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VARGA,S.A. Operating Reactors Branch 1

SUBJECT: Responds to request for addl info re automatic bus transfer feature for certain auxiliary feedwater (AFW) sys components per TMI Item II.E.1.2.Encl study justifies maintaining existing transfer for AFW Valve V2-16A.

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NRC TAC #54896

Director of Nuclear Reactor Regulation
Attention: Mr. Steven A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing
United States Nuclear Regulatory Commission
Washington, DC 20555

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261/LICENSE NO. DPR-23
NUREG-0737, ITEM II.E.1.2
AUXILIARY FEEDWATER SYSTEM AUTOMATIC
INITIATION AND FLOW INDICATION

Dear Mr. Varga:

SUMMARY

The NRC staff requested additional information regarding the automatic bus transfer (ABT) feature for certain auxiliary feedwater system (AFWS) components at the H. B. Robinson Steam Electric Plant Unit No. 2 (HBR2). Carolina Power & Light Company has performed an ABT Study (enclosed) which justifies retaining the ABT.

DISCUSSION

Motor-driven Auxiliary Feedwater System (AFWS) pump discharge valve V2-16A is normally powered from Motor Control Center (MCC) 10. An ABT is provided to transfer the power source for this valve to MCC-9 if MCC-10 becomes unavailable. The staff's position is that electrical independence must be maintained between redundant emergency power sources. The slightly improved defense against a random single failure achieved by the ABT is more than offset by the additional vulnerability to the common mode failure which is created. The staff position is that this ABT feature provides a connection between redundant load groups and should be removed. Carolina Power & Light Company has stated that the breaker scheme employed would prevent the transfer of a fault from one bus to another.

The staff's position is that this is not sufficient justification for the ABT and that faults within the ABT or within the valve itself present potential unnecessary challenges to these protective devices. The staff also mentioned that they understand that certain AFWS automatic initiation signals only start the motor driven AFWS pumps. Given certain single failures, in the absence of the ABT, initiation of flow to two steam generators will be delayed until the steam driven AFWS pump starts. The staff believes, however, that this delay (which only occurs given a certain single failure) is insignificant as opposed to challenging redundant safety systems via the ABT.

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Carolina Power & Light Company has performed an ABT Study of the AFW System. This demonstrates that due to proper breaker coordination, a common mode failure of redundant emergency power sources which feed AFW valve V2-16A is not a significant safety concern.

CONCLUSION

Carolina Power & Light Company believes that this ABT Study, which consists of an engineering review, Event Tree Analysis, and the Availability Analysis, supports and justifies retaining the ABT switchover for AFW valve V2-16A at HBR2. This study demonstrates that a potential common cause failure is highly unlikely, since the system is properly coordinated for a worst case fault.

In addition, the assumptions considered for the analysis are consistent with the Design Criteria applicable to HBR2 as it relates to formulating scenarios for anticipated occurrences or postulated accidents. The following Design Criteria are applicable to HBR2:

1. Concurrent loss of offsite power is assumed for the specific accidents of Main Steam Line Break, Feedwater Line Break, and LOCA.

2. Each Engineering Safety Feature is designed to perform its intended function while accommodating any single failure of an active component.

3. The Reactor Protection System is designed with redundancy and independence to ensure that no single failure will prevent reactor trip.

Therefore, CP&L believes the enclosed ABT Study sufficiently justifies maintaining the existing ABT for the AFW valve V2-16A.

Questions regarding this matter may be referred to Jan Kozyra at (919) 836-7924.

Yours very truly,

S. R. Zimmerman
Manager
Nuclear Licensing Section

JSK/ccc (1627JSK)

Enclosure

cc: Dr. J. Nelson Grace (NRC-RII)
Mr. G. Requa (NRC)
Mr. H. Krug (NRC Resident Inspector - RNP)

AUTOMATIC BUS TRANSFER STUDY

1. ENGINEERING REVIEW

The engineering review consisted of modeling the electrical system by determining the impedence of the various components in the system and assembling an equivalent circuit model (Thevenin equivalent circuit). This model was then analyzed using the short circuit analysis computer program (SHORTC),[1] which calculates the magnitude of the short-circuit current that can result from a three-phase bolted fault, at any point on a power system model. This equivalent circuit model will produce the same response as the electrical distribution system when exposed to a fault condition. In addition, the normal and alternate power supplies were considered to be loaded to a LOCA condition at the time of the fault (worst case).

Attachment 1 is a simplified Auxiliary Feedwater (AFW) system drawing and Attachment 2 is a single line electrical diagram showing the power supplies to AFW valve V2-16A.

The normal power supply (MCC-10) coordination study is tabulated on the time-current characteristic (TCC) curves (Attachment 3). As can be seen from the TCC curves, if the available short circuit current at the ABT exceeds the setting (lower edge of curve for device F) of the protective device, then the protective device is no longer effective. Since, at the ABT, the maximum available fault current (1078 amperes) does not exceed the protective device setting (1400 amperes) it can be reasonably assured that if a fault were to occur on the load side (worst case) of the ABT switch for AFW valve V2-16A, the system is protected from the short circuit. At this maximum available fault current level, the feeder breaker (E) will trip in less than .02 seconds but, the upstream breaker (F) will not trip unless the fault is sustained for 6 seconds. Therefore, it is highly unlikely that the upstream breaker (F) will trip before the feeder breaker (E) causing a loss of MCC-10.

The alternate power supply (MCC-9) coordination study is tabulated on the TCC curves (Attachment 4). Again, as can be seen from the TCC curve, if a fault were to occur on the load side (worst case) of the ABT switch for AFW valve V2-16A, the breakers are coordinated such that the maximum available fault current (792 amperes) does not exceed the protective device setting (1155 amperes). At this maximum available fault current level, the feeder breaker (C) will trip in less than 0.35 seconds but, the upstream breaker (D) would not trip unless the fault was sustained for at least 8 seconds. This ensures that a proper coordination between the breakers D and C exists. The coordination study results are tabulated in Attachment 5.

The breaker coordination study concluded that the normal and alternate power supplies are coordinated under a worst case fault condition. Therefore, a common mode failure is highly unlikely.

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1 The SHORTC computer program has been design verified and meets CP&L's required control and usage of computer codes for analysis of safety-related functions in nuclear power plants. In addition, the code has been verified by bench-marking against a problem with a known solution that encompasses parameters that the code has been designed to model.

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The ABT is a true double throw switch designed as "break before make," and is inherently interlocked both mechanically and electrically. Failure of any coil, or disarrangement of any part will not permit a neutral position or a cross connect between power sources. The main contact is mechanically positioned on either source without the use of hooks, latches, semi-permanent magnets or springs and does not depend on a source of power to maintain its position. Therefore, due to this mechanical and electrical interlock, MCC-9 should not cross connect to MCC-10 through the ABT.

2. EVENT TREE ANALYSIS

CP&L performed an Event Tree Analysis for the AFW valve V2-16A. The Event Tree Analysis consisted of analyzing different failure combinations contained in the AFW valve V2-16A electrical diagrams (Attachment 2). The initiating event for the Event Tree Analysis was considered to be a three phase fault with an annual probability of 8.76E-3. The probability of losing both MCC-9 and MCC-10 is considered to be the annual probability of having a fault, a failure of breaker coordination on the normal power supply, transferring the fault by the ABT switch to the opposite bus, and a failure of breaker coordination on the alternate power supply. The ABT Event Tree Analysis results, tabulated in Attachment 6, demonstrates that if proper breaker coordination exists, the probability of failures of both power sources (per year) is highly unlikely. In addition, the analysis is considered to be conservative since no credit has been taken for detection of failures during normal operation.

3. AVAILABILITY ANALYSIS

An Availability Analysis of the AFW system ABT feature was performed by evaluating the electrical short circuit analysis and quantifying the availability effects of the ABT switch that exists in the power supply circuit for AFW valve V2-16A. An existing GO Model[2] of the HBR2 AFW system was modified and updated to reflect the following features:

-- AFW system success criteria: one AFW pump supplying a total of 240 gpm to two steam generators (120 gpm each).

-- Potential common cause failure of Motor Control Centers (MCC-9, 10).

-- ABT switch for AFW discharge valve V2-16A.

The results of the Availability Analysis provided in Attachment 7 demonstrated there is a slight benefit from retaining the ABT feature (7.7E-5 less 4.7E-3 equals 3.E-5 per demand reduction in unavailability) from the AFW system. The reason for this is that the redundant power source to the AFW valve V2-16A provides additional availability benefits to the AFW system. The Availability Analysis that if the potential common mode failure mechanisms are removed, AFW system unavailability is within published values of AFW system unavailability. As discussed previously, a three phase short circuit causing a common mode failure at the fault levels analyzed is highly unlikely, due to proper system coordination. In addition, the AFW system unavailability per demand for the existing ABT system configuration was compared to the data of NUREG/CR-3228 and NUREG-0880. As

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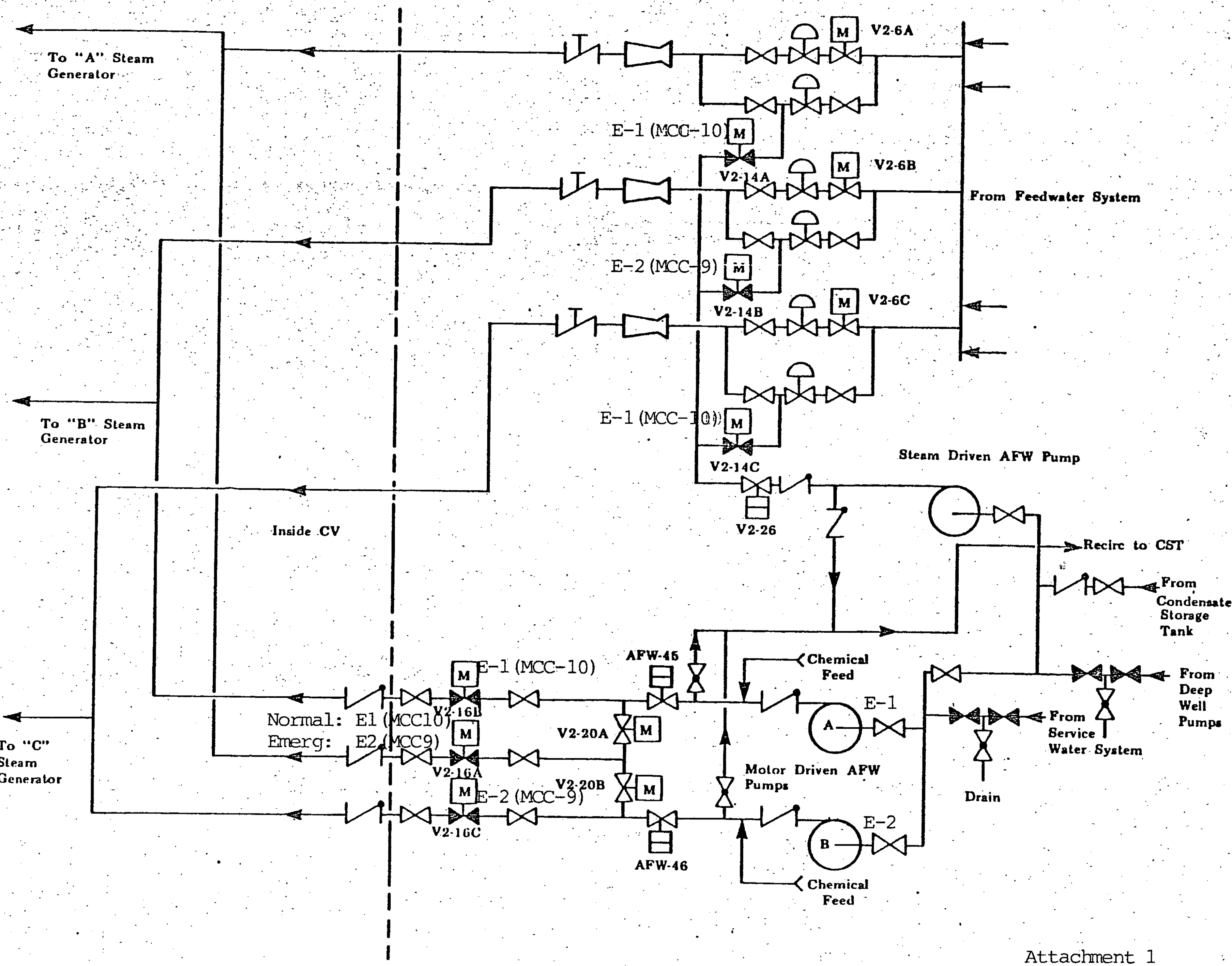
2 EPRI NP-9123-CMM, "Probabilistics GO System Analysis Methodology," June 1983.

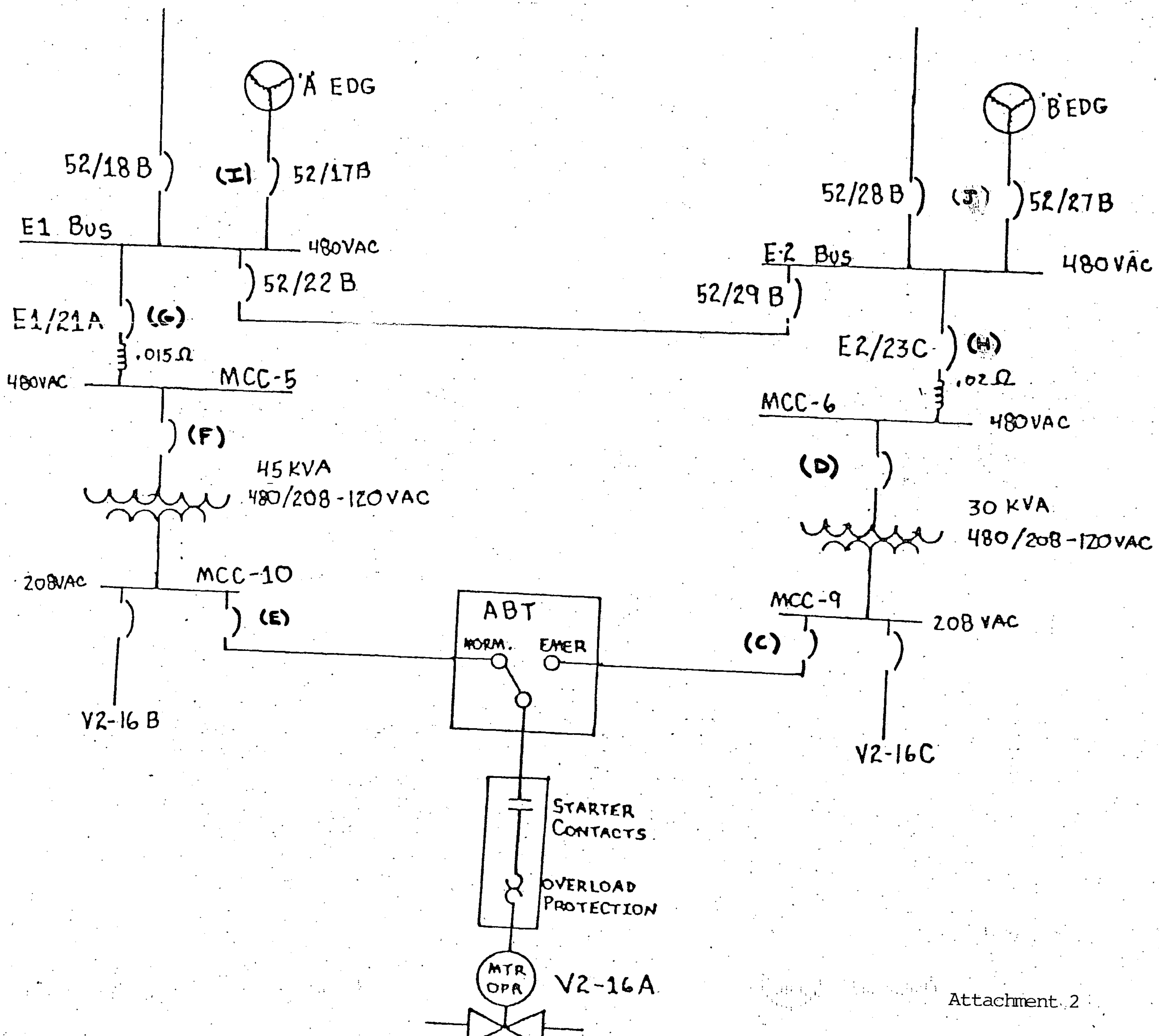
shown in Attachment 7, the estimated AFW system unavailability per demand for the existing configuration does not exceed the acceptable values provided in the referenced NUREGs. Based on the results of this Availability Analysis, CP&L believes maintaining the ABT does not significantly compromise safety.

Auxiliary Feedwater System



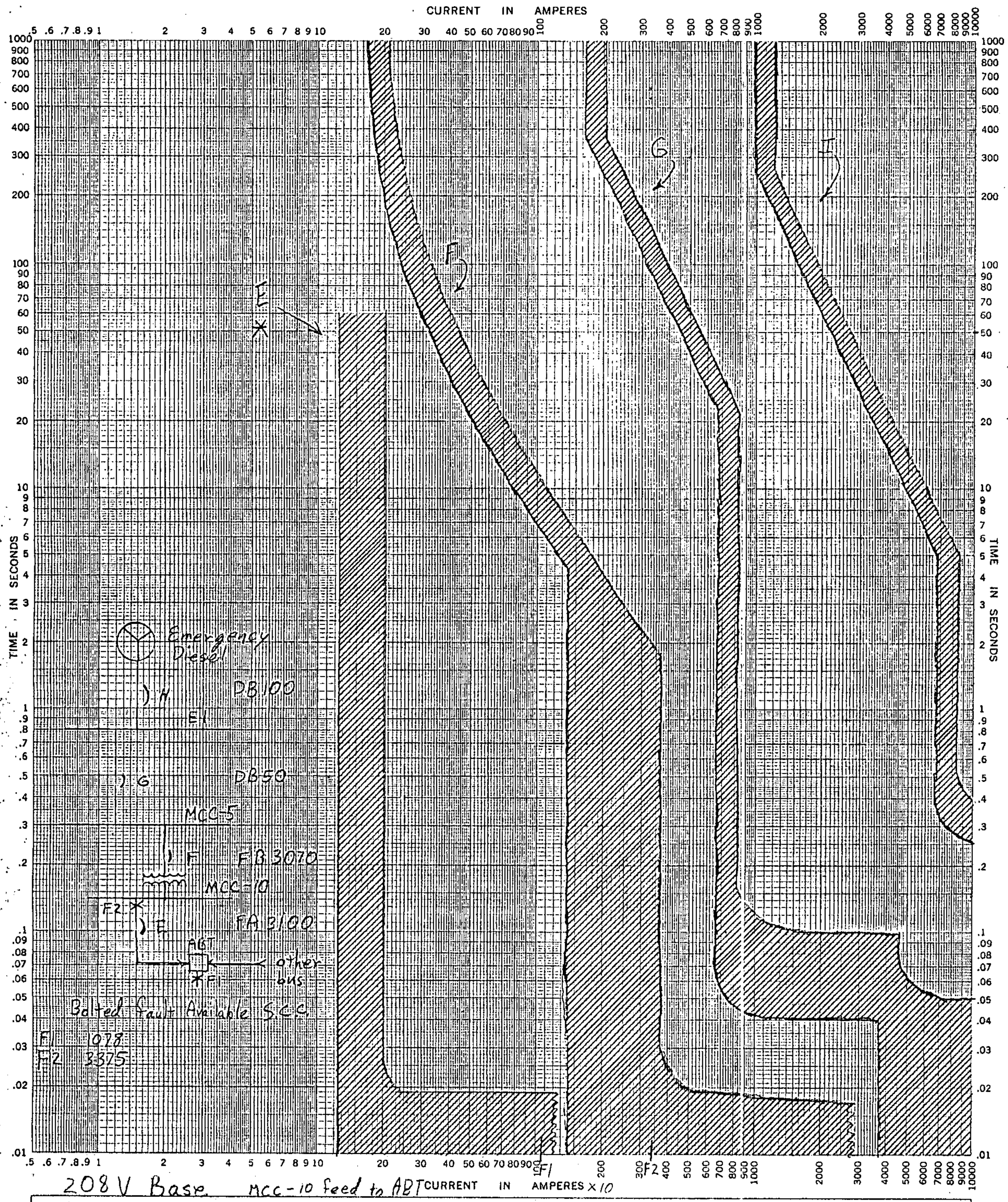
Attachment 1

SINGLE LINE ELECTRICAL DIAGRAM (AFW VALVE V2-16A)



Attachment 2

NORMAL POWER SUPPLY COORDINATION STUDY RESULT



TIME-CURRENT CHARACTERISTIC CURVES

For ______ Fuse Links. In ______

BASIS FOR DATA Standards ______ Dated ______

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

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

No. ______

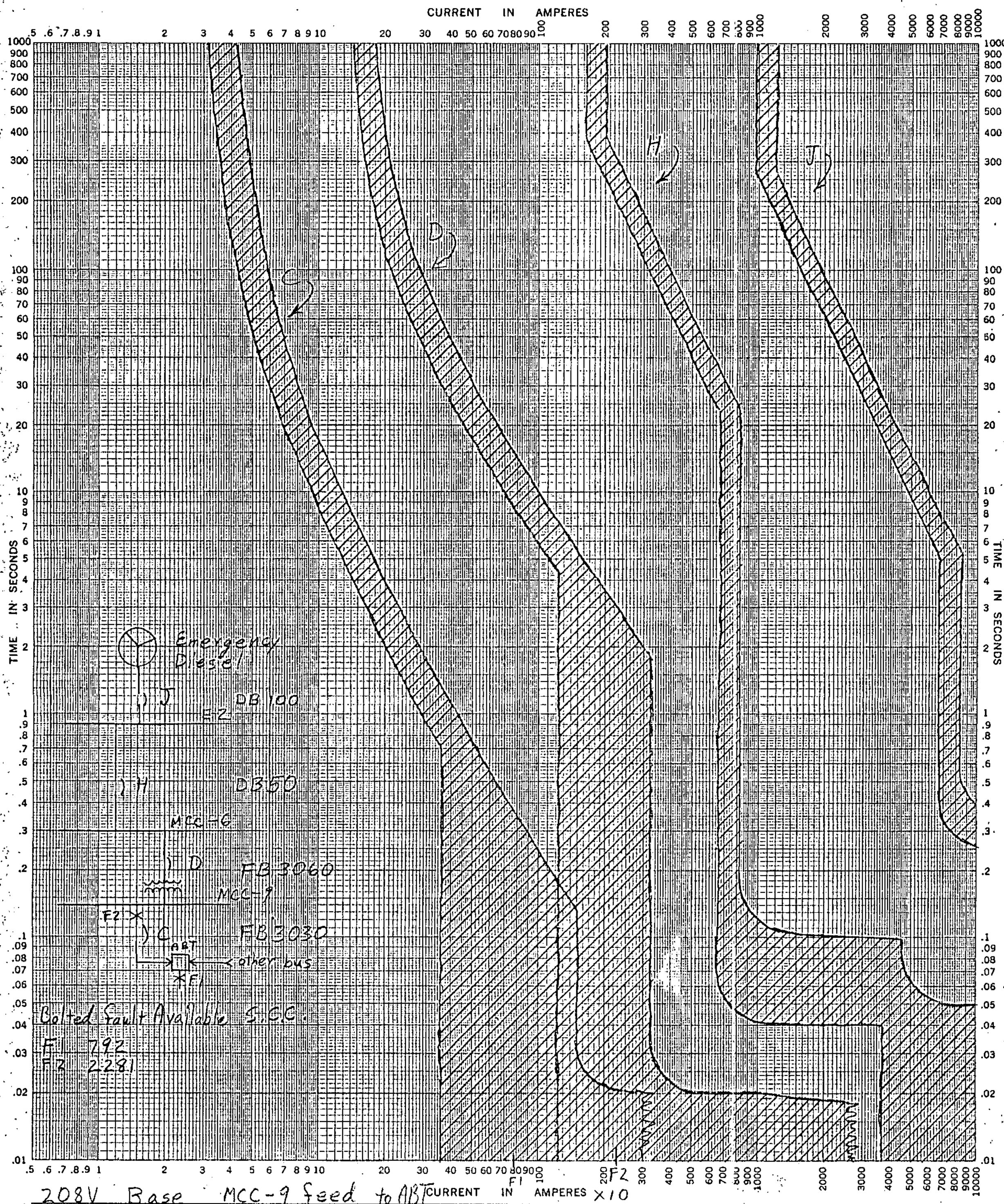
Date ______

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

* Note Thermal overloads for FA3100 are not shown

Fault currents shown are the maximum that can be "seen" by the closest upstream breaker

Attachment 3



208V Base MCC-9 feed to ABT

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

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

Fault currents shown are the maximum that can be "seen" by the closest upstream breaker

Attachment 4

Attachment 5

ENGINEERING REVIEW RESULTS

	FAULT LOCATION	MAXIMUM AVAILABLE FAULT CURRENT* (amps)	DEVICE INSTANT-ANEOUS SETTING* (amps)	INSTANTANEOUS SETTING, UP-STREAM BREAKER* (amps)
Valve V2-16A	Load side of ABT fed from MCC-10	1078	160(E)	1400(F)
	Load side of ABT fed from MCC-9	792	360(C)	1155(D)
	Line side of ABT breaker (E) in MCC-10	3375	1400(F)	37000(G)
	Line side of ABT breaker (C) in MCC-9	2281	1155(D)	37000(H)

* 208V base

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Attachment 6

EVENT TREE ANALYSIS

I. INPUT DATA FOR EVENT TREE ANALYSIS

Component or Failure Mode	Failure Rate (per HR)	Source	Unavailability[1] (per year)
Circuit Breaker	1.E-5	NUREG/CR-2815	8.76E-2
Wire Shorted to Ground	1.E-6	NUREG/CR-2815	8.76E-3

II. HBR2 ABT EVENT TREE ANALYSIS RESULTS

Failure Combinations	Probability of Failure per Year
E-1 and E-2	3.96E-9
MCC-5 and MCC-6	7.5E-7
MCC-9 and MCC-10	6.73E-5

NOTE: The initiating event for the Event Tree is a 3 phase fault at V2-16A with an annual probability of 8.76E-3.

1 Unavailability = Failure Rate (per HR) x 8760 HRS/YR

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AVAILABILITY ANALYSIS RESULTS

AFW System Configuration	AFW System Unavailability Per Demand	NUREG/CR-3226 Table E-2 (p. 230) (Unavailability Per Demand)	NUREG/CR-0880 USNRC 1983 Rev. 0 (Unavailability Per Demand)
With ABT	4.7E-5	1.E-4	1.E-4
ABT Removed	7.7E-5	1.E-4	1.E-4

NOTES:

1. The results given are unavailabilities on demand. The unavailabilities are determined by taking the complement of the availability as determined by the GO Code (EPRI NP-3123-CMM, "Probabilistic GO System Analysis Methodology," June 1983).
2. Uncertainties are estimated to be reflected by an error factor of 10.
3. Three phase fault at the load side (worst case) of the V2-16A ABT was assumed as an initiating fault.
4. No credit has been taken for the dedicated shutdown diesel in this analysis.