING TIME ~ CURRENT CURVES (ATTACH. 12),

6AMP FUSE, TYPE A2Y6-1, WILL MELT IN APPROXIMATELY 0.28 SECS, WITH 24AMPS SUSTAINED CURRENT.

0.28 SECS = $0.28 \times 60 = 16.8$ CYCLES.

∴ THE FUSE WILL NOT MELT AT 5 CYCLES (0.083 SECS).

3. CALCULATION @ 280V D.C. (EQUALIZATION VOLTAGE - ATTACH. 15)

$I_{(Y,CC,X)}$ @ 250V = 24AMPS, SUSTAINED.

∴ $R_{(Y,CC,X)} = \frac{250}{24} = 10.4\ \Omega$

∴ $I_{(Y,CC,X)}$ @ 280V = $\frac{280}{10.4}$ = 26.92AMPS, SUSTAINED. (A)

PER GOULD SHAWMUT MELTING TIME - CURRENT CURVES (ATTACH. 12)

6AMP FUSE, TYPE A2Y6-1, WILL MELT IN APPROXIMATELY 0.18SECS, WITH 26.92AMPS SUSTAINED CURRENT.

0.18SECS = $0.18 \times 60 = 10.8$ CYCLES.

• SUSTAINED CURRENT OF 39AMPS WOULD BE REQUIRED TO MELT 6AMP FUSE IN 5 CYCLES (0.083 SECS)

∴ REQUIRED FUSE SIZE OF 6AMPS IS JUSTIFIED.

7.0 CALCULATION #3 (CONT)

CALC. FOR 250V Rx MOV BD. 2C [HARSH ENVIRONMENT - REF 5.25 AND DWG No. 47W226-112 REV. 2]

$\therefore$ WORST CASE TEMP. $= (202+15)^{\circ}F = 217^{\circ}F = 102.8^{\circ}C$

FUSE DERATING FACTOR, DF $= \sqrt{\frac{150 - T_a}{125}} = \sqrt{\frac{150 - 102.8}{125}} = 0.615$

SUSTAINED CURRENT OF CIRCUIT BREAKER AFTER TEMP. DERATING, $I_N = I_{(Y,N,X)} \times \frac{1}{D.F}$ { $I_{(Y,N,X)}$ IS CURRENT @ 280V. SEE (A) THIS CALC }

$= 26.92 \times \frac{1}{0.615} = 43.77$ AMPS. SUSTAINED

BASED ON DERATING CALCULATION FOR 250V REACTOR MOV BOARD 2C, 10 AMP FUSE IS REQUIRED.

GOULD SHAWMUT FUSE TYPE A2Y10-1
(SEE ATTACHMENT 12)

TECHNICAL JUSTIFICATION: 6 AMP FUSE TYPE A2Y6-1 CAN WITHSTAND SUSTAINED CURRENT OF 39 AMPS FOR 4 CYC. FOR FUSES INSTALLED IN 250V Rx MOV BD. 2C, APPLYING THE TEMP. DERATING FACTOR FOR THIS CKT. INCREASES THE SUSTAINED CURRENT TO 43.77 AMPS. SINCE THIS IS IN EXCESS OF 39 AMPS, A 10 AMP FUSE IS SELECTED. GOULD SHAWMUT FUSE TYPE A6Y10-1 CAN WITHSTAND SUSTAINED CURRENT OF 43.77 AMPS FOR 48 CYCLES. THIS FUSE SELECTION WILL ENSURE PROPER CIRCUIT OPERATION.

BY THB RMS DATE 4-8-88 [ED-Q0281-88139] SHT 35 OF 34

CHKD. BY CCD DOI DATE 5/18/88 OFS NO. — DEPT. NO.

CLIENT TVA

PROJECT BFNP UNIT 2

SUBJECT FUSE PROGRAM [250V REACTOR MOV BOARDS 2A, 2B, 2C]

7.0 250V D.C. TRIP CIRCUIT

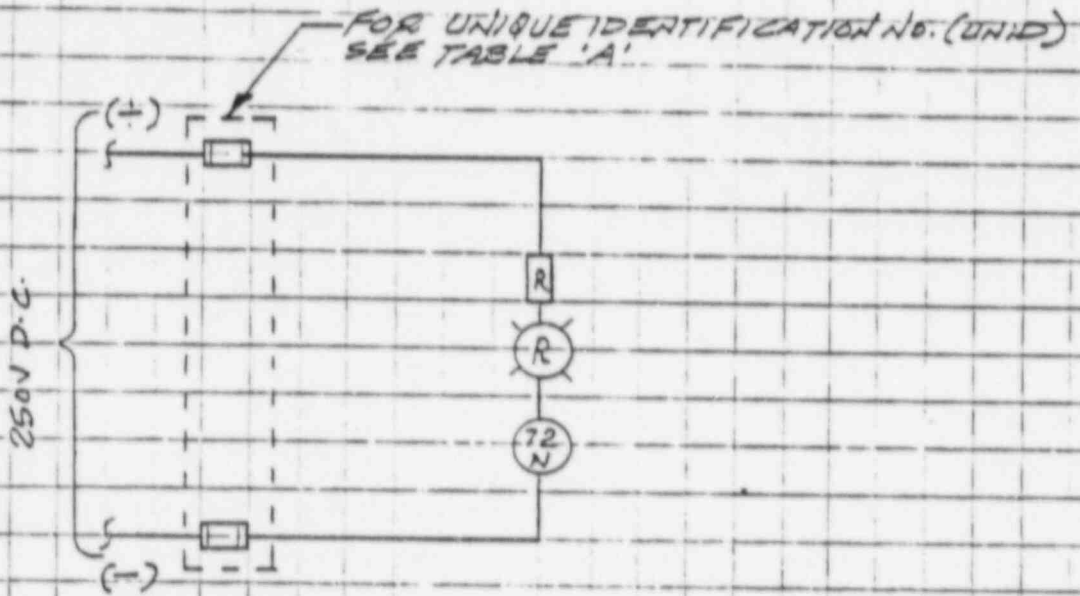


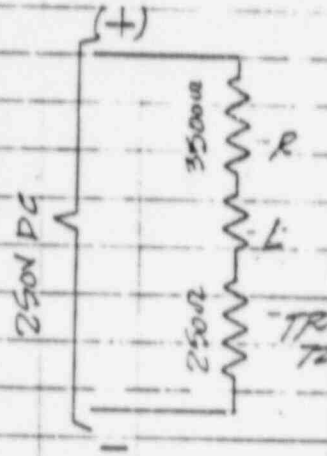
FIGURE 4.0

FOR CALCULATION - 4

NOTE: NORMAL TRIP CIRCUIT SHOWN. EMERGENCY TRIP CIRCUIT IS SIMILAR

7.0 CALC # 4 - 250V D.C TRIP CIRCUIT

EQUIVALENT CIRCUIT OF TRIP CIRCUIT - FIG. [4.]



- LOAD CALCULATION AND FUSE SIZING.
- CIRCUIT LOAD: FIG. 4
- CONNECTED LOAD:
  1. RESISTOR R
  2. INDICATING LIGHT L
  3. TRIP COIL 72N

DEVICE LIST & MANUFACTURER & CAT. No.

R - GE RESISTOR 541A2224-1, 3500Ω (REF. 5.16)
L - GE INDICATING LIGHT CR2940UD212A3 (ATTACH. 1)
72N - GE TRIP COIL FOR TYPE AK CIRCUIT BREAKER (ATTACH. 6)

DESIGN BASIS: INTERNAL RESISTANCE OF INDICATING LIGHT, L, IS CONSIDERED NEGLIGIBLE IN THIS CALCULATION.

CALCULATION: (NORMAL OPERATION)

DURING NORMAL OPERATION, ALL DEVICES; R_2, R & 72N; WILL BE OPERATIVE

1. AT 250V D.C.

CURRENT RATING OF TRIP COIL $I_{72N} = 1.0$ AMPS (ATTACH. 6)

RESISTANCE OF TRIP COIL $R_{72N} = \frac{E_{250}}{I_{72N}} = \frac{250}{1.0} = 250\Omega$

TOTAL RESISTANCE OF CIRCUIT, $R_T = 3500\Omega + 250\Omega = 3750\Omega$

CURRENT FLOWING THRU CKT. $I_{250} = \frac{E_{250}}{R_T} = \frac{250}{3750} = 0.067$ AMPS.

7.0 CALC#4 (CONT)

2. AT 280V. D.C:

DURING TRIPPING OPERATION, INDICATING LIGHT AND RESISTOR WILL DROP OUT. THE ONLY LOAD IN THE CIRCUIT WILL BE 72N LOAD WITH FULL LOAD CURRENT OF 1.0 AMPS.

∴ RESISTANCE IN THE CIRCUIT = 250Ω. = R_{72N}

∴ $I_{72N} = \frac{E_{280}}{R_{72N}} = \frac{280}{250} = 1.12$ AMPS. (A)

REQUIRED FUSE SIZE - 15 AMPS.
(GOULD SHAWMUT FUSE TYPE A2Y15-1.)
SEE ATTACH. 12

2.1 TECHNICAL JUSTIFICATION

15 AMP FUSE IS SELECTED TO MINIMIZE DAMAGE TO EQUIPMENT AND PROVIDE SUFFICIENT TOLERANCE TO PREVENT NUISANCE FUSE OPERATIONS, TO ENSURE BREAKER TRIPPING WILL BE AVAILABLE.

7.0 CALCULATION #4 (CONT)

CALC. FOR 250V Rx MOV. BD 2C [HAREN ENVIRONMENT - REF. 5.25 AND DWG. No. 47W225-112 R2]

$\therefore$ WORST CASE TEMP. $= (202+15)^\circ F = 217^\circ F = 102.8^\circ C$

FUSE DERATING FACTOR, DF $= \sqrt{\frac{150 - T_A}{125}} = \sqrt{\frac{150-102.8}{125}} = 0.615$

LOAD CURRENT AFTER TEMP. DERATING, $I_N = I_{72N} \times \frac{1}{DF}$ $\{ I_{72N}$ = RELAY CURRENT @ 250V. SEE (4) - THIS CALC $\}$

$= 1.12 \times \frac{1}{0.615} = 1.82$ AMPS.

REQUIRED FUSE SIZE - 15 AMPS.
(GOULD SHAWMUT FUSE TYPE A2Y15-1)
SEE ATTACH. 12

TECHNICAL JUSTIFICATION:
SEE CALCULATION #4, ITEM 2.1 FOR TECHNICAL JUSTIFICATION.

1-9 VOLTMETER AND UNDERVOLTAGE CIRCUIT

FOR UNIQUE IDENTIFICATION No. (UNID) SEE TABLE "A" (TYP)

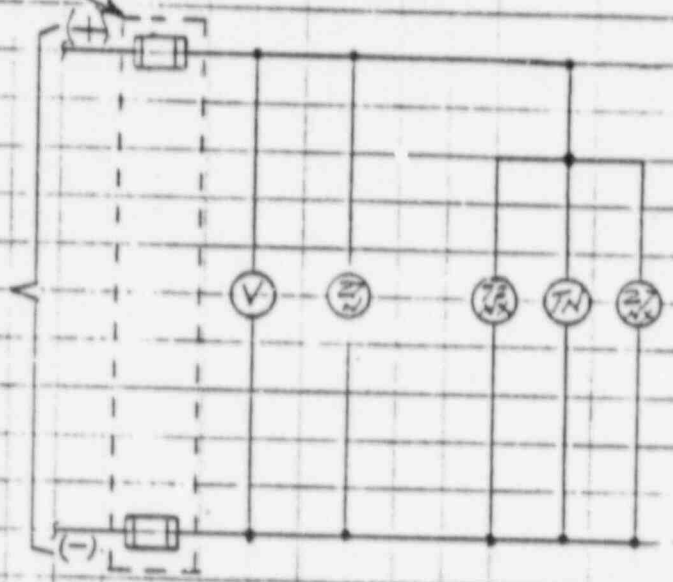


FIGURE 5.0

FOR CALCULATION - 5

NOTE: FOR CLARITY, NON-CONTRIBUTING LOADS NOT SHOWN

BY THB DATE 4-18-88 [ED-20281-88139] T 40 OF 84

CHKD BY CCO DATE 5/18/88 OFS NO. DEPT. NO.

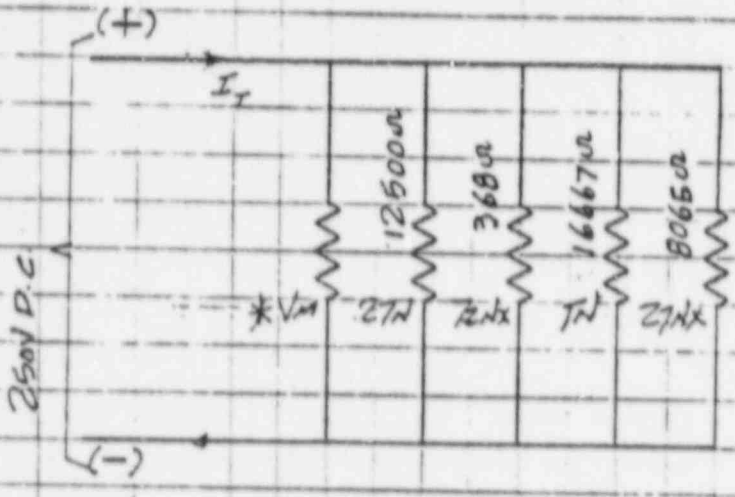
CLIENT IVA

PROJECT BEAP UNIT 2

SUBJECT FUSE PROGRAM [250V REACTOR MOV BOARDS 2A, 2B, 2C]

70 CALC #5 - VOLTMETER AND UNDERVOLTAGE CIRCUIT

EQUIVALENT CIRCUIT:



- LOAD CALCULATION AND FUSE SIZING:
- CIRCUIT LOAD: [FIG. 5.0]
- CONNECTED LOAD:
  1. VOLTMETER.
  2. RELAYS.
  3. TIMER

DEVICE LIST & MANUFACTURER:

*VM - GE VOLTMETER
27N : GE INST. VOLTAGE RELAY 12PJV11AM1A (ATTACH. 8)
72NX - GE AUXILIARY RELAY 1CZBZ0A100BB2BD (ATTACH. 10(a))
TN - AT&C TIMER 308B006M00XK (ATTACH. 9)
27NX - GE AUXILIARY RELAY 12HFA61A41 (ATTACH. 10(b))

DESIGN BASIS: *VOLTMETER LOAD IS CONSIDERED NEGLIGIBLE

LOAD DATA
1. 27N (12PJV11AM1A) - 5 WATTS.
2. 72NX (1CZBZ0A100BB2BD) - 0.68 AMPS (COIL P.U.)
3. TN (308B006M00XK) - 0.015 AMPS
4. 27NX (12HFA61A41) - 0.031 AMPS.

CALCULATION AT 250V.

$$R_{27N} = \frac{E_{250}}{I_{27N}}$$

70 CALC#5 (CONT)

$\therefore R_{27N} = \frac{250^2}{6} = 12500\,\Omega.$

1. $I_{27N} = \frac{E_{250}}{R_{27N}} = \frac{250}{12,500} = 0.02\,AMPS.$ (1)

2. $\therefore I_{72NX} = 0.68\,AMPS$ (2)

3. $\therefore I_{TN} = 0.015\,AMPS$ (3)

4. $I_{27NX} = 0.031\,AMPS$ (4)

$\therefore$ TOTAL CURRENT THRU' CIRCUIT @ 250V. $I_T = (1)+(2)+(3)+(4)$
$= (0.02 + 0.68 + 0.015 + 0.031)\,AMPS.$
$= 0.746\,AMPS.$ (A)

CALCULATION AT 280V.

1. $I_{27N} = \frac{E_{280}}{R_{27N}} = \frac{280}{12,500} = 0.022\,AMPS.$ (5)

2. $R_{72NX} = \frac{E_{250}}{I_{72NX}} = \frac{250}{0.68} = 368\,\Omega$

$\therefore I_{72NX} = \frac{E_{280}}{R_{72X}} = \frac{280}{368} = 0.761\,AMPS$ (6)

3. I_{TN} @ 250V = 0.015 AMPS.

R_{TN} @ 250V $= \frac{E_{250}}{I_{TN}} = \frac{250}{0.015} = 1667\,\Omega$

70 CALC #5 (CONT.)

3. (CONT.)

$\therefore I_{TN}$ @ 280V $= \frac{E_{280}}{R_{TN}} = \frac{280}{16667} = 0.017$ AMPS. (7)

4. I_{27NX} @ 250V = 0.031 AMPS

$R_{27NX} = \frac{E_{250}}{I_{27NX}} = \frac{250}{0.031} = 8065\ \Omega$

$\therefore I_{27NX}$ @ 280V $= \frac{E_{280}}{R_{27NX}} = \frac{280}{8065} = 0.0347$ AMPS (8)

TOTAL CURRENT THRU' CIRCUIT @ 280V I_T = (5) + (6) + (7) + (8)
$= (0.022 + 0.761 + 0.017 + 0.0347)$ AMPS
$= 0.8347$ AMPS (B)

FUSE SIZING CURRENT $= 0.8347 \times 1.25 = 1.04$ AMPS.

REQUIRED FUSE SIZE = 6.0 AMPS (C)
(GOULD SHAWMUT TYPE AZY6-1)
SEE ATTACH. 12

TECHNICAL JUSTIFICATION:
REFER TO CALCULATION NO. 2 ITEM 12 — "TECHNICAL JUSTIFICATION" FOR JUSTIFICATION OF USING 6AMP FUSE.

7.0 CALCULATION #5 (CONT)

CALC. FOR 250V RX MOV BD. 2C [HARSH ENVIRONMENT - REF. E-25 AND DWG. NO. 47W225-112 REV. 2]

∴ WORST CASE TEMP. = (102+5)°F = 217°F = 102.8°C

$$= \sqrt{\frac{150 - T_a}{125}} = \sqrt{\frac{150 - 102.8}{125}} = 0.615$$

LOAD CURRENT AFTER TEMP. DERATING, $I_N = \frac{I_T \times 1.25}{D_F}$ { I_T = TOTAL CURRENT @ 280V SEE ⑤ - THIS CALC }

$$I_N = \frac{0.8347 \times 1.25}{0.615} \text{ AMPS}$$

$$I_N = 1.70 \text{ AMPS}$$

REQUIRED FUSE SIZE = 6.0 AMPS
(GOULD SHAWMUT TYPE A2Y6-1)
SEE ATTACH. 12

TECHNICAL JUSTIFICATION

REFER TO CALCULATION NO. 2, ITEM 12 - "TECHNICAL JUSTIFICATION" FOR JUSTIFICATION OF USING 6AMP FUSE

7.0 250V D.C. REACTOR MOV BDS. BUS UV ANN. CKT.

FIGURE 6.0

FOR CALCULATION - 6

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CHKD. BY CEO DO DATE 5/18/88 OFS NO. DEPT. NO.

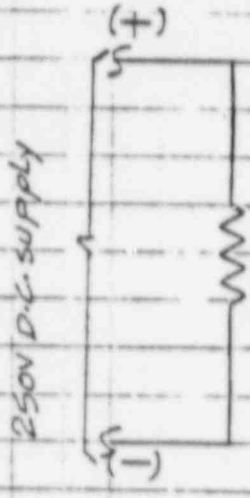
CLIENT TVA

PROJECT BFNP UNIT 2

SUBJECT FUSE PROGRAM [250V REACTOR MOV BOARDS 2A, 2B, 2C]

70 CALC #6 - BUS UNDERVOLTAGE ANNUNCIATOR CIRCUIT

EQUIVALENT CIRCUIT



- LOAD CALCULATION AND FUSE SIZING
- CIRCUIT LOAD: [FIG. 6]
- CONNECTED LOAD: AGASTAT 7022SC UNDERVOLTAGE RELAY - 250V R. MOVED 2A (ATTACH. 10(c))
- LOAD - RELAY - 0.032 AMPS.

CALCULATION AT 250V

1. I_{250} = 0.032 AMPS. (A)

2. $R = \frac{E_{250}}{I_{250}} = \frac{250}{0.032} = 7813\,\Omega$

CALCULATION AT 280V (EQUALISATION VOLTAGE - ATTACH. 15)

$I_{280} = \frac{E_{280}}{R} = \frac{280}{7813} = 0.0358$ AMPS. (B)

FUSE SIZING CURRENT = 0.0358 × 1.25 = 0.0447 AMPS. (C)

REQUIRED FUSE SIZE = 6 AMPS.
(GOULD SHAWMUT TYPE = A2Y6-1 - ATTACH. 12)

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7.0 CALCULATION #6 (CONT)

3. CALC. FOR 250V Rx MOV BD. 2C [HARSH ENVIRONMENT - REF. 5.25 AND DWG. No. 47W225-2 REV. 2]

∴ WORST CASE TEMP. = (202+15)°F = 217°F = 102.8°C

FUSE DERATING FACTOR, DF $= \sqrt{\frac{150 - T_A}{125}} = \sqrt{\frac{150 - 102.8}{125}} = 0.615$

LOAD CURRENT AFTER TEMP. DERATING, $I_N = I_{23} \times \frac{1.25}{DF}$ AMPS.

∴ $I_N = 0.0358 \times \frac{1.25}{0.615}$ AMPS

$I_N = 0.073$ AMPS

REQUIRED FUSE SIZE = 6 AMPS.
(GOULD SHAWMUT TYPE A2Y6-1)
SEE ATTACHMENT - 12

4 TECHNICAL JUSTIFICATION:

REFER TO CALCULATION No. 2, ITEM 12 - "TECHNICAL JUSTIFICATION" - FOR USING 6 AMP FUSE

7.0 250V D.C. TURBINE TRIP CIRCUIT

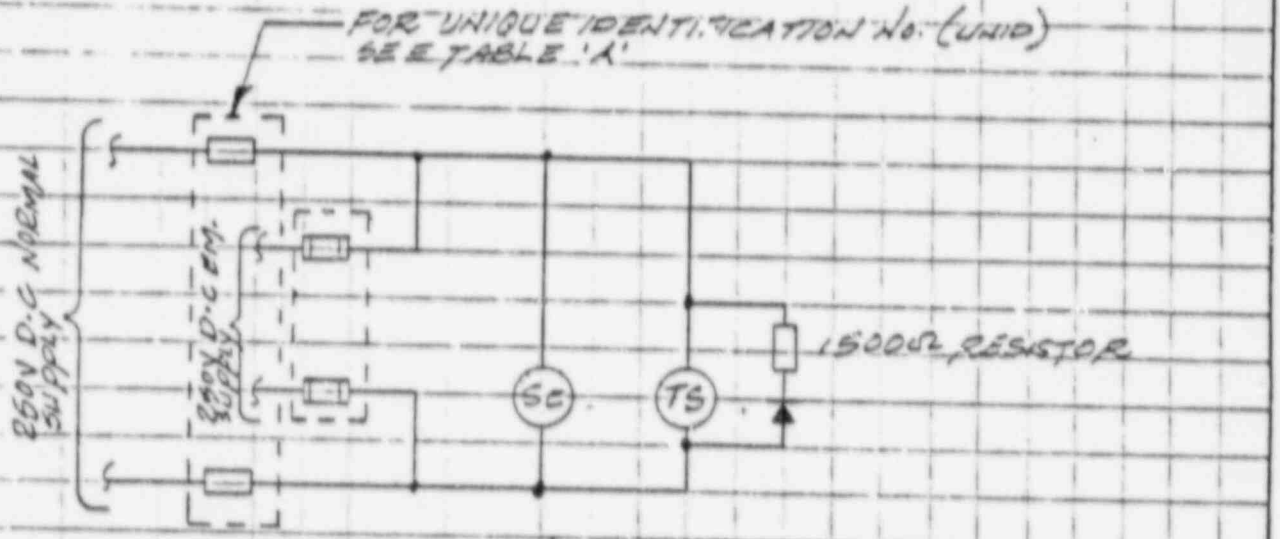


FIGURE 7.0 - FOR CALCULATION No. 7

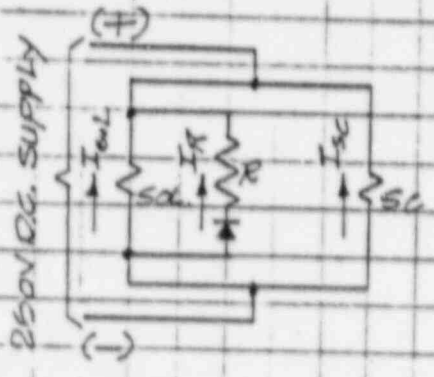
FOR CALCULATION - 7

SC - SOLENOID CONTACTOR

TS - TRIP SOLENOID XX-71-9

79 CALC #7 - 250V D.C. TURBINE TRIP CIRCUIT

EQUIVALENT CIRCUIT:



* LOAD CALCULATION AND FUSE SIZING.
* CIRCUIT LOAD: [FIG. 7]
* CONNECTED LOAD:

SOL: XX-71-2 TRIP SOLENOID - 0.14 AMPS*

R_x: ARC SUPPRESSION = 1600Ω RESISTOR

SC: SOLENOID CONTACTOR - 0.076 AMPS*

* DATA FROM CALC. NO. ED-Q2000-87043, RIMS# B43870805917 (ATTACHMENT # 11)

DESIGN BASIS:

LOAD OF ARC SUPPRESSION RESISTANCE R_x WILL BE CONSIDERED IN THIS CALCULATION (WORST CASE CONDITION WHEN DIODE IS SHORTED OUT)

CALCULATION AT 250V

1. CURRENT I_{SOL} = 0.14 AMPS. (1)

2. CURRENT $I_R = \frac{E_{250}}{R} = \frac{250}{1600} =$ 0.1667 AMPS. (2)

3. CURRENT I_{SC} = 0.076 AMPS. (3)

4. TOTAL CURRENT $I_{250} = I_{SOL} + I_R + I_{SC} = 0.14 + 0.1667 + 0.076$

$\therefore I_{250} =$ 0.3827 AMPS (A)

70 CALC #7 (CONT)

CALCULATION AT 280V.

1. RESISTANCE OF SOL. $R_{SOL} = \frac{E_{250}}{I_{250}} = \frac{250}{0.14} = 1786\,\Omega$

CURRENT $I_{SOL} = \frac{E_{280}}{R_{SOL}} = \frac{280}{1786} = 0.1568$ AMPS. (4)

2. CURRENT $I_R = \frac{E_{280}}{R} = \frac{280}{1500} = 0.1867$ AMPS. (5)

3. RESISTANCE OF SC. $= \frac{E_{250}}{I_{SC}} = \frac{25\Omega}{0.076} = 3289.5\,\Omega$

CURRENT $I_{SC} = \frac{E_{280}}{R_{SC}} = \frac{280}{3289.5} = 0.0851$ AMPS (6)

4. TOTAL CURRENT $I_{280} = 0.1568 + 0.1867 + 0.0851$

$\therefore I_{280} = 0.4286$ AMPS. (8)

FUSE SIZING CURRENT $= 0.4286 \times 1.25$

$= 0.5358$ AMPS.

REQUIRED FUSE SIZE = 10 AMPS.
(GOULD SHAWMUT TYPE A2Y10-1)

TECHNICAL JUSTIFICATION:
REFER TO CALCULATION NO. 2, ITEM 12. "TECHNICAL JUSTIFICATION" - FOR JUSTIFICATION OF USING 10AMP FUSE

7.0 CALCULATION # 7 (CONT)

CALC. FOR 250V Rx MOV BD. 2C [HARSH ENVIRONMENT - REF 5.25 AND DWG. NO. 47W225-42 REV. 2]

∴ WORST CASE TEMP = (202+15)°F = 217°F = 102.8°C

FUSE DERATING FACTOR, DF $= \sqrt{\frac{150-T_a}{125}} = \sqrt{\frac{150-102.8}{125}} = 0.615$

LOAD CURRENT AFTER TEMP. DERATING, $I_N = I_{280} \times \frac{1.25}{DF}$

$$I_N = \frac{0.4286 \times 1.25}{0.615}$$

$$\therefore I_N = 0.8712 \text{ AMPS.}$$

REQUIRED FUSE SIZE = 10 AMPS
(GOULD SHAWMUT TYPE A2Y10-1)

TECHNICAL JUSTIFICATION:
REFER TO CALCULATION NO. 2, ITEM 12 - "TECHNICAL JUSTIFICATION" FOR JUSTIFICATION OF USING 10 AMP FUSE

EBASCO SERVICES INCORPORATED

[ED-20281-B8139]

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CHKD. BY CCO/DS DATE 5/18/88

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CLIENT TVA

OFS NO. _____ DEPT. NO. _____

PROJECT BFNP UNIT 2

SUBJECT FUSE PROGRAM [250V REACTOR MOV BOARDS 2A 2B, 2C]

7.1 DETERMINE SAFETY CLASS & APPLICATION

EQUIPMENT LOCATION: (CLASS 1E BOARDS)

	BOARD REFERENCE (ALL BDS IN Rx BLDG)	ELEV.	REF. DRAWINGS	
			EQUIP LAYOUT	ENVIR.
	250V Rx MOV BD. 2A	621.25	47W200-3	47W225-117
	250V Rx MOV BD. 2B	593.00	47W200-5	47W225-113
*	250V Rx MOV BD. 2C	565.00	47W200-6	47W225-110

SYSTEMS AFFECTED:

THE FOLLOWING SYSTEMS ARE AFFECTED

SYS No	DESCRIPTION	Rx MOV BDS		
		2A	2B	2C
1	MAIN STEAM SYSTEM		X	
69	REACTOR WATER CLEANUP SYSTEM		X	
71	REACTOR CORE ISOL. COOLING SYSTEM			X
73	HIGH PRESSURE COOLANT INJECTION SYS.	X	X	
74	RESIDUAL HEAT REMOVAL SYSTEM		X	
96	RECIRC. FLOW CONTROL SYSTEM	X		
281	250V REACTOR MOV BOARDS.	X	X	

* NOTE: 250V REACTOR MOV BOARD 2C IS LOCATED IN HARSH ENVIRONMENT. (REF 5.24 AND 5.25)

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8.0 SUMMARY OF RESULTS

THE FOLLOWING NOTES ARE APPLICABLE TO TABLES 'B' AND 'C'

1. ACCEPTABLE FUSE SIZE
2. OVERSIZED FUSE
3. UNDERSIZED FUSE
4. CLASS 1E FUSE IS REQUIRED
5. CLASS 1E-ER IS REQUIRED

8.0 SUMMARY OF RESULTS

ITEM	FUSE UNID		FUSE TYPE	RESULT PASS	RESULT FAIL	SAFETY CLASS 1E	SAFETY CLASS NON 1E	SAFETY CLASS 1E-EQ	APPLICATION PENT.	APPLICATION APP'R'	NOTE #1	NOTE #2	NOTE #3	NOTE #4	NOTE #5
1	2-FU2-73	40A	A6Y6-11	X		X	N/A	N/A	N/A	X	X			X	
2	↓	16A	A6Y6-11	↓		↓	↓	↓	↓	↓	↓			↓	
3		47A	A6Y6-11												
4		26A	A6Y6-11												
5		34A	A6Y6-11												
6		35A	A6Y6-11												
7		44A	A6Y6-11												
8		10A	A6Y6-11												
9		30A	A6Y6-11												
10		10C	A6Y6-11												
11		27A	A6Y6-11												
12	↓	3A	A6Y6-11							↓					
13	2-FU2-96	48AA	A6Y6-11							N/A					
14	2-FU2-73	40B	A6Y15-11							X					
15	↓	16B	A6Y15-11												
16		16C	A6Y15-11												
17		47B	A6Y15-11												
18		26B	A6Y15-11												
19		34B	A6Y15-11												
20		35B	A6Y15-11												
21	↓	44B	A6Y15-11	↓		↓	↓	↓	↓	↓	↓			↓	

TABLE B

8.0 SUMMARY OF RESULTS

ITEM	FUSE UNID	FUSE TYPE	RESULT PASS	RESULT FAIL	SAFETY CLASS 1E	SAFETY CLASS NON1E	SAFETY CLASS 1E-EQ	APPLICATION PEN.T	APPLICATION APP'R	NOTES #1	NOTES #2	NOTES #3	NOTES #4	NOTES #5
22	2-FU2-73-10B	A6Y15-11	X		X	N/A	N/A	N/A	X	X			X	
23	-30B	A6Y15-11	↓		↓	↓	↓	↓	↓	↓			↓	
24	-10D	A6Y15-11	↓		↓	↓	↓	↓	↓	↓			↓	
25	-27B	A6Y15-11	↓		↓	↓	↓	↓	↓	↓			↓	
26	-3B	A6Y15-11	↓		↓	↓	↓	↓	↓	↓			↓	
27	2-FU2-96-48AB	A6Y15-11	↓		↓	↓	↓	↓	N/A	↓			↓	
28	2-FU2-281-2AB	A6Y6-11	↓		↓	↓	↓	↓	↓	↓			↓	
29	-2AD	A6Y6-11	↓		↓	↓	↓	↓	↓	↓			↓	
30	-2AH	A6Y6-11	↓		↓	↓	↓	↓	↓	↓			↓	
31	-2AK	A6Y6-11	↓		↓	↓	↓	↓	↓	↓			↓	
32	2-FU2-281-2AC	A6Y30-11		X	↓	↓	↓	↓	↓		X		↓	
33	-2AE	A6Y30-11		↓	↓	↓	↓	↓	↓		↓		↓	
34	-2AJ	A6Y30-11		↓	↓	↓	↓	↓	↓		↓		↓	
35	-2AL	A6Y30-11		↓	↓	↓	↓	↓	↓		↓		↓	
36	2-FU2-281-2AA	A6Y6-11	X		↓	↓	↓	↓	↓	X			↓	
37	-2AG	A6Y6-11	↓		↓	↓	↓	↓	↓	↓			↓	
38	2-FU2-281-2AF	A6Y6-11	↓		↓	↓	↓	↓	↓	↓			↓	
39	2-FU2-69-2A	A6Y6-11	↓		↓	↓	↓	↓	X	↓			↓	
40	-73-36A	A6Y6-11	↓		↓	↓	↓	↓	X	↓			↓	
41	-74-108A	A6Y6-11	↓		↓	↓	↓	↓	N/A	↓			↓	
42	-74-47A	A6Y6-11	↓		↓	↓	↓	↓	X	↓			↓	

TABLE 8

8.0 SUMMARY OF RESULTS

ITEM	FUSE UNID	FUSE TYPE	RESULT PASS	RESULT FAIL	SAFETY CLASS IE	SAFETY CLASS NON IE	SAFETY CLASS IE-EQ	APPLICATION PENT.	APPLICATION APP'R'	NOTES #1	NOTES #2	NOTES #3	NOTES #4	NOTES #5
43	SPARE	NONE	–	–	–	–	–	–	–	–	–	–	–	
44	2-FU2-96-48BA	A6Y6-11	X		X	N/A	N/A	N/A	N/A	X			X	
45	-1-56A	A6Y6-11	↓		↓	↓	↓	↓	X	↓			↓	
46	-69-2E	A6Y15-11	↓		↓	↓	↓	↓	↓	↓			↓	
47	-73-36B	A6Y15-11	↓		↓	↓	↓	↓	↓	↓			↓	
48	-74-108B	A6Y15-11	↓		↓	↓	↓	↓	N/A	↓			↓	
49	-74-47B	A6Y15-11	↓		↓	↓	↓	↓	X	↓			↓	
50	-74-47C	A6Y15-11	↓		↓	↓	↓	↓	X	↓			↓	
51	SPARE	NONE	–	–	–	–	–	–	–	–	–	–	–	
52	↓	↓	–	–	–	–	–	–	–	–	–	–	–	
53	2-FU2-96-48BB	A6Y15-11	X		X	N/A	N/A	N/A	N/A	X			X	
54	-1-56B	A6Y15-11	↓		↓	↓	↓	↓	X	↓			↓	
55	-1-56C	A6Y15-11	↓		↓	↓	↓	↓	X	↓			↓	
56	-281-28B	A6Y6-11	↓		↓	↓	↓	↓	N/A	↓			↓	
57	-281-28D	A6Y6-11	↓		↓	↓	↓	↓	↓	↓			↓	
58	-281-28H	A6Y6-11	↓		↓	↓	↓	↓	↓	↓			↓	
59	-281-28K	A6Y6-11	↓		↓	↓	↓	↓	↓	↓			↓	
60	-281-28C	A6Y30-11		X	↓	↓	↓	↓	↓		X		↓	
61	-281-28E	A6Y30-11		↓	↓	↓	↓	↓	↓		↓		↓	
62	-281-28J	A6Y30-11		↓	↓	↓	↓	↓	↓		↓		↓	
63	-281-28L	A6Y30-11		↓	↓	↓	↓	↓	↓		↓		↓	

TABLE B

8.0 SUMMARY OF RESULTS

ITEM	FUSE UNID	FUSE TYPE	RESULT PASS	RESULT FAIL	SAFETY CLASS 1E	SAFETY CLASS NON1E	SAFETY CLASS 1E-EQ	APPLICATION PENT.	APPLICATION APP'R'	NOTES #1	NOTES #2	NOTES #3	NOTES #4	NOTES #5
64	2-FU2-281-28A	A6Y6-11	X		X	N/A	N/A	N/A	N/A	X			X	
65	-281-28G	A6Y6-11												
66	-281-28F	A6Y6-11												
67	2-FU2-71-29A	A6Y6-11			NA		X							X
68	-71-37A	A6Y6-11												
69	-71-39A	A6Y6-11												
70	-71-8A	A6Y6-11												
71	-71-34A	A6Y6-11												
72	-71-9A	A6Y6-11												
73	-71-3A	A6Y6-11												
74	-71-19A	A6Y6-11												
75	-71-38A	A6Y6-11												
76	-71-18A	A6Y6-11												
77	-71-17A	A6Y6-11												
78	-71-25A	A6Y6-11												
79	-71-31A	A6Y6-11												
80	-71-29B	A6Y15-11												
81	-71-29C	A6Y15-11												
82	-71-37B	A6Y15-11												
83	-71-37C	A6Y15-11												
84	-71-39B	A6Y15-11												

TABLE B

EBASCO SERVICES INCORPORATED

BY THB DATE 5-18-88 [ED-Q028/-88/39]

CHKD. BY CCP/DB DATE 5/18/88 OFS NO. _____ DEPT. NO. _____

CLIENT TVA

PROJECT BFNP UNIT 2 SHEET 57 OF 84

SUBJECT FUSE PROGRAM [ESSN REACTOR MON BOARDS 2A, 2B, 2C]

581 9-87

8.0 SUMMARY OF RESULTS

ITEM	FUSE UNID	FUSE TYPE	RESULT PASS	RESULT FAIL	SAFETY CLASS 1E	SAFETY CLASS NON1E	SAFETY CLASS 1E-EQ	APPLICATION PERT.	APPLICATION APP'R'	NOTE #1	NOTE #2	NOTE #3	NOTE #4	NOTE #5
B5	2-FU2-71-39C	A6Y15-11	X		N/A	N/A	X	N/A	N/A	X				X
B6	-71-88	A6Y15-11												
B7	-71-8C	A6Y15-11												
B8	-71-34B	A6Y15-11												
B9	-71-34C	A6Y15-11												
90	-71-9B	A6Y15-11												
91	-71-9C	A6Y15-11												
92	-71-3B	A6Y15-11												
93	-71-3C	A6Y15-11												
94	-71-19B	A6Y15-11												
95	-71-19C	A6Y15-11												
96	-71-38B	A6Y15-11												
97	-71-38C	A6Y15-11												
98	-71-18B	A6Y15-11												
99	-71-18C	A6Y15-11												
100	-71-17B	A6Y15-11												
101	-71-17C	A6Y15-11												
102	-71-25B	A6Y15-11												
103	-71-25C	A6Y15-11												
104	-71-31B	A6Y15-11												
105	-71-31C	A6Y15-11												

TABLE B

8.0 SUMMARY OF RESULTS

ITEM	FUSE UNID	FUSE TYPE	RESULT PASS	RESULT FAIL	SAFETY CLASS 1E	SAFETY CLASS NON1E	SAFETY CLASS 1E-EQ	APPLICATION PENT.	APPLICATION APP'R'	NOTE #1	NOTE #2	NOTE #3	NOTE #4	NOTE #5
106	2-FU2-281-2CB	A6Y 6-11		X	N/A	N/A	X	N/A	N/A	Y		X		X
107	↓ -2CD	A6Y 6-11		↓	↓	↓	↓	↓	↓			↓		↓
108	↓ -2CH	A6Y 6-11		↓	↓	↓	↓	↓	↓			↓		↓
109	↓ -2CK	A6Y 6-11		↓	↓	↓	↓	↓	↓			↓		↓
110	↓ -2CC	A6Y 30-11		↓	↓	↓	↓	↓	↓		X			↓
111	↓ -2CE	A6Y 30-11		↓	↓	↓	↓	↓	↓		↓			↓
112	↓ -2CJ	A6Y 30-11		↓	↓	↓	↓	↓	↓		↓			↓
113	↓ -2CL	A6Y 30-11		↓	↓	↓	↓	↓	↓		↓			↓
114	↓ -2CA	A6Y 6-11	X		↓	↓	↓	↓	↓	X				↓
115	↓ -2CG	A6Y 6-11	↓		↓	↓	↓	↓	↓	↓				↓
116	↓ -2CF	A6Y 6-11	↓		↓	↓	↓	↓	↓	↓				↓
117	2-FU2-71 -9D	A6Y 10-11	↓		↓	↓	↓	↓	↓	↓				↓
118	↓ -9E	A6Y 10-11	↓		↓	↓	↓	↓	↓	↓				↓

TABLE 8

9.0 CONCLUSION AND RECOMMENDATION

1. TABLE 'C' IS A TABULATION OF REQUIRED FUSES FOR 250 V. DC REACTOR MOV BOARDS 2A, 2B, AND 2C BASED ON THE RESULTS OF THIS CALCULATION.

2. FUSE TYPE A2Y(AMP)-1 SUPERSEDES TYPE A6Y(AMP)-11, SEE ATTACHMENT 13, PAGE 81. FOR REPLACEMENT FUSES NEW TYPE NUMBER IS INDICATED - SEE TABLE 'C' UNDER "REQUIRED" COLUMN

9.0 CONCLUSION AND RECOMMENDATION

ITEM	FUSE UNID	FUSE REQUIRED	ATT.	SAFETY CLASS 1E	SAFETY CLASS NON 1E	APPLICATION 1E-EQ	APPLICATION PENT.	APPLICATION APP'R	NOTE #1	NOTE #2	NOTE #3	NOTE #4	NOTE #5
1	2-FU2-73-40A	A2Y6-1	12	X	N/A	N/A	N/A	X	X			X	
2	-16A	A2Y6-1	12										
3	-47A	A2Y6-1	12										
4	[illegible]A	A2Y6-1	12										
5	[illegible]A	A2Y6-1	12										
6	35A	A2Y6-1	12										
7	-44A	A2Y6-1	12										
8	-10A	A2Y6-1	12										
9	-30A	A2Y6-1	12										
10	-10C	A2Y6-1	12										
11	-27A	A2Y6-1	12										
12	-3A	A2Y6-1	12										
13	2-FU2-96-48AA	A2Y6-1	12					N/A					
14	2-FU2-73-40B	A2Y15-1	12					X					
15	-16B	A2Y15-1	12										
16	-16C	A2Y15-1	12										
17	-47B	A2Y15-1	12										
18	-26B	A2Y15-1	12										
19	-34B	A2Y15-1	12										
20	35B	A2Y15-1	12										
21	44B	A2Y15-1	12										

TABLE-C

SEE SECTION 8.0 JYR TABLE 'C'

EBASCO SERVICES INCORPORATED

BY THS DATE 05-08-88 CHKD. BY CCD/DB DATE 5/18/88 CLIENT TVA

EED-Q0281-PP1379

PROJECT BFNP UNIT 2 CIS NO.

SUBJECT FUSE PROGRAM [250V. DC REACTOR MOV BOARDS 2A, 2B, 2C]

SHEET 61 OF 84

10 CONCLUSION AND RECOMMENDATION

ITEM	FUSE UNID	REQUIRED	ATT.	SAFETY CLASS 1E	SAFETY CLASS NON1E	SAFETY CLASS 1E-EQ	APPLICATION PERM.	APPLICATION APPR'	NOTE *1	NOTE *2	NOTE *3	NOTE *4	NOTE *5
22	2-FU2-73-10B	A2Y15-1	12	X	N/A	N/A	N/A	X	X			X	
23	-30B	A2Y15-1	12	—	—	—	—	—	—			—	
24	-10D	A2Y15-1	12										
25	-27B	A2Y15-1	12										
26	-30	A2Y15-1	12										
27	2-FU2-96-48AB	A2Y15-1	12					N/A					
28	2-FU2-281-2AB	A2Y6-1	12					—					
29	-2AD	A2Y6-1	12										
30	-2AH	A2Y6-1	12										
31	-2AK	A2Y6-1	12										
32	2-FU2-281-2AC	A2Y15-1	12										
33	-2AE	A2Y15-1	12										
34	-2AJ	A2Y15-1	12										
35	-2AL	A2Y15-1	12										
36	2-FU2-281-2AA	A2Y6-1	12										
37	-2AG	A2Y6-1	12										
38	2-FU2-281-2AF	A2Y6-1	12										
39	2-FU2-69-2A	A2Y6-1	12					X					
40	-73-36A	A2Y6-1	12					X					
41	-74-108A	A2Y6-1	12					N/A					
42	-74-47A	A2Y6-1	12					X					

TABLE-C

9.0 CONCLUSION AND RECOMMENDATION

ITEM	FUSE UNID	FUSE REQUIRED	ATT.	SAFETY CLASS 1E	SAFETY CLASS NON1E	APPLICATION 1E-EQ	APPLICATION PEVT.	APPLICATION APP'R	NOTE #1	NOTE #2	NOTE #3	NOTE #4	NOTE #5
43	SPARE	NONE	—	—	—	—	—	—	—	—	—	—	—
44	2-FU2-96-48BA	A2Y6-1	12	X	N/A	N/A	N/A	N/A	X			X	
45	-1-56A	A2Y6-1	12					X					
46	-69-28	A2Y15-1	12										
47	-73-36B	A2Y15-1	12										
48	-74-108B	A2Y15-1	12					N/A					
49	-74-47B	A2Y15-1	12					X					
50	-74-47C	A2Y15-1	12					X					
51	SPARE	NONE	—	—	—	—	—	—	—	—	—	—	—
52	SPARE	NONE	—	—	—	—	—	—	—	—	—	—	—
53	2-FU2-96-48BB	A2Y15-1	12	X	N/A	N/A	N/A	N/A	X			X	
54	-1-56B	A2Y15-1	12					X					
55	-1-56C	A2Y15-1	12					X					
56	-281-28B	A2Y6-1	12					N/A					
57	-281-28D	A2Y6-1	12										
58	-281-28H	A2Y6-1	12										
59	-281-28K	A2Y6-1	12										
60	-281-28C	A2Y15-1	12										
61	-281-28E	A2Y15-1	12										
62	-281-28J	A2Y15-1	12										
63	-281-28L	A2Y15-1	12										

TABLE-C

9.0 CONCLUSION AND RECOMMENDATION

ITEM	FUSE: UNID	FUSE: REQUIRED	FUSE: ATT.	SAFETY CLASS: 1E	SAFETY CLASS: NON1E	SAFETY CLASS: 1E-EQ	APPLICATION: RENT.	APPLICATION: APP'R'	NOTE 1	NOTE 2	NOTE 3	NOTE 4	NOTE 5
64	2-FU2-281-28A	A2Y6-1	12	X	N/A	N/A	N/A	N/A	X			X	
65	-281-28G	A2Y6-1	12										
66	-281-28F	A2Y6-1	12										
67	2-FU2-71-29A	A2Y6-1	12	N/A		X							X
68	-71-37A	A2Y6-1	12										
69	-71-39A	A2Y6-1	12										
70	-71-81	A2Y6-1	12										
71	-71-34A	A2Y6-1	12										
72	-71-9A	A2Y6-1	12										
73	-71-3A	A2Y6-1	12										
74	-71-19A	A2Y6-1	12										
75	-71-38A	A2Y6-1	12										
76	-71-18A	A2Y6-1	12										
77	-71-17A	A2Y6-1	12										
78	-71-25A	A2Y6-1	12										
79	-71-31A	A2Y6-1	12										
80	-71-29B	A2Y15-1	12										
81	-71-29C	A2Y15-1	12										
82	-71-37B	A2Y15-1	12										
83	-71-37C	A2Y15-1	12										
84	-71-39B	A2Y15-1	12										

TABLE-C

9.0 CONCLUSION AND RECOMMENDATION

ITEM	FUSE UNID	FUSE REQUIRED	ATT	SAFETY CLASS 1E	SAFETY CLASS NON1E	SAFETY CLASS 1E-EQ	APPLICATION PENT.	APPLICATION APP'R'	NOTE #1	NOTE #2	NOTE #3	NOTE #4	NOTE #5
85	2-FU2-71-39C	A2Y15-1	1 2	N/A	N/A	X	N/A	N/A	X				X
86	↓ -71-8B	A2Y15-1	1 2	↓	↓	↓	↓	↓	↓				↓
87	-71-8C	A2Y15-1	1 2										
88	-71-34B	A2Y15-1	1 2										
89	-71-34C	A2Y15-1	1 2										
90	-71-9B	A2Y15-1	1 2										
91	-71-9C	A2Y15-1	1 2										
92	-71-3B	A2Y15-1	1 2										
93	-71-3C	A2Y15-1	1 2										
94	-71-19B	A2Y15-1	1 2										
95	-71-19C	A2Y15-1	1 2										
96	-71-38B	A2Y15-1	1 2										
97	-71-38C	A2Y15-1	1 2										
98	-71-18B	A2Y15-1	1 2										
99	-71-18C	A2Y15-1	1 2										
100	-71-17B	A2Y15-1	1 2										
101	-71-17C	A2Y15-1	1 2										
102	-71-25B	A2Y15-1	1 2										
103	-71-25C	A2Y15-1	1 2										
104	-71-31B	A2Y15-1	1 2										
105	↓ -71-31C	A2Y15-1	1 2	↓	↓	↓	↓	↓	↓				↓

TABLE-C

9.0 CONCLUSION AND RECOMMENDATION

ITEM	FUSE UNID	FUSE REQUIRED	ATT.	SAFETY CLASS 1E	SAFETY CLASS NON 1E	SAFETY CLASS 1E-EQ	APPLICATION PENT.	APPLICATION APP'R'	NOTE #1	NOTE #2	NOTE #3	NOTE #4	NOTE #5
106	2-FU2-281-2CB	A2Y10-1	12	N/A	N/A	X	N/A	N/A	X				X
107	-2CD	A2Y10-1	12										
108	-2CH	A2Y10-1	12										
109	-2CK	A2Y10-1	12										
110	-2CC	A2Y15-1	12										
111	-2CE	A2Y15-1	12										
112	-2CJ	A2Y15-1	12										
113	-2CL	A2Y15-1	12										
114	-2CA	A2Y6-1	12										
115	-2CG	A2Y6-1	12										
116	-2CF	A2Y6-1	12										
117	2-FU2-71-9D	A2Y10-1	12										
118	-9E	A2Y10-1	12										

TABLE-C

EBASCO SERVICES INCORPORATED

BY THB DNE 05-18-88 [ED-Q0281-88139] SHEET 66 OF 34

CHK'D. BY CLO/DS: DATE 5/18/88 OFS NO. DEPT. NO.

CLIENT TVA

PROJECT BFNP UNIT 2

SUBJECT FUSE PROGRAM [250V REACTOR MOV BOARDS 2A, 2B, 2C]

10.0 LIST OF ATTACHMENTS

ATTACH. No.	DESCRIPTION	CONTRACT No & /OR ID NUMBER
1.	GE CR2940U SERIES INDICATING LIGHTS	64542 GEA-8112A
2.	GE D.C. CONTACTORS AND RELAYS.	90744 GEH-1496
3.	GE ET-16 SERIES INDICATING LIGHTS.	90744 GEH-3500
4.	GE-ELECTRICAL CLOSING DATA FOR TYPE AK BRKR	GE-SPEC GEA 10265A
5	BFNP "DOC. TRANSMITTAL" LETTER DATED 12.01.87	RIMS # B22871201303
6.	GE TYPE AK CIRCUIT BRKR TRIP CIRCUIT	GE SPEC: GEA 10265A
7.	GE TYPE AK CIRCUIT BRKR CLOSING CIRCUIT	GE SPEC: GEA 10265A
8	GE INSTANTANEOUS VOLTAGE RELAY 12PJV11AM1A	GEI-28802C
9	AT&C TIMER TYPE 3036006M00 XK	CONT # 69-64706

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10.0 LIST OF ATTACHMENTS (CONT.)

ATTACH. No.	DESCRIPTION	CONTRACT #/OR ID NUMBER
10 (a)	GE AUXILIARY RELAY TYPE IC2B20A100BB2BD	TVA PROCEDURE METHOD PM 86-07
10 (b)	GE AUXILIARY RELAY TYPE HFA51A41	TVA PROCEDURE METHOD PM 86-07
10 (c)	AGASTAT UNDERVOLTAGE RELAY TYPE 7022SC	TVA PROCEDURE METHOD PM 86-07
11 (a)	TROMBETTA CORP. TRIP SOLENOID SR. No. 54906	RIMS #B43870805917 SHEET #114
11 (b)	SQUARE 'D' CLASS 7002 TRIP SOLENOID CONTACTOR	RIMS # B43870805917 SHEET #114
12	GOULD SHAWMUT MELTING TIME-CURRENT DATA FOR FORM 600 (A6Y/A6Y) FUSES	CP-60M-1086-REV-1186
13	GOULD ELECTRONICS LETTER ON A6Y (1-60A) TYPE II FUSES	LETTER DATED 12-19-87 TO MR BAUGHER.
14	SHEET No. 3-1 OF ELECTRICAL PROTECTION HAND BOOK	BUSSMAN PUBLICATION SPD87
15	D.C SYSTEM EQUALIZATION VOLTAGES - MEMO FROM R.L. LEWIS TO E.O HILL	RIMS #R40860919800

EBASCO SERVICES INCORPORATED

[ED-Q0281-88139]

BY THB DMS 5-18-88 SHEET 69 OF 84

CHKD. BY CCO/DS DATE 5/18/88 OFS NO. DEPT. NO.

CLIENT TVA

PROJECT BFNP UNIT 2

SUBJECT FUSE PROGRAM [250V REACTOR MOV BOARDS 2A, 2B, 2C]

10.0 LIST OF ATTACHMENTS (CONT)

ATTACH. NO.	DESCRIPTION	CONTRACT No. & /OR ID NUMBER
16	D.C. VOLTAGE RATINGS OF GOULD FUSES - GOULD INC. CIRCUIT PROTECTION DIV.	GOULD CPD SLS-MKTG P01

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EBASCO SERVICES INCORPORATED

BY THB DMS DATE 5-18-88 [ED-Q0281-88139] ATTACHMENT - 1 SHEET 69 OF 84

CHKD. BY [illegible] DATE 5/18/88 OFS NO. ______ DEPT. NO. ______

CLIENT TVA

PROJECT BFNP UNIT-2

SUBJECT FUSE PROGRAM (250 V. DC REACTOR MOV BOARDS 2A, 2B, 2C.

HEAVY-DUTY OIL-TIGHT PUSH BUTTONS

CR2940 U ORDERING INFORMATION

A-C or D-C

Continuous Current 10 amp

600 Volts Max.

ACCESSORIES AND COMPONENTS

Color Ring Standard [illegible]

[illegible]

Amber and Aluminum Rings [illegible]

¾" Deep Color Ring Used With Combination Units

For converting [illegible] any one color to any other color.

CR2943 U200AC [illegible]
CR2943 U200AD [illegible]
CR2943 U200AE [illegible]
CR2943 U200AF (Green)
CR2943 U200AG (Bright metal)
CR2943 U200CAG [illegible]

1 ⅛" Deep Color Ring

Adapts CR2940 [illegible] combination [illegible]

CR2943 U200G [illegible]
CR2943 U200W (Red)
CR2943 U200X (Yellow)
CR2943 U200AA (Green)
CR2943 U200AB (Bright metal)

Constituted Switch Guard Ring

1 ⅛" deep ring for combination [illegible]

CR2943 U200CJ (Black)
CR2943 U200BU (Bright metal)
CR2943 U200CK (Green)

Separate Mushroom Head (1 ⅛" Diameter)

Black	CR2943 U200AH
Red	CR2943 U200AJ
Yellow	CR2943 U200AK
Orange	CR2943 U200AM

Bat Lever Knob

Black	CR134 G133
Red	CR134 G133
Yellow	CR134 G134
Green	CR134 G135
White	CR134 G136
Blue	CR134 G137

Locking Means

[illegible]

CR2943 [illegible]

Selector-switch Locking Means

[illegible]

CR2943 [illegible]

[illegible]

[illegible]

INDICATING LIGHT UNITS

Full-voltage Indicating-light Unit Less Color Cap

Operating Voltage	Color of Color Cap	For Panel Mounting CR2940 Form	For Base Mounting CR2943 Form
6 Volts	Less Cap	[illegible]	
12 Volts	Less Cap	[illegible]	[illegible]
18 Volts	Less Cap	[illegible]	[illegible]
24 Volts	Less Cap	[illegible]	[illegible]
32 Volts	Less Cap	[illegible]	[illegible]
110/125 Volts	Less Cap	[illegible]	[illegible]
(Bayonet)	Less Cap and Bulb	[illegible]	[illegible]
(Candelabra) 6 Watts	Less Cap and Bulb	[illegible]	[illegible]

Full-voltage type with 656 incan. lamp included

Operating Voltage	Color of Color Cap	For Panel Mounting CR2940 Form	For Base Mounting CR2943 Form
110 125 Volts AC DC Lamp 6 Watts	Red	[illegible]	[illegible]
	Green	[illegible]	[illegible]
	Amber	[illegible]	[illegible]
	Blue	[illegible]	[illegible]
	White	[illegible]	[illegible]
	Clear	[illegible]	[illegible]

Full-voltage type with NE-45 Neon Lamp

Operating Voltage	Color of Color Cap	For Panel Mounting CR2940 Form	For Base Mounting CR2943 Form
110 125 Volts AC DC Lamp ¼ Watt	Red	[illegible]	[illegible]
	Amber	[illegible]	[illegible]
	Clear	[illegible]	[illegible]

Resistor type with 656 incan. lamp included

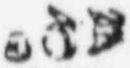
Operating Voltage	Color of Color Cap	For Panel Mounting CR2940 Form	For Base Mounting CR2943 Form
Lamp 6 Watts, Input 12 Watts, 220 125 Volts AC DC	Less Cap	[illegible]	[illegible]
	Red	[illegible]	[illegible]
	Green	[illegible]	[illegible]
	Amber	[illegible]	[illegible]
	Blue	[illegible]	[illegible]
	White	[illegible]	[illegible]
	Clear	[illegible]	[illegible]

Transformer type with No. 55, 6V incan. lamp included

Lamp 1.5 Watts, Input 3 ½ Watts. Refer to nearest General Electric Apparatus Sales Office for 25-cycle forms

Operating Voltage	Color of Color Cap	For Panel Mounting CR2940 Form	For Base Mounting CR2943 Form
110 Volts 60/50 Cycles	Less Cap	[illegible]	[illegible]
	Red	[illegible]	[illegible]
	Green	[illegible]	[illegible]
	Amber	[illegible]	[illegible]
	Blue	[illegible]	[illegible]
	White	[illegible]	[illegible]
	Clear	[illegible]	[illegible]
220 Volts 60/50 Cycles	Less Cap	[illegible]	[illegible]
	Red	[illegible]	[illegible]
	Green	[illegible]	[illegible]
	Amber	[illegible]	[illegible]
	Blue	[illegible]	[illegible]
	White	[illegible]	[illegible]
	Clear	[illegible]	[illegible]
440 Volts 60/50 Cycles	Less Cap	[illegible]	[illegible]
	Red	[illegible]	[illegible]
	Green	[illegible]	[illegible]
	Amber	[illegible]	[illegible]
	Blue	[illegible]	[illegible]
	White	[illegible]	[illegible]
	Clear	[illegible]	[illegible]
550 Volts 60/50 Cycles	Less Cap	[illegible]	[illegible]
	Red	[illegible]	[illegible]
	Green	[illegible]	[illegible]
	Amber	[illegible]	[illegible]
	Blue	[illegible]	[illegible]
	White	[illegible]	[illegible]
	Clear	[illegible]	[illegible]

SILICONE RUBBER LENS UNITS



No. 12 Lamp

[illegible]

FLASHER LIGHT TRANSFORMER TYPE—60/50 CYCLES—NO. 455 LAMP

[illegible]

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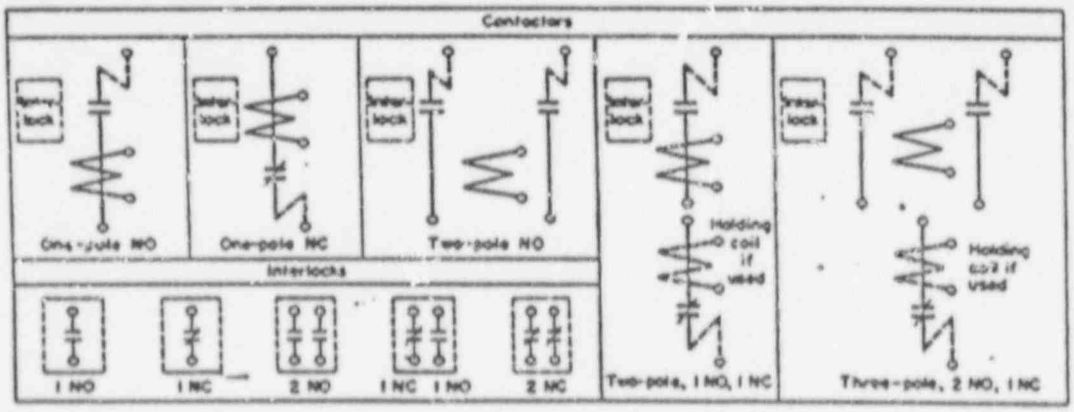
GENERAL-PURPOSE CONTACTORS

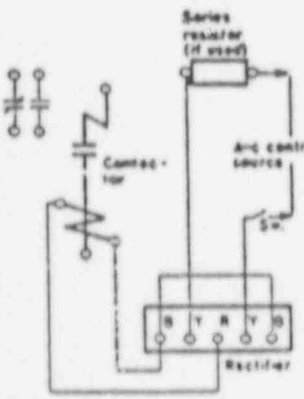
Control power requirements

Contactor Size	Poles	Number of Contactors	Total Power Requirements					
			[illegible]			[illegible]		
			Volts D-c			Volts A-c		
			115	230	550	110	220	440
1	1 NO	1	0.107	0.038	0.054	22	33	66.5
	1 NC	1	0.107	0.038	0.054	22	33	66.5
	1 NO, 1 NC	1	0.107	0.038	0.054	22	33	66.5
	2 NO	2	0.213	0.107	0.050	41.8	79.4	66
2	1 NO	1	0.131	0.039	0.077	24.2	44	44
	1 NC	1	0.131	0.039	0.077	24.2	44	44
	1 NO, 1 NC	1	0.131	0.039	0.022	24.2	44	44
	2 NO	1	0.234	0.118	0.044	37.4	66	72.5
	2 NO, 1 NC	1	0.234	0.118	0.044	37.4	66	72.5
3	1 NO	1	0.234	0.118	0.044	37.4	66	72.5
	1 NC	1	0.234	0.118	0.044	37.4	66	72.5
	1 NO, 1 NC	1	0.234	0.118	0.044	37.4	66	72.5
	2 NO, 1 NC	1	0.234	0.118	0.044	37.4	66	72.5
	2 NO	1	0.234	0.118	0.044	37.4	66	72.5

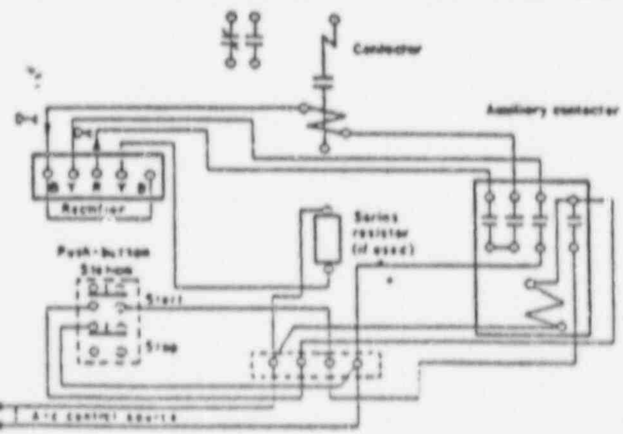
Total power requirements—Total power requirements for a-c operation include requirements of rectifiers, series resistors, and auxiliary contactors, as well as main contactor coil or coils. Values for a-c operation are based on holding resistor in circuit when used.

Wiring symbols (front view)





Size 1 and 2 contactors—typical diagram for a-c operation



Size 3 contactors—typical diagram for a-c operation

GEH-1500

RATINGS

Resistors ET-16 12.5 Watts
ET-17 1 Watt

BULB	DESIGN VOLTAGE	DESIGN AMPS	CANDLE POWER	AVERAGE LIFE (HOURS)
1819	28	.04A	Approx. .34	2500
1635	55	.05A	Approx. 1.1	5000
81A	105-125	.3 MA	-	15,000

CONNECTIONS

See Figure 1A and 1B for typical tell-tale and dim-bright connections.

RECOMMENDED PANEL ASSEMBLY

Thread pal nut against shoulder of the receptacle. Insert remaining threads thru panel and thread escutcheon nut against panel. Assemble color cap fully, hand tighten, (do not force). Turn escutcheon nut back, up against color cap, then back off 1/2 to 3/4 turn (recommend 3/4 turn) to give at least 1/64 but not more than 1/32 clearance between color cap and escutcheon nut-(for up to 3/16 panel). For 1/4 panel, color cap will be flush with escutcheon nut. Tighten pal nut against panel to 10-12 inch pounds torque.

TABLE 1

ET-16 - INDICATING LAMP

CIRCUIT VOLTAGE RATED	MIN.	MAX.	CAT. NO. (INCLUDES LAMP, COLOR CAP, & RESISTOR	RESISTOR 0165A7844 PART NO.	RESISTOR 0165A7844 OHMIC VALUE	BULB GE CAT. NO	RECEPTACLE	COLOR CAP *	CARTON	OUTLINE
24 D-c	22	28	01168670861	1	10	1819	01168670961	SEE ORDERING TABLE 1	0165A8325P1	0165A7859
48 D-c	44	56	01168670862	2	200					
125 D-c	110	140	01168670863	3	2000					
250 D-c	220	280	01168670864	4	5100	1835				
120 A-c	95	130	01168670865	5	1900					
240 A-c	195	260	01168670866	6	4800					

TABLE 2

ET-16 - FOR DIM-BRIGHT APPLICATION

CIRCUIT VOLTAGE RATED	MIN.	MAX.	CAT. NO* (INCLUDES LAMP, COLOR CAP, AND RESISTOR)	RESISTOR 0165A9217 PART NO.	RESISTANCE OHMS TOTAL	TAP	BULB GE CAT. NO.	RECEPTACLE	COLOR CAP *	CARTON	OUTLINE
48 D-c	44	56	01278810861	1	450	50	1835	01168670963	SEE ORDERING TABLE 1	0165A9257 P2	0165A9216
125 D-c	110	140	01278810862	2	2550	1700					
250 D-c	220	280	01278810863	3	6000	4400					
120 A-c	95	130	01278810864	4	2450	1600					
240 A-c	195	260	01278810865	5	5700	4200					

EBASCO SERVICES INCORPORATED

BY THB DATE 5-18-88 [ED-Q0281-08139] SHEET 12 OF 84

CHKD. BY GCO/DS DATE 5/18/88 ATTACHMENT - 4 OFS NO. _____ DEPT. NO. _____

CLIENT TVA

PROJECT BFNP UNIT-2

SUBJECT FUSE PROGRAM (250V. DC REACTOR MOV BOARDS 2A, 2B, 2C)

Type AKR Breakers

Description

The closing mechanisms of low voltage power circuit breakers may be either the manually or electrically operated type. Manual is for local control, electrical for remote operation.

Both mechanisms employ the stored energy principle by interposing an energy storage spring between the operator and the breaker contacts. This provides a constant closing speed not influenced by the operator or control power voltage level, promoting reduced maintenance and increased contact and breaker life.

Manual Closing

The manually operated AKR-30, 50 and AKRT-50 frame models have front-mounted handles. The closing springs are charged by any number of handle strokes from one to four, depending on the angle through which the handle is rotated. Upon completion of the charging action, the springs are held prodded in the fully charged position and discharge only upon receipt of a closing signal. Normal closing is initiated by depressing a mechanical CLOSE button on the escutcheon. A maintenance handle is provided for the slow-closing motion required during contact adjustment procedures. A control solenoid for remote closing is optionally available.

AKR-75 and -100 manual breakers require four handle strokes to charge the springs, unlike the smaller AKR frame sizes above, the breaker's contacts close during the fourth handle stroke — initiation of closing by separate CLOSE button is not available.

Manually operated AK-25 models are closed by first rotating the handle counterclockwise approximately 100 degrees; this resets the mechanism and partially charges the closing spring. Returning the handle clockwise to the normal position completes the spring charging and drives the toggle mechanism over center, closing the contacts.

Electrical Closing

All electrically operated AKR breaker types utilize a motor to automatically keep the closing springs in a charged state; upon receipt of a closing signal, a control solenoid releases the springs, closing the breaker's contacts. An electrical CLOSE pushbutton is mounted on the breaker escutcheon when specified. A manual closing handle is provided for maintenance purposes.

All electrically operated breakers close in 5 cycles. Spring charging requires approximately 3 seconds.

Electrically operated AK-25 breakers employ a solenoid to actuate the toggle mechanism.

Opening

All breakers, manual and electrical, are equipped with a mechanical TRIP button located on the breaker escutcheon. Electrical breakers include a shunt trip device for remote opening (unless an under-voltage release is specified).

OPERATING MECHANISMS

"O" Type Electrically Operated

"O" Type Manually Operated

"O" Type Manually Operated

AKR-30, 50 & AKRT-50 Escutcheons

AKR-75 & 100 Escutcheons

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CHKD. BY CCO/BS: DATE 5/18/88 ATTACHMENT-5 OFS NO. DEPT. NO.

CLIENT TVA

PROJECT BFNP UNIT-2

SUBJECT FUSE PROGRAM (250V.DC REACTOR MOV BOARDS 2A,2B,2C)

QA

B22 [illegible]

TENNESSEE VALLEY AUTHORITY

Browns Ferry Nuclear Plant
P. O. Box 2000, Decatur, Alabama 35602

DEC 01 1987

Ebasco Services Incorporated
P. O. Box 608
Tanner, Alabama 35671

Attention: Susan Gros, Document Control Supervisor

Dear Ms. Gros:

BROWNS FERRY NUCLEAR PLANT - BROWNS FERRY ENGINEERING PROJECT - DOCUMENT TRANSMITTAL

Per your request, Engineering Records Control Unit is transmitting documents for Task Scoping Document E101 shown on the enclosed list. Please acknowledge receipt of documents by signing below and returning this form within ten working days.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

Susan A Burt

S. A. Burt, Engineering Records Control Unit Supervisor
Division of Nuclear Engineering

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Type AKR Breakers

Accessories

Shunt Trip

Offers remote electrical opening of breaker. Usually controlled by a switch or button, it may also be used in conjunction with protective relays for automatic tripping.

The shunt trip coil is rated for intermittent duty. When factory installed, it is supplied with a cutoff switch which automatically removes control power following a breaker trip.

Selective Trip (Type EC-1)

Applied to circuit breakers in series so that only the breaker nearest the overcurrent fault opens. Allows for added system coordination.

Undervoltage Trip (UV)

Protects against harmful drops in the voltage by automatically tripping the breaker. This device is set to pickup at approximately 85% of bus voltage and drop out between 30% and 60%.

The UV device is also available with an optional static time-delay unit. This offers a field adjustable 2 to 6 second delay between undervoltage fault and breaker trip to prevent potential nuisance tripping due to momentary loss of voltage.

The time-delay unit is mounted external to the breaker. It is rated 125 or 250 V. DC or 208/240 VAC, 50 or 60 Hz. For any other AC source voltage, a control power transformer with a 240 volt secondary rated at least 100 VA is required.

Key Interlock Provision

Prevents operation of a remote function unless the breaker has been tripped. Provision is made to accept a lock assembly furnished by purchaser (GEE or Kirk).

Auxiliary Switch

Used for remote indication of breaker main contact position. Available in groupings of four contacts (two stages) or ten contacts (five stages). Each stage is composed of one "a" Type (N.O.) contact and one "b" Type (N.C.) contact. All contacts feature rugged double break construction.

Reverse Current Device

Used with D-c breakers. Designed to trip the breaker if current reverses direction.

Neutral Connector

For use in general-purpose enclosures, provides termination for system neutral.

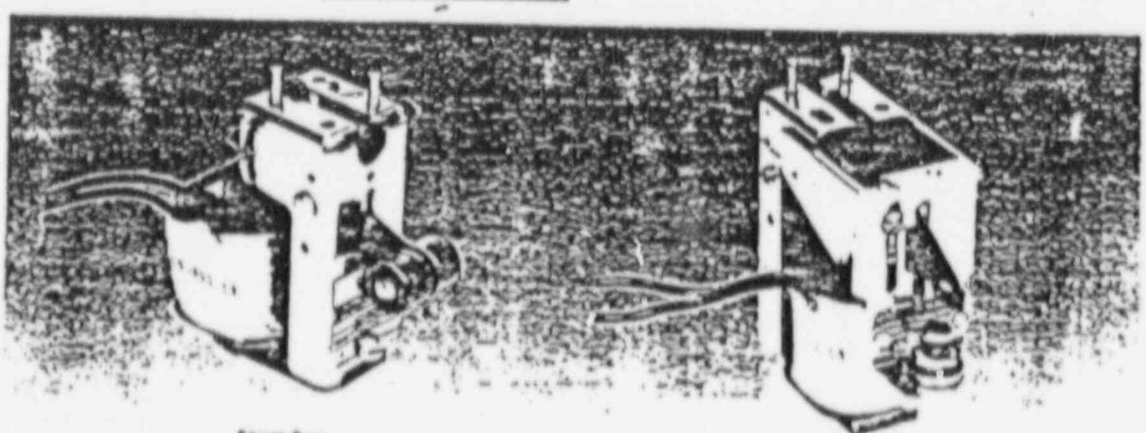
CONTROL VOLTAGE			Shunt Trip Amperes	
Nominal		Operating Range	Inrush	Sustained
	48	28-56	4.5	4.5
	125	70-140	1.9	1.9
	250	140-280	1.0	1.0
	120	104-127	12.3	10.8
	208	175-225	3.2	2.5
60 Hz. Ac	240	208-254	3.9	3.4
	480	416-508	3.4	3.1
	575	475-625	2.8	2.5

Control Voltage		UV Coil Amperes	
		Inrush	Sustained
Dc	48	0.20	0.20
	125	0.07	0.07
	250	0.04	0.04
60 Hz Ac	120	0.68	0.24
	208	0.51	0.17
	240	0.37	0.12
	480	0.23	0.08
50 Hz Ac	120	0.75	0.25
	208	0.30	0.10
	240	0.34	0.11
	480	0.25	0.07

Breaker Main Contacts	Auxiliary Switch Position	
	"a" Contact	"b" Contact
Open or Tripped	Open	Closed
Closed	Closed	Open

Control Voltage		Auxiliary Switch Interrupting Ratings (Amperes)	
		Non-Inductive	Inductive
Dc	125	11 ①	6.3 ①
	250	2	1.8
Ac	115	75 ①	50 ①
	240	50 ①	25 ①
	480	25 ①	12 ①

① [illegible]



Shunt Trip Device

Undervoltage Device

"DE" LINEAGE POWER SERIES G.E. GE SPEC: GEA 10265A

Type AKR Breakers

Accessories

Operations Counter

A 5-digit non-resettable counter situated on the breaker cam shaft. Mounts on breaker.

Bell Alarm With Lockout

The bell alarm operates one a and one b contact or, two a's or two b's. It is activated when the breaker is tripped by any means (automatic) other than the manual trip button or the shunt trip device.

The contacts may be used for remote indication of an automatic trip.

The lockout feature is available to mechanically lock the breaker "open" when the device is activated. "Reset" is accomplished through operation of the manual trip button or shunt trip device.

The bell alarm is available without the lockout feature when so specified.

Electric Lockout

The electric lockout device provides a means of electrically interlocking breakers so that two cannot be closed at the same time. This electromechanical device consists of a coil whose winding must be energized to close the breaker. Once the breaker is closed, loss of voltage will not trip the breaker. A bypass interlock is provided for initial startup. Refer to the UV device for ratings and coil characteristics.

Auxiliary switches for [illegible] must be ordered separately.

Remote Close Solenoid for Manually-Operated AKR-30, 50, AKRT-50 Breakers

Provides a means to electrically close the above breakers from a remote location. May be controlled by a switch or pushbutton for fast-cycle closing. Breaker must be charged locally. Available ratings

Closing Mechanism Operating Amperes

Breaker Frame	120 Volt, 60 Hz Operating Range 104-127 VAC			240 Volt, 60 Hz Operating Range 208-254 VAC			125 Volt, Dc Operating Range 105-140 VDC			250 Volt, Dc Operating Range 200-280 VDC		
	Inrush	Sustained	Recommended Fuse Size	Inrush	Sustained	Recommended Fuse Size	Inrush	Sustained	Recommended Fuse Size	Inrush	Sustained	Recommended Fuse Size
AKR-30 UKR-30 AKRT-30	25	5	6	12	3	6	27	5	6	13	3	6
AKR-75 AKR-100	25	8.1	10	12	3.5	10	27	7	10	13	3.2	10
AK-25	153	78	30	68	28	15	44	44	10	24	24	6
AK-50 AKT-50 AK-75	9	4	6	4	2.8	6	30	4	6	15	2	6
AK-100	9	4	10	4	3.2	10	30	5	10	15	2.5	10

Control Voltage		Bell Alarm Contact Ratings (amperes)	
		Inrush	Continuous
Dc	125	2.5	2.5
	250	0.9	0.9
60 Hz Ac	120	30	10
	240	15	5
	480	7	3

Bell Alarm Device with Lockout

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GEI-28802 Instantaneous Voltage Relay Type PJV

* TABLE II

	2 Amp Tap	0.2 Amp Tap
ry Tripping Duty	30 Amps	5 Amps
arry Continuously	3 Amps	0.3 Amps
D-C Resistance	0.13 Ohms	7 Ohms
mpedance (60 Cycles)	0.53 Ohms	52 Ohms

* TABLE III

	DC				AC		
V	24	48	125	250	115	230	460
A	5	2	1	0.5	5	2	1

CONTACTS

The contacts will carry 5 amps continuously or 30 amps for tripping. The contact interruption capacities are given in Table III.

CHARACTERISTICS

The time voltage curves are shown in Figs. 1 and 2. The pickup voltage is adjustable for 61 to 139 per cent of the rating. The dropout voltage is 90 to 95 per cent of the pickup voltage on AC and 70 to 90 per cent on DC circuits. The dropout voltage is not adjustable.

* TABLE IV

TYPE	No. of Relay Units	Contacts Each Unit No.	Contacts Each Unit Code	Target M=Mech. O=None	Reset H=Hand S=Self	Type of Case	Outline Fig. No.	Int. Conn. Fig. No.	Relay Type AC or DC Overvolt. **	Relay Type AC or DC Undervoltage
PJV11J	3	3	11	O	S	M3	5	8		AC
PJV11L	1	2	all	O	S	S1	3	8		AC
PJV11N	3	3	11	M	S	M3	5	8		
PJV11AF	1	3	all	M	S	S1	3	8	AC	
PJV11AH	2	3	all	M	S	S2	4	9	AC	
PJV11AK	1	3	all	O	S	S1	3	8	AC	
PJV11AJ	2	2	all	O	S	S2	4	9		DC
PJV11ALs	2	3	all	O	S	S2	4	9		AC
+ PJV11AM	1	2	all	M	S	S1	3	8		DC
+ PJV11AN	2	2	all	M	S	S2	4	9	DC	
PJV11AR	2	2	all	M	S	S2	4	9	DC	
PJV11AS	3	2	all	M	S	M2	5	7	AC	
JV11AW	1	2	all	M	S	S1	3	12	AC	
JV11AZ	1	2	20		S	S1	3	8		AC
V12B	1	2	all	M	H	S1	3	13	AC	
V12C	3	2	11	M	H	S1	3	8	AC	
V14B	1	40	22	O	S	M2	5	76	AC-DC	AC
PJV14C	1	40	22	M	S	S2	4	11		
PJV15A	1	40	22	M	H	S2	4	11	AC-DC	
						S1	3	10	AC-DC	

+ Hand-reset relays = Hand-reset on normally closed contacts only.

** Overvoltage relay — AC - Not for continuous operation in the picked up position.

+ Dropout equals 85% to 90% of pick up voltage.

RATINGS AND BURDENS

* TABLE I

Rating Volts	Rating Freq.	Cal. Range	Volt-Amps A	Volt-Amps B	Volt-Amps C	Watts A	Watts B	Watts C
115	60	70-160	5.52	8.56	9.3	2.56	4.15	4.9
115	50	70-160	5.0	6.8	7.8	2.03	3.2	4.1
115	25	70-160	1.9	2.5	2.8	1.0	1.6	1.9
230	60	140-320	5.52	8.56	9.3	2.56	4.15	4.9
230	50	140-320	5.0	6.8	7.8	2.03	3.2	4.1
230	25	140-329	1.9	2.5	2.8	1.0	1.6	1.9
460	60	280-640	5.52	8.56	9.3	2.56	4.15	4.9
460	50	280-640	5.0	6.8	7.8	2.03	3.2	4.1
460	25	280-640	1.9	2.5	2.8	1.0	1.6	1.9
125	DC	50-160	--	--	--	5.1	5.1	5.1
250	DC	100-320	--	--	--	5.0	5.0	5.0

A = at rated volts with plunger set for pick-up at minimum point of range.

B = at rated volts with plunger set for pick-up at rated volts.

C = at rated volts with plunger set for pick-up at maximum point of range.

SPECIFICATIONS

MODELS
One only. Does not reset on power interruption.

RANGES
15 standard ranges, from 15 sec to 60 hrs at 60 Hz (18 sec to 70 hrs at 50 Hz). 5 ranges, from 30 sec to 240 min for DC operation; as listed in Price Sheet.

MIN. SETTING
1/60th of range.

REPEAT ACCURACY
± 0.2% of full scale (AC only).

RESET TIME
1/10 sec full scale.

PILOT LIGHT
Standard, wired in parallel with motor.

DIAL DIVISIONS
60 sec., 120 sec., 240 sec., 6 min., 60 min., 120 min., 240 min., 6 hr. and 60 hr. — 120 Dial Divisions

15 sec., 30 sec., 15 min., 30 min., 15 hr. and 30 hr. — 150 Dial Divisions

LIFE EXPECTANCY
MECHANICAL: 1,000,000 operations.
CONTACTS: over 1,000,000 operations (average) under a resistive or inductive load of 1A.

TIMING MOTOR — AC MODELS
Synchronous, permanently lubricated.

TIMING MODES
Single cycle interval timing only.

LOAD SWITCHES
NUMBER: two SPDT switches with open blade contacts; also available with one SPDT switch, on quantity orders only.

CONTACT RATING
(non-inductive): 10 A at 115V AC
5 A at 230V AC
½ A at 115V DC

TERMINALS
Screw terminals accessible at rear; wiring diagram on housing.

HOUSING
Push-on design, dimpled for gasketed, dust-tight when surface or panel mounted.

POWER REQUIREMENTS
AC MODELS: 115 or 230V, 50 or 60 Hz; 5 watts max.
DC MODELS: 28, 48, 125 or 250V, 5 watts.
Special voltages and frequency on order.

TEMPERATURE RATING
32 to 120°F (0 to 50°C)

WEIGHT
NET: 1 lb.
SHIPPING: 1 lb., 5 oz.

MOUNTING ACCESSORIES
STANDARD: Hardware is provided to mount timer so that it is dust-tight from front of panel.
OPTIONAL: (See last pages of catalog for detailed descriptions). NEMA 12 case for one timer. NEMA 1 case for one or two timers.

AT&C TIMER TYPE 308B006M00XK