TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

October 9, 1981

RECEIVED
OCT 15 1981
U.S. NUCLEAR REGULATORY COMMISSION

Director of Nuclear Reactor Regulation
Attention: Ms. E. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Ms. Adensam:

In the Matter of the Application of	)	Docket Nos. 50-390
Tennessee Valley Authority	)	50-391

During a meeting on September 17 and 18, 1981, employees of the Tennessee Valley Authority (TVA) and the Nuclear Regulatory Commission Power Systems Branch (PSB) discussed various NRC concerns related to Watts Bar Nuclear Plant (WBN). Enclosed is additional information requested by the PSB. This information reflects TVA's understanding of the status of the concerns of the PSB reviewers. Mechanical systems are discussed in Enclosure 1. Electrical systems are discussed in Enclosure 2.

The revisions to the WBN Final Safety Analysis Report as specified in the enclosures will be included in Amendment 45.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills, Manager
Nuclear Regulation and Safety

Sworn to and subscribed before me
this 9th day of October 1981
Paulette H. White
Notary Public
My Commission Expires 9-5-84

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Enclosures

ENCLOSURE 1

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
RESPONSES TO NRC POWER SYSTEMS (MECHANICAL) BRANCH REVIEW CONCERNS

Questions 40.44, 40.96 and 40.75 - The Watts Bar FSAR (Section 9.5.5) will be revised to state that 'After four hours of operation at less than 30-percent load, the diesel generator is run at a minimum of 50-percent load for at least 30 minutes. After an accident situation when the diesel generator has run for an extended period of time at low or no load, the load is gradually increased until the exhaust smoke is approximately twice as dense as normal. The increasing load is then stopped until the smoke clears. This procedure is repeated until full load can be carried with a clear exhaust.'

FSAR Section 9.5.1.5 (Personnel Qualification and Training) will be revised as follows:

> 'Each shift engineer and assistant shift engineer receives a formal Fire Incident Command Course prior to his appointment and once every four years thereafter.'

Questions 40.49 and 40.112 - The Watts Bar FSAR (section 10.2.4) will be revised to read as follows:

10.2.4 Evaluation

The following operational transients which are caused by operation of turbine, generator, or distribution system protection equipment, can occur:

1. Turbine trip due to turbine abnormalities.

2. Turbine trip due to generator abnormalities.

3. Transients due to rapid load changes or system abnormalities.

All turbogenerator protective trips that will automatically trip the turbine due to turbine (mechanical) and generator (electrical) abnormalities are tabulated below. Reactor trip and safety injection signals also will automatically trip the turbine. All turbine trips, except for the first three trips tabulated in the turbine (mechanical) abnormalities list below, are also shown in figure 10.2-1.

I. Automatic Turbine Trips Due to Turbine (Mechanical) Abnormalities

   1. Low Bearing Oil Pressure Trip
   2. Low Vacuum Trip
   3. High Thrust Bearing Trip
   4. High Turbogenerator Vibration Trip

5. Low Differential Water Pressure Across Generator Station Coils Trip (alarm only below 15-percent power)
6. High Stator Coil Outlet Water Temperature Trip (alarm only below 15-percent power)
7. Low EHC Fluid Tank Level
8. Low Lube Oil Tank Pressure
9. Low EHC Fluid Pressure Trip
10. Low Auto Stop Oil Pressure Trip
11. 111 Percent Rated Speed Electrical Overspeed Trip
12. 111 Percent Rated Speed Mechanical Overspeed Trip
13. EHC DC Power Failure Trip
14. Loss of Both Main Feedwater Turbines Trip
15. Steam Generator High High Level Trip

II. Automatic Turbine Trips Due to Generator (Electrical) Abnormalities

1. Generator Differential Current Trip
2. Generator Neutral Overvoltage Trip
3. Generator Time Overcurrent (Voltage Supervised) Trip
4. Generator Negative Sequence Trip
5. Generator Backup and Main Transformer Feeder Differential Trip
6. Generator Reverse Power Trip
7. Unit Station Service Transformer A Overcurrent Trip
8. Unit Station Service Transformer B Overcurrent Trip
9. Main Transformer Sudden Pressure Trip
10. Main and Unit Station Service Transformers Differential Trip
11. 500 kV, Bus 2, Station 3 Breaker Failure Trip
12. 500 kV, Bus 2, Station 3 Differential Set 1 Trip
13. 500 kV, Bus 2, Station 3 Differential Set 2 Trip

The analyses of the consequences of the severest of these events with respect to reactor safety are discussed in Chapter 15, Accident Analysis.

There can be any number of component or system operational abnormalities that can be postulated to produce a turbogenerator load transient. However, since the effects of such abnormalities can be no worse than a turbine or generator trip, these occurrences are not formally listed.

Any noble gas activity in the secondary system, as well as the particulate activity present due to moisture carryover from the steam generators, enters the high-pressure turbine.

The subsequent activity entering the low-pressure turbine is reduced due to the moisture separation that occurs between the exit of the high-pressure turbine and the entrance to the low-pressure turbines.

Activity levels in the turbine are expected to be low and all necessary shielding is provided by the piping, turbine casing, and other components. If any additional shielding is required in local areas, it will be provided so that unlimited access to the turbine area is possible. Details of the shielding design are discussed in Chapter 12.

The closure time of the main steam stop (throttle) and control (governor) and reheat stop and interceptor valves is 0.15 second. Each of the four throttle valves is arranged in series with a governor valve and each of the six reheat stop valves is arranged in series with an interceptor valve.

If the turbine unit should overspeed, the overspeed protection controller (OPC) will open trained (A&B) solenoid valves (FSV-47-26A and -26B) and dump the control fluid from the control and interceptor valves (causing the valves to rapidly close) at 103 percent of rated turbine speed. If the turbine speed should continue to increase to 111 percent, the mechanical overspeed trip mechanism will actuate a hydraulic dump valve, which dumps autostop oil to drain. Depressurization of the autostop oil system then causes FCV-47-27 to open and depressurize both the stop and control valve emergency trip fluid systems which causes all control, stop, reheat stop, and interceptor valves to trip close (see figure 10.2-3). Concurrently with the above trip fluid action, independent, redundant electrical trip signals are also generated when the autostop oil system is depressurized which energizes FSV-47-24 and FSV-47-26A (train A) , and FSV-47-26B and FSV-47-27 (train B) to independently depressurize both the stop and control valve emergency trip fluid systems, and this causes all of the above steam valves to trip close (see figure 10.2-1). In addition to the above mechanical overspeed trip, an independent, redundant electrical overspeed trip will also energize both trains of the above solenoid valves (FSV-47-24, -26A, -26B, and -27) at 111 percent of rated speed to depressurize the autostop oil, the stop valve emergency trip fluid, and the control valve emergency trip fluid systems and this trips all of the above steam valves closed.

Redundancy in the overspeed protection system is assured by independent mechanical and electrical overspeed trips, a separate overspeed controller, trained (A and B) electrical trip circuitry, serial and parallel trip fluid systems, and double isolation in the steam systems. A single failure will not prevent the overspeed protection system from triping the turbine. Since the electrical and mechanical overspeed trips are independent, only one of these trips need to function to trip the turbine. The electrical trip circuitry and the Westinghouse trip fluid systems are designed such that if the single failure occurred in these systems, the overspeed protection system will still perform its intended function. Isolation of either the stop valve or control valve in each piping loop upstream of the high pressure turbine and of either the reheat stop valve or intercept valve in each piping loop upstream of the low-pressure turbines will prevent steam from entering the turbine and consequently limit the overspeed to within the acceptable range. Therefore, the single failure of a steam valve or any other component in the overspeed protection system will have no effect on the overspeed protection system performing its intended protection function.

A turbine trip (or overspeed or power/load unbalance) signal also generates an electrical trip signal which deenergizes the solenoid dump valves on the power assist nonreturn valves in the number 1, 2, 3, and 4 extraction lines and the moisture separator reheater (MSR) drain lines. When the above solenoid dump valves are deenergized, a quick exhauster vents the air from the power assist nonreturn valve cylinder allowing a spring-loaded piston to provide positive force to close the above nonreturn valves in less than a second. Concurrently, the above turbine trip signal (which dumps the stop or control valve emergency fluids as described in earlier paragraphs above) also activates a fluid-operated air pilot valve, XDV-47-27 (see figure 10.2-3). If the above solenoid dump valves fail to deenergize, this valve (XDV-47-27) will vent the air (through the energized solenoid dump valves) from the nonreturn valve cylinders causing the nonreturn valves to close in less than three seconds. In either of the above cases, the nonreturn valves will close prior to flow reversal occurring in these extraction and MSR drain lines. Consequently, the above heaters and MSR drains cannot 'flash back' and cause or significantly contribute to a turbine overspeed situation.

Since heaters 5, 6, and 7 are located in the condenser neck, physical piping arrangements and economic considerations prohibit the use of nonreturn valves in these extraction lines. However, anti-flash orifices in the heater shells (sized in accordance with the turbine manufacturer's recommendations) restrict the reverse flow from these heaters to a sufficiently low flow so that it cannot adversely affect turbine overspeed or thermally shock the LP turbine.

Response to Question 40.77(B, E)

The communication systems listed in question 40.77(C) are used during operation of the plant. This includes plant trips, cooldown, full power, refueling, startup, and testing. Telephone locations with high sound levels are equipped with sound dampening phone booths. We believe that using the communications systems during these modes of operation qualifies the communication system for all possible operation modes including accident and transient conditions. In addition, during hot functional and startup testing, cooldown and plant operation from the backup control room is required. This testing requires establishing and maintaining effective communications with plant employees throughout the plant.

The only test performed on communications equipment is done on the sound-powered phone system primarily because this system is seldom used. It is our position that the use of PAX and paging systems during normal and simulated emergency conditions verifies the suitability of these communications systems and no additional testing is required.

Question 40.95

During diesel generator operation, the entire jacket water system, with the exception of the jacket water expansion tank, is filled with jacket water. During standby, however, the piping from the engine jacket water outlet to the temperature control valve will drain to an equalized level with the expansion tank. This span of piping will contain air during engine startup which is vented into the top of the expansion tank when the pipe fills with water. The jacket water pumps are engine driven and as such would fill this pipe slowly as the engine starts and comes up to speed. In addition, the pumps draw water from the expansion tank, evacuating it and thus creating a vacuum which would enhance the venting. Should any air proceed through the piping, there is a vent on top of the lubricating oil cooler which will allow it to return to the expansion tank.

Question 40.97

The jacket water expansion tank has a nominal capacity of 80 gallons at the recommended level with approximately 20 gallons between the full and low levels on the expansion tank sight glass. The jacket water system contains a total volume of approximately 250 gallons. Inspections for proper water level and any system leakage are made on regular intervals. Under these circumstances, we anticipate that any system leakage will be insignificant as compared to the expansion tank capacity. If leakage rates are very conservatively assumed to be as high as one gallon per day, this would not adversely affect the diesel generator's ability to perform its safety function during the stated 7-day continuous operation.

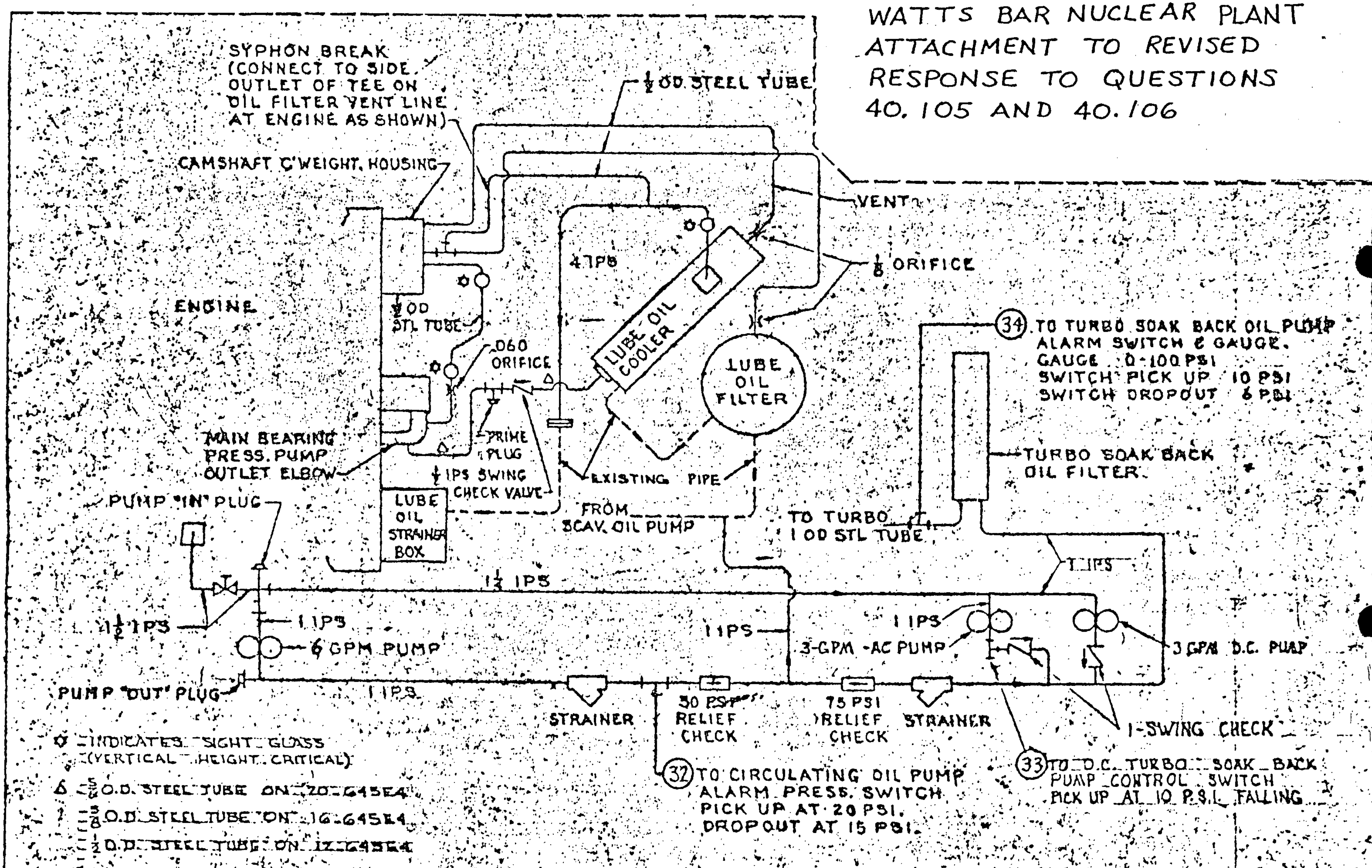
Questions 40.105 and 40.106

The diesel engine manufacturer (EMD/GM) has proposed a modification to the lubricating oil system shown in the attached diagram. Included in this modification are a dc motor-driven pump, an additional ac motor-driven pump, and piping modifications. The dc motor-driven pump supplies oil to the turbocharger if the ac motor-driven pump cannot and provides a method of removing heat from the turbocharger bearings if the engine is shut down without the ac pump operable. The additional ac motor-driven pump ensures proper lubrication of the turbocharger during the start sequence. The piping modifications preclude the draining down of the lubricating oil system and provides warm oil directly to the engine crankshaft bearings during standby, thus providing protection from 'dry' starts and improves standby temperature maintenance. TVA intends to complete this modification prior to fuel loading at WBNP-1.

Question 40.118

Discuss the measures taken for detecting, controlling and correcting condenser cooling water leakage into the condensate stream. Provide the permissable cooling water inleakage and time of operation with inleakage to assure that condensate/feedwater quality can be maintained within safe limits.

WATTS BAR NUCLEAR PLANT
ATTACHMENT TO REVISED
RESPONSE TO QUESTIONS
40.105 AND 40.106



SCHEMATIC DIAGRAM

Response

Each condenser is equipped with a sampling system that continuously monitors the condensate conductivity. A given increase in co nductivity at one or more of the nine sampling points indicates condenser cooling water inleakage. The nine sampling points were isolated in such a manner that the operator could determine (1) which tube bundle is leaking, (2) where the leak is located within the three condenser pressure zones, and (3) whether the leak is in the area of the tube-to-tubesheet joint; and if so, which of the four tubesheets is leaking.

Since each unit's condenser waterbox is divided into two sections, one section can be isolated during unit operation if the other section is found to be leaking. Each unit has the capability of operating at a reduced power level while one-half of its condenser waterboxes are isolated. By isolating one-half of the condenser waterboxes at a time, repairs and/or plugging of defective tubes can be accomplished as soon as leaks are detected.

Any impurities in the condenser cooling water which are introduced into the condensate stream by condenser inleakage are removed by the Condensate Demineralizer System (CDS). The CDS is capable of maintaining the condensate/feedwater quality within the specified limits during a continuous inleakage of up to 15 gpm (total inleakage into either or both unit condensers) When the condenser inleakage is greater than 15 gpm, the leak must be located as soon as possible, the affected condenser section isolated, and the leak repaired. The time required to detect and locate condenser inleakage and to isolate a condenser section for corective action is six hours maximum. Each unit's CDS is capable of maintaining the condensate feedwater/quality for six hours with condenser inleakage of up to 180 gpm.

Section 8.3.1.3 - Possible Interconnection Between Redundant Divisions and Possible Sharing of A-C Power Systems Between Units

A discussion of the proposed auxiliary power system modification indicated that there would be no need for any maintenance intertie breakers since the shutdown utility bus is being eliminated. The discussion was considered satisfactory. This item was considered closed.

Section 8.3.1.4 - Diesel Generator Protective Trips

The bypassing scheme for the diesel generator protective trip was explained, and drawing numbers 45W760-82-2 and 45W760-82-5 (schematics) were discussed. The discussion was considered satisfactory, and this item is closed.

Section 8.3.1.6 - Diesel Generator Reliability Qualification Testing

TVA supplied the required test report to the NRC in a letter from J. E. Gilleland to Bernard C. Rusche dated December 30, 1975. This information was submitted on the Sequoyah Nuclear Plant Docket (50-327, 50-328). The diesel generators at Watts Bar are the same as those at Sequoyah.

A discussion of TVA's compliance to RG-1.9, Rev. 2, 'Selection, Design, and Qualification of Diesel-Generator Units' follows:

Regulatory Position

C. 1 Full compliance

C. 2 Full compliance

C. 3 Full compliance

C. 4 Full compliance

C. 5 Degree of compliance with this position will be determined later and the NRC notified of the results.

C. 6 Full compliance

C. 7 (a) Full compliance

(b) Full compliance

C.8 Does not comply - Although a first-out serveillance system is not installed at Watts Bar, all diesel generator protective trips such as differential overcurrent have been provided with targets to indicate which protective device operated. In addition, the status of protective devices installed to shut down the diesel generator unit for generator or engine trouble are alarmed in the main control room. Where more than one protective device target is operated, an analysis of the problem will be done to determine which device operated first.

C.9 It is TVA's position that the intent of this position has been fully met. TVA's response to NRC question 112.33 relating to seismic qualifications of Watts Bar safety-related equipment was provided by letter dated April 8, 1981 from L. M. Mills to H. R. Denton. In addition, please refer to FSAR Table 3.10.1, sheet 2, for a summary of the seismic qualification of electrical equipment, including the diesel generators. Further, please refer to Table 3.10.3 'Watts Bar Seismic Qualifications,' sheets 11 through 20 for tests, results, and references of the seismic qualification of various components of the diesel generator unit.

C.10 Full compliance

C.11 Full compliance

C.12 N/A

C.13 N/A

C.14 Does not comply. The load qualification test was not done as part of the type qualification test. This test is being run as part of the preoperational test program, but the requirements of IEEE 387-1977 are being followed. It is TVA's position that running the short-time load test at the end is a more severe test and this sequence is justifiable.

Section 8.3.2.3 - DC System Reliability

It is TVA's understanding that this item is being dropped from the SER because it is being actively pursued on a generic basis by the ACRS.

Section 8.3.3.5 - Application of the Single Failure Criterion to Manually Controlled Electrically Operated Valves

Redundant valve position indication on manually controlled electrically operated valves was discussed. TVA explained that these valves currently have valve position indication via lights near the handswitch as well as on the status light panel. TVA drawing 45W760-63-2 (schematic) shows the redundant valve position indication. The discussion was considered satisfactory, and this item is considered closed.

Question 40.81

The fill connections for truck deliveries are integral with the diesel generator building wall embedded in concrete only 12' from the outside face of the wall. Any tank can be filled from any one of the four connections using the transfer pump and piping.

The vent lines from the tanks are only exposed for the last 18' above the roof. They are only 12' from the parapet wall that extends 18' above the top of the vent. We feel that this parapet wall provides adequate tornado missile protection.

Question 40.83

The only underground piping exists between the yard storage tanks and the 7-day fuel oil storage tanks. Piping and components are wrapped with polyethylene and all joints are taped. Cathode protection is not used since this part of the system is not safety related. The 7-day fuel oil storage tanks are internally coated with Rustband 357 as manufactured by Humble Oil Company. The exterior of the tank is coated with a single coat of red lead in oil. All coating was done by the tank manufacturer.

Question 40.84

The diesel generator auxiliary systems were not designed to conform to Regulatory Guide 1.26 since it was not in effect on the docket date for the WBN construction permit as noted in FSAR pages 3.2-1 and 3.2-2 (attached). All the piping on the skid is designed to ANSI B31.1 as required in the vendor contract (see excerpt attached). The boundary for skid piping is the first welded, screwed, or flanged connection on the skid. All auxiliary systems related to a safety function have the design class shown in FSAR table 3.2-2a. All other auxiliary systems have the class boundaries shown on their respective system flow diagrams and in the system description portion of the FSAR.

assigned to nuclear power plant equipment per the August 1970 Draft of ANSI N18.2,"Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants." The TVA piping classification system for WBNP does not conform strictly to the guidance of Regulatory Guide 1.26 (which was not in affect on the docket date for the Construction Permit). The ANS safety classification of each component has been considered in the various aspects of design, fabrication, construction, and operation. 28 5.3

3.2.2.1 Class A

Class A applies to reactor coolant pressure boundary components whose failure could cause a loss of reactor coolant which would not permit an orderly reactor shutdown and cooldown assuming that makeup is only provided by the normal makeup system. Branch piping 3/8 inch inside diameter and smaller, or protected by a 3/8 inch diameter or smaller orifice, is exempted from Class A.

3.2.2.2 Class B

Safety Class B applies to those components of safety systems necessary to fulfill a system safety function. The classification is specifically applicable to containment and to components of those safety systems, or portions thereof, through which reactor coolant water flows directly from the reactor coolant system or the containment sump.

3.2.2.3 Class C

Class C applies to components of those safety systems that are important to safe operation and shutdown of the reactor but that do not recirculate reactor coolant.

3.2.2.4 Class D

Class D applies to components not in TVA Class A, B, or C 28
the failure of which would result in release to the environment of gaseous radioactivity normally held up for radioactive decay.

3.2.2.5 Relationship of Applicable Codes to Safety Classification for Mechanical Components

The applicable codes used for the design, material selection, and inspection of components for the various safety classes are shown in Table 3.2-4. The applicable TVA classification and ANS Safety Classification for each of the fluid systems are tabulated in Table 3.2-2. TVA classifications are also delineated on flow diagrams which have been included in those

3.2 CLASSIFICATION OF STRUCTURES, SYSTEMS, AND COMPONENTS

3.2.1 Seismic Classifications

The Watts Bar Nuclear Plant structures, systems, and components important to safety have been designed to remain functional in the event of a Safe Shutdown Earthquake (SSE). These structures, systems, and components, designated as Category I, are those necessary to assure:

1. The integrity of the reactor coolant pressure boundary.

2. The capability to shut down the reactor and maintain it in a safe shutdown condition, or

3. The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to or in excess of the guideline exposures of 10CFR Part 100.

Piping, pumps, valves, and vessels which must retain limited structural integrity because their failure could jeopardize to an unacceptable extent the achievement of a primary safety function or because they form an interface between Seismic Category I and non-Seismic Category I plant features, are designated by TVA as Seismic Category I(L) (i.e., limited requirements). Those fluid containing elements which are included in Seismic Category I(L) are seismically qualified to meet the intent of Regulatory Position 2 or the requirements of Position 3 of NRC Regulatory Guide 1.29. Where portions of mechanical systems are Category I and the remaining portions not seismically classified, the systems have been seismically qualified through the first seismic restraint beyond the defined boundary such as a valve.

All Category I safety-related structures, portions of mechanical systems, and electrical systems and components are listed in Tables 3.2-1, 3.2-2, and 3.2-3, respectively. Those Category I(L) portions of mechanical systems are also described in Table 3.2-2. These structures, systems, and components are classified in accordance with Regulatory Guide 1.29 and are designed to remain functional and/or to maintain structural integrity as required to fulfill their safety function in the event of a Safe Shutdown Earthquake (SSE).

3.2.2 System Quality Group Classification

Fluid system components for the Watts Bar Nuclear Plant that 23
perform a safety related function are identified by TVA
Classes A, B, C, or D. These piping classes are assigned to fluid
systems based on the ANS Safety Classes 1, 2a, 2b, and 3 respectively, 31
which are

[illegible] one set of accumulators will serve as a standby [illegible]. Each set of accumulators shall be equipped with shutoff [illegible], pressure gauges, drain valves, safety valves, and low-pressure alarm contacts for use on 125-volt d-c circuit.

c. Two motor-driven air compressors shall be supplied for each power package. Each compressor shall be sized to recharge one set of accumulators in 30 minutes. Motors shall be 480 volts, 3 phase, 60 Hz. Motor starters will be furnished by TVA.

d. Solenoid valves shall have continuous duty coils for 125-volt d-c service and shall be equal to ASCO bulletin HB8300C58 (Red Hat type).

e. Piping between air system and engine will be supplied by TVA.

f. If starting is by air motor, redundant motors shall be supplied.

g. On skid piping, fittings, valves, and other fuel equipment shall conform to the requirements of ANSI Standard B-31.1 "Power Piping."

h. Off skid piping shall conform to the requirements of ASME Section III, Class 2. Boundary of code jurisdiction shall be the first welded, screwed or flanged piping connection on the skid.

18. Engine Cooling System

a. A closed circuit water circulating cooling system shall be furnished for each engine.

b. System shall include pump, heat exchanger, and all accessories.

c. Piping from the service water system to the heat exchanger will be furnished by TVA.

d. Engine cooling water shall be circulated by a shaft-driven pump. Pump shaft shall be of stainless steel.

e. An expansion tank equipped with a float valve shall be furnished to provide a means for supplying makeup water.

f. Tubes in the heat exchangers shall be 304L stainless steel, or approved equal. Tubes shall be 5/8-inch diameter. Heat exchangers shall be the straight tube design with end covers removable. Design pressure for tubes and waterbox shall be not less than 200 psig. Heat exchangers shall be designed for a service water temperature of 93 F. Piping shall be arranged for service water through tubes, jacket water through shell.

Sect III, Class 3

by thermostats to ensure rapid starting. Heaters shall be rated 480 volts, 3 phase, with 120-volt, single-phase control. Heater starters will be furnished by TVA.

p. A thermocouple shall be installed at each cylinder exhaust port. Control panel shall have a temperature indicator and selector switch to provide measurements of exhaust temperature.

q. Engines shall have catwalks, if necessary, to provide access for maintenance.

r. Contractor shall maintain within the continental area of the United States a stock of replacement functioning parts and equipment suitable for overnight shipment, with the exception of the crankshaft.

16. Fuel System

a. Each unit shall have its own fuel system complete with fuel oil filters, fuel pumps, valves, etc.

b. A day tank having a capacity for 4 hours, or maximum allowable storage permitted by NFPA, at full load shall be provided for each unit.

c. Fuel pumps shall be gear driven and shall take suction from the day tank. Piping between day tanks and engines shall be provided by Contractor.

d. Each day tank shall be equipped with two level switches connected in parallel to start and stop two transfer pumps to be furnished under this contract. Level switches shall have three independent contacts for use on 125-volt d-c circuit or 120-volt a-c circuit.

e. Outdoor storage tank and piping to day tanks will be supplied by others.

f. Any necessary solenoid valves shall be provided, shall have continuous duty coils forr125-volt d-c service, and shall be equal to ASCO bulletin HB8300C58 (Red Hat type).

g. On skid piping, fittings, valves, and other fuel equipment shall conform to the requirements of the Underwriters Laboratories, Incorporated, and ANSI Standard B-31.1 "Power Piping."

h. Off skid piping shall conform to the requirements of ASME Section III, Class 2. Boundary of code jurisdiction shall be the first welded, screwed, or flanged piping connection on the skid.

17. Diesel Engine Starting System

a. Each engine shall be equipped with an independent pneumatic starting system mounted on a common base, complete with all valves, piping, [illegible], etc.

[illegible] for each engine.

Question 40.87

The Watts Bar Emergency Diesel Fuel Oil System design was completed prior to the issue date for ANSI N195, which was April 1976. The system was designed to ANSI B31.1 which meets the Watts Bar design basis.

Question 40.100

Response to Question 40.100

Air dryers will be installed on the starting air system of the emergency diesel generators before fuel load.

Questions 40.102 and 40.106

(1) Temperature differentials, flow rate, and heat removal rate of the Interface Cooling System are within the vendor's scope of design due to the fact that jacket water is used as the cooling medium. ERCW supply to the jacket water heat exchanger is designed for $95^{\circ}F$ at 715 gpm, with the manufacturer's requirement being $105^{\circ}F$ at 650 gpm.

(2) The oil quality is monitored during periodic inspections per Maintenance Instruction M.1.82.1.

(3) The crankcase has a pressure detector to alarm in the emergency mode and shut down during test mode.

(4) Oil leaks will also be monitored during periodic test starts according to Maintenance Instruction M.1.82.1.

Question 40.109

The exhaust system is identical to the design on SNP and has been complete for six years. Due to the climate in the region, it is not feasible for the 36' diameter exhaust stack to be completely closed by freezing rain or sleet. Any rain, ice, or snow which falls into the stack falls to the bottom of a 90° elbow which is located in a heated room and is carried away by a drain.

Question 040.110 and 40.108

TVA Response

The worst case postulated fire in the diesel generator building is considered to be within an engine room and associated with the lube oil or fuel oil systems. Each engine room is separated from adjacent engine rooms by 3-hour fire-rated compartments and each engine room is provided with an automatic total flooding carbon dioxide fire suppression system. As previously stated in the response to NRC Question 50 of TVA's September 9, 1980, submittal, each diesel

40-102

CLIFTON, NEW JERSEY

EXCHANGER SPECIFICATION SHEET

CUSTOMER	POWER SYSTEMS	JOB NO.	
ADDRESS	ROCKY MOUNT, N.C.	REFERENCE NO.	1964/379
PLANT LOCATION	TVA	INQUIRY NO.	A-1744-74
SERVICE OF UNIT	JACKET WATER COOLER	DATE	4/16/74
		ITEM NO.	
SIZE	16 96 TYPE AEL	CONNECTED IN	
SURFACE PER UNIT	309 SHELLS PER UNIT 1	SURFACE PER SHELL	309

PERFORMANCE OF ONE UNIT (TEST)

		SHELL SIDE	TUBE SIDE
FLUID CIRCULATED		JACKET WATER	RAW WATER
TOTAL FLUID ENTERING	#/HR.	425015.957	325000.000 (650GPM)
VAPOR	#/HR.		
LIQUID	#/HR.		
STEAM	#/HR.		
NON-CONDENSABLES	#/HR.		
FLUID VAPORIZED OR CONDENSED			
STEAM CONDENSED			
MOLECULAR WEIGHT-VAPORS			
LATENT HEAT-VAPORS	B.T.U./#		
SPECIFIC HEAT	B.T.U./# F	1.000	1.000
DENSITY	#/CU.FT.	60.576	61.822
VISCOSITY	CP.	0.342	0.573
THERMAL CONDUCTIVITY		0.390	0.370
TEMPERATURE IN	F	190.000	105.000
TEMPERATURE OUT	F	173.236	126.923
OPERATING PRESSURE	#/SQ.IN.	30.000	100.000
FOULING RESISTANCE		0.	0.
NUMBER OF PASSES		1	1
VELOCITY	FT./SEC.	3.408	4.087
PRESSURE DROP	#/SQ.IN.	4.738	0.898

HEAT EXCHANGED-B.T.U./HR. 7124999.875 MTD(CORRECTED) 65.623

TRANSFER RATE-SERVICE 480.875 CLEAN 480.875

CONSTRUCTION PER SHELL

		SHELL SIDE	TUBE SIDE
DESIGN PRESSURE	#/SQ.IN.	150.000	200.000
TEST PRESSURE	#/SQ.IN.	225.000	300.000
DESIGN TEMPERATURE	F	300.000	300.000

TUBES SS 316 SA 249 Ø.D. 0.625 PITCH 0.8125 TRI

NUMBER OF TUBES 236 BWG. 18 (AW) LENGTH 8.00

SHELL CS SA 53 B I.D. Ø.D. 16" THICKNESS

SHELL COVER FLT'G HEAD COVER

CHANNEL CS SA 53 B CHANNEL COVER CS

TUBESHEETS-STATIONARY CS FLOATING

BAFFLES CS SA-36 THICKNESS 1/4 PITCH 12.20 TYPE SPLIT SEGMENTAL

BAFFLE-LONG THICKNESS TYPE

GASKETS COMPRESSED ASBESTOS 1/8"

CONNECTIONS-SHELL IN 8.000 OUT 8.000 SERIES 150# R.F.S.O.

CHANNEL-IN 8.000 OUT 8.000 SERIES 150# R.F.S.O.

CORROSION ALLOWANCE-SHELL SIDE 1/16" TUBE SIDE 1/16"

CODE REQUIREMENTS 1971: ASME SEC III, CL-3 - BOTH SIDES TEMA CLASS C

WEIGHTS-EACH SHELL 2432 LBS. BUNDLE FULL OF WATER 3310 LBS

REMARKS:

40.102

CREATORS OF ELECTRICAL POWER SUPPLY SYSTEMS

POWER SYSTEMS
A MORRISON-KNUDSEN DIVISION

101 GELO ROAD · POST OFFICE BOX 1928
ROCKY MOUNT, NORTH CAROLINA 27801
PHONE (919) 977-2720 · TWX (510) 929-0725

JUNE 18, 1980

DESIGN SPECIFICATION

COMPONENT: Heat Exchanger - Jacket Water Cooler

REFERENCE: T.V.A. Contract 74C63-83090
PSD Purchase Order #42701-6036

SUPPLIER: Atlas Industrial Manufacturing Co.

DRAWING: C-3989-2

TYPE: AEL #16-96

APPLICATION: The heat exchanger cools the diesel engine jacket water.

DESIGN REQUIREMENTS:

HEAT EXCHANGER:	SHELL SIDE	TUBE SIDE
Design Pressure:	150 PSIG	200 PSIG
Test Pressure:	225 PSIG	300 PSIG
Design Temperature:	300° F	300° F
Corrosion Allowance (Carbon Steel):	1/16"	1/16"

SHELL SIDE:		
Flow of Service Water	0	900 GPM
Flow of Engine Jacket Water:	850 GPM	0
Temperature In:	185° F	93° F
Temperature Out:	168.2° F	108.8° F
Pressure Drop:	4.8 PSIG	1.7 PSIG
Fouling Resistance:	0	0.00120

HEAT EXCHANGED: 7,125,000 BTU/Hr.

NOTE: Shall also be capable of removing 7,481,250 BTU/Hr. without exceeding 190°F jacket water inlet temperature.

TUBE BUNDLE: Removable

COVERS: Removable without requiring the breaking of any pipe connection.

CONSTRUCTION: Identical to Drawing C3989-2 as manufactured on Bruce GM, Purchase Order #19954-379, TVA No. 74C63-83090.

ENVIRONMENTAL CONDITIONS:

Ambient Temperature	- 0°F Minimum - 110°F Maximum
Relative Humidity	- 0-100%
Elevation	- 742 feet above sea level.
Radiation	- Total integrated dose in the accident condition is 10^{3} Rads.

SEISMIC REQUIREMENT:

These horizontal motion spectra are applicable for both the north-south and east-west directions; the vertical motion is two-thirds of the horizontal motion. The floor response spectra for elevation 742 applies. The attached spectra are for the 1/2 Safe Shutdown Earthquake and must be doubled to obtain the Safe shutdown Earthquake spectra levels.

TVA Seismic Design Criteria, Apendix C, WB-DC-40-31.2.

Response Spectra, Figure 10, 11, 12, 13, 14, and 15.

SEISMIC REPORT:

Dynatech Project No. AIM-20.
Dynatech Report No. 1237.

CODE CLASSIFICATION:

The heat exchanger shall be constructed in accordance with the ASME Section III, Class 3, Division 1, 1971 Edition, Summer 1973 Addenda. Heat exchanger shall be "N" stamped.

TEMA C

BOUNDARIES OF JURISDICTION:

1. The face of the first flange in bolted connections.
2. The first threaded joint in screwed connections.
3. The bottom face of the fixed cradles.

OPERABILITY:

The component is to remain operable before, during and after a design basis event.

NOZZLE LOADS:

The nozzle loads shall be as stated in Dynatech R/D Company, Project AIM-20, Report #1237.

MATERIAL REQUIREMENTS:

The material shall be from those listed in Tables I-7.0 and I-8.0 of Appendix 1, ASME Section III, Class 3, Division 1, Summer 1973 Addenda.

SPECIFIC REQUIREMENTS FOR TUBES:

Tubes - SS316-SA 249 5/8 Diameter

HYDROSTATIC TEST:

Shell Side - 225 PSIG
Tube Side - 300 PSIG

IMPACT TEST:

None

CERTIFICATION:

This is to certify to the best of my knowledge and belief that this document, along with Drawing C3989-2 and Environmental Conditions constitutes the design specification for the above referred heat exchanger on P.S.D. Purchase Order No. 42701-6036 and is complete and correct and in compliance with the requirements of Paragraph NA-3250 of ASME Boiler and Pressure Vessel Code Section III Nuclear Power Plant Components, Division 1, 1971 Edition, Summer 1973 Addenda.

NORTH CAROLINA REGISTERED SEAL 7033 ENGINEER HARRY WILLIAM FALTER

June 18, 1980

Harry W. Falter

Harry W. Falter, P.E.

7033

North Carolina License Number

Revision 1, October 2, 1980

Page 2: OPERABILITY section added. Oct 2, 1980 generator engine room is provided with 1-1/2-hour fire-rated dampers in the ventilation openings between the engine room and the air intake and exhaust rooms. These dampers are normally operated by release of the CO_2 suppression system. Assuming a single failure of the fire protection system, i.e., failure of the CO_2 system, the dampers are also provided with fusible links which will allow the dampers to close, thereby preventing any significant quantities of smoke or combustion products from passing through the air intake room associated with the involved diesel generator and into an adjacent diesel generator combustion air supply.

It is therefore TVA's position that a potential fire in a diesel generator engine room concurrent with a single failure of the fire suppression system will not degrade the quality of combustion air to the remaining diesels such that they will not operate at full rated load.

A less severe postulated fire involving the lubricating oil associated with the combustion air intake filters in the ventilation air intake rooms has been evaluated. Based on the quantity of lube oil in each filter, i.e., 45 gallons each and the fact that the diesel engines can operate at full rated load with approximately a 20-percent-by-volume reduction in oxygen content of the combustion air (reduction from 20 to 16.8 percent), a fire associated with the combustion air intake filters will not result in an adjacent diesel generator not being able to operate at full rated load.

A postulated fire in all other areas of the diesel generator building would not produce more adverse conditions than those discussed above.

Response to Question 40.124

The turbine bypass system is not a safety-related system designed to mitigate any design basis events. The loss of offsite power will make the turbine bypass system inoperable. As a result, TVA has stated that we will use the steam generator PORVs and safety valves to cool down with loss of offsite and/or onsite ac power.

At present, the operability of the steam generator PORVs and safety valves are ensured by following the ASME Section XI testing requirements on these valves. The steam dump system was designed to be used as a method for passing steam to the condensors and not dumping the steam to the atmosphere for reactor trips from power and cooldowns. The system was not designed to 'prevent undue challenges' to the PORVs and safety valves.

The controls on the system were not designed with testability of the system in mind. Stroke testing all of the valves in the system is not possible using the normal controls. This can be done only by isolating all 12 of the steam dump valves. This results in the loss of steam dump capability during the test period which is directly opposed to the intent of NRC's position. Testing the valves individually will entail the use of jumpers and wire lifts on the system controls. If the tests must be done every three months, this will require testing at power or at least hot conditions. Any use of jumpers, wire lifts, or work in the controls of the system will increase the chances of inadvertently opening one or more of the valves. At low powers, this could cause a cooldown which would violate the 50°F/h cooldown limit in the technical specifications and add to the fatigue usage factor problem.

As an alternative, we suggest that stroke testing the valves be done on no more than a refueling outage basis. This interval is in line with the time interval associated with the ASME Section XI testing of the PORVs and safety valves. This will allow stroking of all the valves at one time and will minimize the possibilities of inadvertent cooldowns.

Response to Queston 40.125

Heavy-duty turbocharger drive gear assemblies will be installed on all emergency diesel generators before operation after the first refueling outage.

ENCLOSURE 2

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
RESPONSES TO NRC POWER SYSTEMS (ELECTRICAL) BRANCH CONCERNS

Section 8.2.2.1 - Availability of Offsite Power Circuits

The Watts Bar FSAR will be revised as follows:

Insert the following paragraph between the second and third paragraphs on page 8.2-6.

Figure 8.2-1a shows a single line diagram of the Watts Bar Hydro Plant switchyard. The switchyard is controlled by operators continuously on duty in the plant control room. The control room is adjacent to the switchyard and houses the controls and relays for the switchyard. In the event of trouble which locks out switchyard breakers (i.e., bus differential, breaker failure, bus breakup, etc.) the operator can reset relays and reestablish the switchyard connections, after determining that the fault has been cleared or isolated.

The 161-kV breakers are oil circuit breakers equipped with an accumulator tank charged by a 250-volt dc compressor motor to provide compressed air for the closing operation. Spring energy is used for tripping the breaker. These breakers may be manually tripped at the breaker cabinet, remotely from the control room or automatically by protective relay action.

Replace the last paragraph of section 8.2.1.5 as follows:

> Control power for power circuit breakers and associated protective relays is supplied by two independent 250-volt batteries and is distributed via circuit breakers on separate panels. Figures 8.2-1b and 8.2-1C show the single line diagrams for the two panels.
>
> Two separate 250-volt dc buses are provided in these panels. Each bus can be fed from one of the two 250-volt battery boards through manual, mechanically interlocked, nonautomatic circuit interrupters. The power circuit breaker and associated relay control circuits are allocated to these two dc buses on the basis of switchyard connections. This allocation of control circuits ensures that the control and relay circuits of the two nuclear plant lines are fed from two independent dc distribution buses.
>
> Should a system disturbance cause a total loss of off-site power, a black start can be accomplished for worst-case scenario in less than 1 hour. This is within the capacity of the vital batteries at the nuclear plant.

Sections 8.2.2.2, 8.3.1.1, and 8.3.3.2

Auxiliary power system analyses made as part of scheduled design review studies showed that the system now described in the Watts Bar Nuclear Plant FSAR could not perform its intended functions over the necessary range of transmission grid conditions. A Nonconformance Report describing this deficiency dated September 23, 1980, was issued and system design changes begun.

The modified Watts Bar Nuclear Plant ac auxiliary power system is shown in sketches, APS 1 and 2 provided to John Knox (NRC) during the TVA-NRC meeting of September 17-18, 1981. The Class 1E ac power system is shown entirely in sketch APS 2.

Preferred shutdown power is supplied from TVA's 161-kV transmission grid at Watts Bar Hydro Plant switchyard over two separate transmission lines, each connecting to two 161 - 6.9-kV common station service transformers at Watts Bar Nuclear Plant. For any unit generator trip, the Class 1E power system for the tripped unit automatically fast transfers from its unit-connected power source to offsite power supplied through common station service transformers C and D. There is no intentional delay in initiation of this transfer, and it is completed in approximately six cycles.

For all unit generator trips except those caused by electrical faults that open the main generator 500-kV circuit breaker, the Balance of Plant (BOP) ac auxiliary power system remains connected to its unit sources for 30 seconds, then fast transfers to offsite power supplied through common transformers A and B. If the unit trip is caused by an electrical fault, the BOP system transfer is not delayed.

System analyses have been made that show for an acceptable range of transmission grid conditions, one offsite power circuit consisting of one transmission line and transformers A and D, or the other transmission line and transformers B and C, is capable of starting and running all required safety-related loads, and at least half of all running BOP loads for a design basis accident in one unit and a concurrent full-load rejection in the other unit. The analyses for the Class 1E power systems assumed that all equipment that is started by a safety injection signal (SIS) started at the same time, all equipment that is tripped off by a SIS was tripped, and that all continuous loads that could be operating immediately after the SIS, whether safety-related or not, were running.

The Class 1E ac power system for each unit is divided into two redundant power trains. Each train includes a 6900-volt shutdown board powering the larger safety-related motors, pressurizer-heaters, and three 480-volt distribution subsystems. The 480-volt subsystems each include a 6900-480-volt power transformer, 480-volt switchgear, and 480-volt motor control centers. The Class 1E 480-volt subsystems supply both safety-related and non safety-related electric equipment. A fourth 6900 - 480-volt transformer will be provided in each power train as an installed spare. It will not normally be connected to either the 6900-volt shutdown board or to the 480-volt buses.

Each 6900-volt shutdown board can be powered through one of four supply breakers. For normal unit startup and operation, the power is from the 6900-volt unit board connection, the breaker shown normally closed on sketch APS 2. Shown normally open are the first and second alternate supply breakers connecting to the offsite power circuits, and the standby breaker connecting to a diesel generator. As stated above, for unit trips both 6900-volt shutdown boards for the tripped unit automatically fast transfer to offsite power via their first alternate breakers.

Each 6900-volt shutdown board is equipped with loss-of-voltage relaying and degraded voltage relaying. The loss-of-voltage relays initiate slow bus transfers (supervised by residual voltage relays) from the normal source to the first alternate, or standby supply, in that order of preference. Relays monitor each source and permit connection only if adequate power is available. When a 6900-volt shutdown board is powered from an alternate supply, the loss-of-voltage relays will initiate automatic transfer to the standby supply. Protective relays are provided in each shutdown board that lock out all supply breakers if the loss of voltage is caused by overload or electrical fault. Transfer between power sources in the reverse order are operator controlled only. The first alternate power connection for train A shutdown boards is to common transformer C, winding Y, and for train B shutdown boards is to common transformer D, winding X. The second alternate power connection for train A shutdown boards is transformer D, winding Y. For train B shutdown boards, the second alternate connection is to transformer C, winding X. Either transformer C or D can supply the Class 1E power system for both units, with one unit in a design basis accident and the other unit in a concurrent full load rejection, without exceeding its self-cooled power rating.

The staff degraded voltage positions are addressed as follows:

1. Overvoltage relays alarm in the control room. Undervoltage relays operate if a 6900-volt shutdown board bus voltage drops below the level required to successfully start all safety-related equipment that would be started for a SIS. The undervoltage relays initiate two time delay sequences. The first sequence will ride through normal system voltage transients, but is short enough to allow safety-related equipment to be powered within the time required by the safety analysis. At the end of the first sequence, if no SIS has been initiated, the undervoltage will be alarmed in the control room. If a SIS has been initiated, or is subsequently initiated, the shutdown board will transfer to its diesel generator. The second time delay is long enough to allow operator action but not allow damage to connected safety-related equipment. At the end of the second sequence, the shutdown board will transfer to its diesel generator. The undervoltage relaying system design meets all the staff requirements.

2. Degraded voltage relaying will not open the standby supply breaker and will not initiate load shedding and resequencing if a 6900-volt shutdown board is supplied by its diesel generator. The loss-of-voltage relays will initiate load shedding and resequencing.

However, the voltage set point and time delay for these relays prevent their operation for any motor starting transients when adequate power is being supplied to the shutdown board. Maximum and minimum limits for the loss-of-voltage relay set points will be included in the Technical Specifications.

3. The auxiliary power system analyses for Watts Bar Nuclear Plant satisfy the staff position and TVA's Quality Assurance requirements for documentation. The analyses will be issued in a formal report.

4. The auxiliary power system analyses will be verified in the preoperational test program.

Section 8.3.1.7 - Possible Interconnection Between Redundant Divisions Through the Normal and Alternate Power to the Battery Charger

The following information will be incorporated after the last sentence in paragraph 2 on page 8.3-5 of the Watts Bar FSAR chapter 8 for the manual transfer of loads between power trains:

> All circuit breakers supplying the alternate feeders for the manual transfers in Table 8.3-10 (with the exception of the spent fuel pit pump C-S) are normally opened. Closure of the alternate feeder supply circuit breaker and/or transfer of the manual transfer switch to the alternate position is alarmed in the main control room. For the manual transfer switch on the spent fuel pit pump C-S, the circuit breaker supplying the alternate supply will be maintained in the normally open position.

Section 8.3.2.1 - Sharing of DC Distribution Systems and Power Supplies Between Units 1 and 2

FSAR Section 8.1.5.3 - Compliance to Regulatory Guides and IEEE Standards - Note 3

RG-1.81
Position C.1
Does Not Fully Comply

Justification:

The design of the WBNP 125-volt vital dc system and the construction permit application was made before June 1, 1973. The design, as a minimum, meets the requirements of position 3 of the subject regulatory guide and branch technical position E1CSB 7 as follows: The system is capable of supplying minimum ESF loads and the loads required for attaining a safe and orderly shutdown of the unit assuming a single failure and loss of offsite power. The ESF output relays and their trained loads that require power to operate, are assigned as follows:

1. Unit 1 'A' train - 125V dc Vital Battery I, 120V ac Vital UPS 1-I
2. Unit 1 'B' train - 125V dc Vital Battery II, 120V ac Vital UPS 1-II
3. Unit 2 'A' train - 125V dc Vital Battery III, 120V ac Vital UPS 2-III
4. Unit 2 'B' train - 125V dc Vital Battery IV, 120V ac Vital UPS 2-IV

Thus the ESF loads are not shared.

The 120-volt ac vital instrument power is supplied by four UPS units per unit. They furnish power for the four-channel reactor protection system (RPS) input relays. The relays fail safe, actuate reactor protection system (RPS) signal, on a loss of power, thus a single failure and/or a loss of offsite power does not prevent the safe and orderly shutdown of either unit.

Plant common loads such as emergency gas treatment are supplied from unit 1, channels I and II.

In no case does the sharing inhibit the safe shutdown of one unit while the other unit is experiencing an accident. All shared systems are sized to carry all credible combinations of normal and accident loads.

RG-1.81
Position 2

a. Watts Bar is a two-unit plant.

b. With a single failure (Loss of a battery or loss of a diesel generator) in the plant sufficient ESF loads are still automatically available to the accident unit and to safely shut down the remaining unit.

c. The most severe DBE is an accident in one unit and a trip of the other unit. Sufficient diesel generator (DG) power is available to attain a safe and orderly shutdown of both units with the loss of one DG unit.

d. The DG units and the standby distribution system are arranged in two redundant trains per unit. Due to the shared ESF system (example: ERCW) only one DG unit per plant can be taken out for maintenance or tested at the same time. With only one DG unit unavailable, this position is met assuming loss of offsite power.

e. No interface of the unit operators is required to meet position 2.b. and 2.c.

f. Control and status indication for the DG units is provided on a central control board (Panel O-M-26) available to both unit operators. DC system status (volts, current, etc.) is provided on a unit basis.

g. The recommendation of RG-1.6, 1.9, and 1.47 are met.

h. The construction permit for WBNP was issued before June 1, 1973.

Section 8.3.2.2 Battery Charge Capacity

The Watts Bar FSAR (page 8.3-54, paragraphs 2 and 3) will be revised to read as follows:

Capacity

The system has the capacity to continuously supply all steady state loads and maintain the battery in a fully charged condition. With the batteries in the fully charged condition, the system has the capacity to supply the connected loads for a minimum of two hours with a loss of all ac power. The battery rating stated by the manufacturer is a minimum 2-hour discharge rating of 600 amperes at 60°F when discharged to a minimum terminal voltage of 105 volts. This rating will be confirmed by TVA acceptance tests.

Charging

The chargers have the capacity to continuously supply all steady state loads and maintain the batteries in the design maximum charged state or to recharge the batteries from the design discharge state within acceptable time interval while supplying the normal loads. Each charger may be replaced by a spare charger. One spare charger is provided for each two normal chargers.

The Watts Bar FSAR (page 8.3-57) will also be revised as follows (beginning with the first complete sentence on that page).

The 135-V column indicates actual loads expected while the battery charger (set at 'float voltage') supplies the battery board load. The 125-V column represents the actual loads expected with the battery board being supplied from the vital battery (480V ac unavailable), at its normal charged state. The 105-V column represents the actual loads expected with the battery board being supplied from the vital battery (480-V ac unavailable), at its minimum charged state. The actual load current during an ac power outage will depend on the discharge state of the battery. This subject is also treated in the section on Tests and Inspections. Loads are assigned to the systems according to the loads' divisional requirements. Four divisional loads are assigned to the four channels, two divisional loads are assigned to Channels I or III and II or IV. The loads primarily associated with unit 1 are assigned to Channels I and II, while loads primarily associated with unit 2 are assigned to Channels III and IV. Nondivisional loads primarily associatd with unit 1 are assigned to Channels I or II. Similarly, nondivisional loads associated with unit 2 are assigned to Channels III or IV. Nondivisional loads that are primarily associated with plant common services are distributed among the four channels. Some loads have a normal and alternate feeder. The normal feeder is from one channel, while the latnerate feeder is from another channel. These loads are listed in Tables 8.3-19 through 8.3-26. The transfer of the loads between the two feeders is manual and is interlocked to prevent paralleling the redundant power sources.

Maximum steady state dc loads (during battery recharge following an ac outage, the inverters and lighting loads are supplied from ac power) for each channel are supplied from a battery charger when it has either normal or standy ac power available from the 480-V shutdown boards. If the normal charger is unavailable, the loads are supplied from either the associated battery or a spare charger which can be manually connected to the battery board.

TABLE 8.3-23

125V DC Vital Battery System I Design Loads

Load	135V	Current 125V**	105V**
6.9-kV Shutdown Board 1A-A Nor Bus nor Fdr	10.8	10	8.4
480V Shutdown Board 1A1-A Nor Bus Nor Fdr	3.24	3	2.52
480V Shutdown Board 1A2-A Nor Bus Nor Fdr	3.24	3	2.52
Unit 1 Reactor Trip Swgr Bkr BYA Supply 1-L-116	2.16	2	1.68
480V Aux Bldg Com Board Nor Fdr	3.24	3	2.52
Gas Analyzer O-L-206	3.24	3	2.52
Unit 1 Rod Drive Power Supply Switchgear Bkr 1A 1-L-115	3.24	3	2.52
Unit 1 Generator Auxiliaries Panel Annunciator 1-L-39	2.16	2	1.68
Aux Boric Acid Evaporator Package A O-L-1A	2.16	2	1.68
Unit 1 Fuse Assemblies Col D	7.56	7	5.88
Unit 1 Fuse Assemblies Col E	7.56	7	5.88
6.9-kV Shutdown Board 2A-A Backup Bus Nor Fdr	10.8	10	8.4
480V Shutdown Board 2A1-A Backup Bus Nor Fdr	3.24	3	2.52
480V Shutdown Board 2A2-A Backup Bus Nor Fdr	3.24	3	2.52
Unit 1 Reactor Trip Switchgear Train A Supply 1-L-116	2.16	2	1.68
Unit 1 Auxiliary Relay Rack 1-R-54	5.4	5	4.2
Unit 2 Auxiliary Feed Pump Turbine Nor Fdr	19.8	18.3	15.4
Unit 1 Fuse Asemblies Col A	7.56	7	5.88

TABLE 8.3-23 (Contin.)

Load	135V	Current 125V**	105V**
Unit 1 Fuse Assemblies Col B	7.56	7	5.88
Unit 1 Fuse Asemblies Col C	7.56	7	5.88
Emerg DC Lighting Cabinet LD-1	0	86.5	72.7
120V AC Vital Instrument* Inverter 1-I	0	166.6	198.3
120V AC Vital Instrument* Inverter 2-I	0	166.6	198.3
Totals	115.9	527.0	559.5

*Constant kW load

**480V ac unavailable

TABLE 8.3-24

125V DC Vital Battery System II Design Load

Load	135V	Current 125V**	105V**
6.9-kV Shutdown Board 1B-B Nor Bus Nor Fdr	10.8	10	8.4
480V Shutdown Board 1B1-B Nor Bus Nor Fdr	3.24	3	2.52
480V Shutdown Board 1B2-B Nor Bus Nor Fdr	3.24	3	2.52
Electric Test Bench	13.0	12	10.1
Unit 1 Reactor Trip Swgr Bkr BYB Supply 1-L-116	2.16	2	1.68
Waste Disposal Panel 0-L-2B	5.4	5	4.2
Unit 1 Rod Drive Power Supply Switchgear Bkr 1B 1-L-115	3.24	3	2.52
Common Control and Service Air Compressors - Nor Fdr	4.32	4	3.36
Waste Evaporator Package A 0-L-105A	2.16	2	1.68
Unit 1 Fuse Assemblies Col D	7.56	7	5.88
Unit 1 Fuse Assemblies Col E	7.56	7	5.88
6.9-kV Shutdown Board 2B-B Backup Bus Nor Fdr	10.8	10	8.4
480V Shutdown Board 2B1-B Backup Bus Nor Fdr	3.24	3	2.52
480V Shutdown Board 2B2-B Backup Bus Nor Fdr	3.24	3	2.52
Unit 1 Reactor Trip Switchgear Train B Supply 1-L-116	2.16	2	1.68
Unit 1 Auxiliary Relay Rack 1-R-55	5.4	5	4.2
Unit 1 Gland Steam Spillover to Condenser	1.94	1.8	1.51

TABLE 8.3-24 (Contin.)

Load	135V	Current 125V**	105V**
Unit 2 Auxiliary Feed Pump Turbine Alt Fdr	19.8	18.3	15.4
Unit 1 Fuse Assemblies Col A	7.56	7	5.88
Unit 1 Fuse Assemblies Col B	7.56	7	5.88
Unit 1 Fuse Assemblies Col C	7.56	7	5.88
Emerg DC Lighting Cabinet LD-2	0	74	62.2
120V AC Vital Instrument* Inverter 1-II	0	166.6	198.3
120V AC Vital Instrument* Inverter 2-II	0	166.6	198.3
Totals	131.94	529.3	561.4

*Constant kW load

**480V ac unavailable

TABLE 8.3-25

125V DC Vital Battery System III Design Load

Load	135V	Current 125V**	105V**
6.9-kV Shutdown Board 1A-A Backup Bus Nor Fdr	10.8	10	8.4
480V Shutdown Board 1A1-A Backup Bus Nor Fdr	3.24	3	2.52
480V Shutdown Board 1A2-A Backup Bus Nor Fdr	3.24	3	2.52
Unit 1 Annunciator*	0	61	72.6
Unit 2 Reactor Trip Swgr Bkr Bya Supply 2-L-116	2.16	2	1.68
Waste Disposal Panel 0-L-2A	5.4	5	4.2
Unit 2 Rod Drive Pwr Supply Switchgear Bkr 2A 2-L-115	4.32	4	3.36
Unit 2 Generator Auxiliaries Panel Annunciator 2-L-39	2.16	2	1.68
Waste Evaporator Package A 0-L-105B	2.16	2	1.68
Unit 2 Fuse Assemblies Col D	7.56	7	5.88
Unit 2 Fuse Assemblies Col E	7.56	7	5.88
6.9-kV Shutdown Board 2A-A Nor Bus Nor Fdr	10.8	10	8.4
480V Shutdown Board 2A1-A	3.24	3	2.52
480V Shutdown Board 2A2-A Nor Bus Nor Fdr	3.24	3	2.52
Unit 2 Reactor Trip Switchgear Train A Supply 2-L-116	2.16	2	1.68
Unit 2 Auxiliary Relay Rack 2-R-54	5.4	5	4.2
Unit 1 Auxiliary Feed Pump Turbine Nor Fdr	19.8	18.3	15.4

TABLE 8.3-25 (Contin.)

Load	135V	Current 125V**	105V**
Unit 2 Fuse Assemblies Col A	7.56	7	5.88
Unit 2 Fuse Assemblies Col B	7.56	7	5.88
Unit 2 Fuse Assemblies Col C	7.56	7	5.88
Emerg DC Lighting Cabinet LD-3	0	46	38.6
120V AC Vital Instrument* Inverter 1-TII	0	166.6	198.3
120V AC Vital Instrument* Inverter 2-III	0	166.6	198.3
Totals	115.92	547.5	598.1

*Constant kW load

**480V ac Unavailable

TABLE 8.3-26

125V DC Vital Battery System IV Design Load

Load	135V	Current 125V**	105V**
6.9-kV Shutdown Board 1B-B Backup Bus Nor Fdr	10.8	10	8.4
480V Shutdown Board 1B1-B Backup Bus Nor Fdr	3.24	3	2.52
480V Shutdown Board 1B2-B Backup Bus Nor Fdr	3.24	3	2.52
Unit 2 Annunciator*	0	24	28.6
Unit 2 Reactor Trip Swgr Bkr BYB Supply 2-L-116	2.16	2	1.68
Drumming Rm Pnl 0-L-151	2.16	2	1.68
Unit 2 Rod Drive Pwr Supply Switchgear Bkr 2B 2-L-115	4.32	4	3.36
Common Control and Service Air Compressors - Alt Fdr	4.32	4	3.36
Boric Acid Evaporator Package B 0-L-1B	2.16	2	1.68
Unit 2 Fuse Assemblies Col D	7.56	7	5.88
Unit 2 Fuse Assemblies Col E	7.56	7	5.88
6.9-kV Shutdown Board 2B-B Nor Bus Nor Fdr	10.8	10	8.4
480V Shutdown Board 2B1-B Nor Bus Nor Fdr	3.24	3	2.52
480V Shutdown Board 2B2-B Nor Bus Nor Fdr	3.24	3	2.52
Unit 2 Reactor Trip Switchgear Train B Supply 2-L-116	2.16	2	1.68
Unit 2 Gland Steam Spillover to Condenser	1.94	1.8	1.51
Unit 2 Auxiliary Relay Rack 2-B-55	5.4	5	4.2

TABLE 8.3-26

Load	Current 135V	125V**	105V**
Unit 1 Auxiliary Feed Pump Turbine Alt Fdr	19.8	18.8	15.4
Unit 2 Fuse Assemblies Col A	7.56	7	5.88
Unit 2 Fuse Assemblies Col B	7.56	7	5.88
Unit 2 Fuse Assemblies Col C	7.56	7	5.88
Emerg DC Lighting Cabinet LD-4	0	44.5	37.4
120V AC Vital Instrument* Inverter 1-IV	0	166.6	198.3
120V AC Vital Instrument* Inverter 2-IV	0	166.6	198.3
Totals	116.68	507.8	553.4

*Constant kW load
**480V ac Unavailable

Section 8.3.2.4 (Page 26) - Availability of the Battery Supplies to Vital Instrument Buses

Further clarification and availability evaluation on the diode auctioneering circuit:

The diode auctioneering circuit consists of a power diode, which during normal operation (480V ac available) is used as a 'blocking diode.' This diode which is maintained normally in a reverse biased state (because the dc regulated power supply, derived from the 480V ac supply, is higher than the voltage on the battery board) allows for a very smooth transfer from the dc regulated power supply to the battery during a loss of ac power (i.e. the power diode changes state from the reversed bias state to forward bias) allowing the inverter to be powered from the battery until ac power is restored.

The combination of the dc regulated power supply and the above power diode will preserve the reliability of the 120V ac vital instrumentation system in order to comply with section 5.3.3(3) of IEEE 308. As verified by the results of the Sequoyah I&C Power System Availabilities Evaluation (Volume I, page I.23 'Sequoyah Station Power Component Availabilities') performed by Kaman Science Corporation, the rectifier/diode's availability (.999976) is approximately equal to the battery charger's availability (.99986). These availabilities apply to Watts Bar because of component similarities. Incorporation of the inverter as a normal load on the battery charger would decrease its availability because the charger's capacity would need to be approximately triple the present charger size. Therefore, per WASH 1400 (Table III-1, page 20) the increase in solid-state device component ratings for the larger battery charger will cause more failures which in turn decreases the charger's availability.

Therefore, the present rectifier/diode configuration on the 120V ac vital instrumentation system will provide a reliability that is greater than or equal to the battery charger configuration.

Section 8.3.2.5 - Diesel Generator Battery System

The following will be the replacement for the existing paragraph under 'Diesel Generator Control Power' as an amendment to the FSAR on page 8.3-16:

Diesel Generator Control Power

The 125-volt dc diesel-generator battery system is a Class 1E system whose function is to provide control power for control and field flashing of the diesel-generator sets.

There are four diesel-generator battery systems (one per diesel-generator set). Each system consists of a battery charger (which supplies the normal steady-state dc loads and maintains the battery in a fully charged state and is capable of recharging the battery from the design minimum discharge of 105 volts dc while supplying the normal steady-state dc loads), a battery (for control and field flushing of the diesel-generator set), and a distribution board (which facilitates the dc loads and provides circuit protection). Each battery system is ungrounded and incorporates ground detection devices. Each battery system is physically and electrically independent (see pages 8.3-57, -58, and figure 8.3-46 for physical separation).

Each battery is of the lead-acid type and has 57 cells connected in series and divided into 19 units, every unit having three cells. The battery is a type 3DCU-9, furnished by the C&D Batteries Division of Eltra Corporation, rated at 26 ampere-hours at 60°F for a 30-minute discharge rate. With the battery in the fully charged condition, the battery has the capacity to supply 48 amperes (A) for two seconds and 25 amperes for 30 minutes. The estimated design loads on the battery, during a loss of ac power, is 48 amperes (field flash) for two seconds and 12 amperes (control) for 30 minutes. Each battery is normally required to supply loads only during the time interval between loss of normal feed to its charger and the receipt of emergency power to the charger from its respective diesel-generator.

The normal supply of dc current to the battery boards is from the battery charger. Each charger maintains a floating voltage of approximately 128 volts on the associated battery board bus (the battery is continuously connected to this bus also) and is capable of maintaining 133 volts during an equalizing charge period (all loads can tolerate the 133-volt equalizing voltage). The charger supplies normal steady-state load demand on the battery board and maintains the battery in a charged state. AC power for each charger is supplied from its respective 480-volt ac, 3-phase diesel generator auxiliary board. Each charger has access to a normal and alternate ac supply (see figures 8.3-30 and -31, typical), from the two respective 480-volt ac diesel generator auxiliary boards. If the normal circuit is unavailable, the alternate circuit is selected by a manual transfer. The charger is a solid-state type which converts a 3-phase 480-volt ac input to a nominal 125-volt dc output having a rated capacity of 20 amperes. Over this output current range the dc output voltage will vary no more than +1.0 percent for a supply voltage amplitude variation of +10 percent and frequency variation of +2.0 percent. Some operational features of the chargers are: (1) an output voltage adjustable over the range of 125 to 133 volts, (2) equalize and float modes of operation (the charger normally operates in the float mode at 128 volts, but can be switched to the equalize mode with an output of 133 volts, (3) a current-limit feature which limits continuous overload operation to 125 percent of rated output, (4) protective devices which prevent a failed charger from discharging its associated battery and protect the charger from external overloads, (5) metering and alarm circuits to monitor the charger output.

The diesel-generator 125-volt dc control and field flash circuits are supplied power from their respective dc distribution panels located in the diesel building on El. 742 (see figure 8.3-1). A typical panel and its associated loads is shown on figure 8.3-55. Each circuit (including the battery charger input to the panel) is protected by a thermal-magnetic circuit breaker. The battery input circuit to the panel is protected by a thermal-magnetic circuit breaker and a coordinated fuse. Local metering on the distribution panel and battery charger includes battery and charger current, battery and charger voltage, and battery system ground detection. Low battery charger output voltage and loss of 480-volt ac supply to the charger is alarmed in the main control room.

Before placing the 125-volt dc diesel generator battery system into service, the system components will be tested to ensure their proper operation. The diesel-generator batteries will be preoperationally tested for the following conditions:

1. To verify that the diesel generator battery capacity will meet the manufacturer's guaranteed performance.

2. To verify that the diesel generator battery system has the ability to supply power before, during, and after loss of the 480V ac power supply to the diesel generator battery charger in the worst case condition.

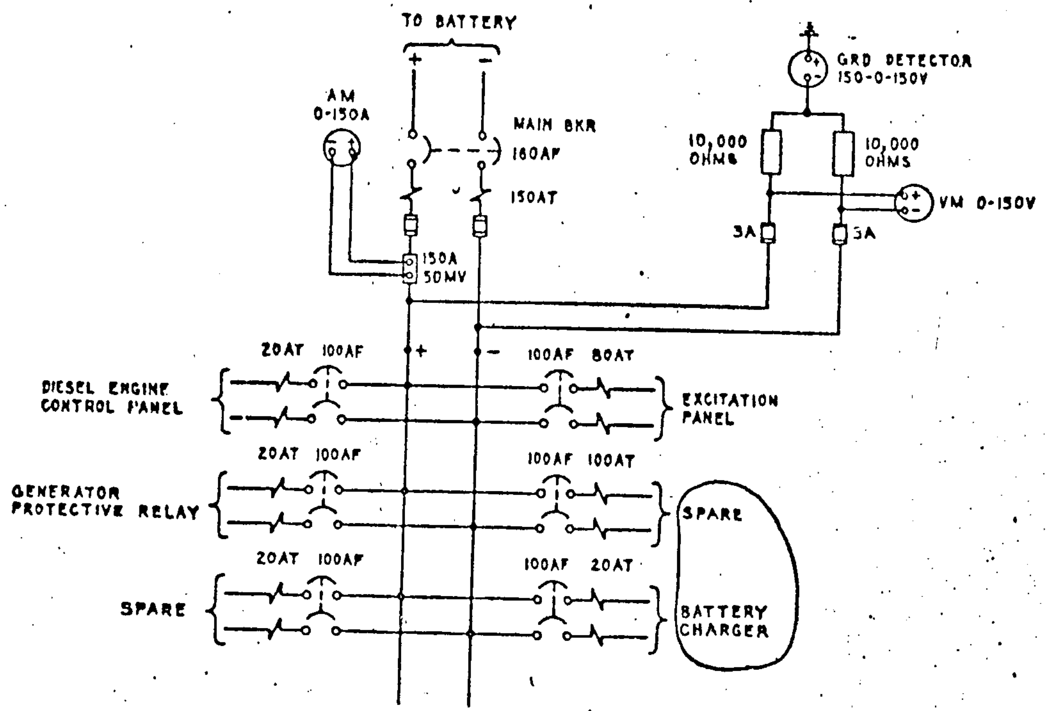
3. To verify that the battery charger will recharge the diesel generator battery to the nominally fully charged condition while supplying power to the normal control loads.

4. To verify that the diesel generator is able to start, come to speed, flash the generator field, and build up voltages when the diesel generator battery is on equalize charge.

<u>Section 8.3.3.1 (Part A) - Physical Identification of Electrical Cables</u>

As stated in the Watts Bar FSAR section entitled <u>Regulatory Guide 1.75 'Physical Independence of Electric Systems'</u>

> The criteria and their bases for the separation of Class 1E equipment and circuits at Watts Bar are given in sections 7.1.2.2 and 8.3.1.4. As stated in section D. 'IMPLEMENTATION' of Regulatory Guide (RG) 1.75, January 1975, this guide applies to construction permit applications for which the issue date of the Safety Evaluation Report is February 1, 1974, or after. The Watts Bar Construction Permit was issued January 23, 1973. RG 1.75 was issued after the Watts Bar design was complete.
>
> However, the Watts Bar design basically meets RG 1.75 except in the area of isolation devices and subsequent associated circuits, cable marking at intervals, and separate spreading areas.
>
> The Watts Bar design utilizes circuit breakers and/or fuses in circuits as isolation devices. Since these devices are qualified as part of the Class 1E equipment, they are considered to provide



APPROVED
THIS APPROVAL DOES NOT RELIEVE THE CONTRACTOR FROM ANY PART OF HIS RESPONSIBILITY FOR THE CORRECTNESS OF DESIGN, DETAILS & DIMENSIONS.
TENNESSEE VALLEY AUTHORITY
DATE AUG 7, 1974

TVA 7-16-74
WATTS BAR
CONTRACT No.
74C63-83090
USE: DIESEL ENGINE

Figure 8.3-55

C379 TVA WATTS BAR CONTRACT No. 74C63-83090	POWER SYSTEMS DIVISION BRUCE GM DIESEL INC. ROCKY MT. NORTH CAROLINA 27801
APPROVED / DATE ENGINEER — DUGR — 3/27/74 CHECKER — T.J. — 3/27/74 DRAFTSMAN — — 3/27/74	TITLE SCHEMATIC DIAGRAM D C DISTRIBUTION PANEL

acceptable isolation for supplying nondivisional loads. The circuits for the nondivisional loads are classified as nondivisional. Thus, no circuits at Watts Bar have been designated as associated. The routing of nondivisional (nonsafety-related) circuits is described in Section 8.3.1.4.3. The nondivisional circuits are subject to the same requirements as Class 1E circuits such as cable derating, environmental qualification, flame retardance, splicing restrictions and raceway fill.

Conduit tags are located at conspicuous intervals (e.g., at entrance and exit points of large rooms, and at terminations) showing their respective division of separation. Markers are located on exterior side surfaces of Class 1E cable trays at intervals not to exceed 15 feet. Cables routed in Class 1E (train or channel) cable trays are identified at intermediate points. These color coded identifications (by means of marking, tagging, or taping) occur near tray intersections at sufficient intervals to provide visual verification that the cable installation conforms to the separation criteria. The computer cable routing program (discussed in section 8.3.1.4.5) ensures that proper separation of circuits is maintained . . .

TVA's report which summarizes the findings of the completed electrical separation field audit was provided to the NRC by letter dated February 24, 1981 from L. M. Mills to A. Schwencer.

<u>Section 8.3.3.1 (Part B) - Associated Circuits</u>

Justification

Nondivisional circuits that are routed in cable trays designated for Class 1E circuits have not been identified as 'associated' circuits but have been treated the same as the Class 1E circuits. The nondivisional circuits are subject to the same environmental qualification, flame retardance, cable derating, splicing restrictions, and cable tray fill. Cables (both Class 1E and nondivisional) are designed to sustain a short circuit whereby the load protective device malfunctions and the upstream device isolates the fault. Thus, an electrically initiated fire is unlikely to occur.

The divisional cable tray systems are divided into separate networks (e.g. train A network is separate from train B network) by voltage level, such as 6.9 kV and 480V. The computerized cable routing program ensures that once a nondivisional cable is routed in a divisional tray, that 'associated' cable is not subsequently routed onto a tray containing redundant cables.

Thus, by cable design and restrictive routing, we conclude that 'associated' cables are not a threat to Class 1E cables.

Section 8.3.3.1 (Part C) - Separation Criteria Between Class 1E and Non-Class 1E Circuits

The nondivisional cables that are routed in nondivisional cable trays within Category I structures are the same types and have the same design requirements, such as cable derating, voltage level separation, short circuit characteristics, and circuit protection, as Class 1E cables. All cable tray supports have seismic Category I supports in areas of Category I structures that contain safety-related equipment. In addition, in areas outside primary containment containing one or both redundant divisions of cable trays, (divisional circuits are routed in conduit within primary containment), all exposed surfaces of cables (including nondivisional cables) in horizontal or vertical routings will be coated with a fire-resistant material.

Based on the foregoing, it is our judgment that the TVA standard spacing criteria between divisional and nondivisional cable trays is acceptable.

Section 8.3.3.2 - Reactor Containment Electrical Penetrations

FSAR Section 8.1.5.3 Compliance to Regulatory Guides and IEEE Standards Note 1.

RG 1.63 Position C

C.1 The electric penetrations have been designed to withstand the maximum fault current for the time duration of the backup protective device. A redundant overcurrent protection system is provided (a breaker and a fuse) for all penetrations except instrumentation circuits where fault current is not a problem and the 6900-volt penetration circuits which are for the reactor coolant pumps (RCP).

The RCP penetrations when connected to unit power have a single circuit breaker equiped with dual overcurrent detection systems (CTs, relays, control power source, trip coils). When connected to the offsite power through the common station service transformers, two breakers in series are provided. A reliability analysis shows the one breaker equipped with dual overcurrent systems to be 98.3 percent as reliable as two breakers in series. This justifies acceptability of the installed system.

The 480-volt load center circuits have a low voltage power circuit breaker backed up by a current limiting fuse. The penetration withstands the available fault current vs. time duration for the load center breaker and fuse. The breakers have direct acting trips and are independent of control power. The fuse is located in the cable termination compartment of the load center bolted to the breaker cable terminal.

The 480-volt motor control center (MCC) circuits have a molded case circuit breaker backed up by a fuse. The penetration withstands the available fault current vs. time duration for the breaker and fuse. Molded case breakers have direct acting trips. The breaker-fuse was furnished in the standard design of the MCC and are located in the same compartment with approximately two inches of air space separation. This is considered adequate because of the diverse principle of operation of the fuse and breaker.

Low-voltage control circuits which have sufficient fault currents availabe to damage a penetration have a molded case breaker backed up by a fuse. The penetration withstands the available fault current vs. time duration for the breaker and fuse. The molded case breakers have direct acting trips.

The energy levels in the instrument systems are sufficiently low so that no damage can occur to the containment penetration.

Table 8.1-2 lists the parameters that show the capability of each typical penetration to withstand without loss of mechanical integrity, the maximum fault current vs. time condition that could occur as a result of a single random failure of the primary overload protection. Thus the single failure criterion of IEEE 279 is met.

In addition to the single failure criterion of IEEE 279, the following requirements of IEEE 279 are met as follows:

1. Testability: The overcurrent protection system provided for 6900-volt penetration circuits include drawn out-type relays which are field testable using manufacturer provided test sets or TVA test sets to simulate fault currents following established procedures. Low voltage power circuit breakers and molded case circuit breakers are field tested using test sets built by Multiamp Corporation or equal. Testing is done by simulating fault current following established procedures.

   The only method recommended by fuse manufacturers for periodic testing of fuses is the measurement of their resistance. Resistance measurement is one of the final checks made at the factory to assure fuses have been manufactured correctly and are properly labled as to size. The validity of duplicating a factory test that measures milliohms in the field is questionable. In lieu of field testing by resistance, we propose to establish a fuse inspection and maintenance program that will ensure: (1) that the proper size fuse is installed, (2) that the fuse shows no sign of deterioration, and (3) that the fuse connections are tight and clean. (See IEEE Std-242, 1975 'Recommended Practice for Protection and Coordination' of Industrial and Commercial Power Systems).

   Non-Class 1E Circuits are those penetration circuits for loads which receive their power from non-Class 1E electrical boards. The boards are seismic Class 1L (designed and anchored so as to retain their position). This assures the overcurrent protection system remains operable during

TVA 489E (EN DES-12-76) TENNESSEE VALLEY AUTHORITY SHEET 1 OF 4

SUBJECT: PENETRATION CIRCUIT BREAKER RELIABILITY
PROJECT: WATTS BAR NUCLEAR PLANT
COMPUTED BY: D. LOVELESS DATE: 9/13/81 CHECKED BY: DATE:

PURPOSE

TO EVALUATE THE RELATIVE RELIABILITIES OF THE CIRCUITS GIVEN ON SHEET 2 TO INTERRUPT A FAULT

APPROACH

- A MISSION TIME OF 240,000 HRS (27.4 YRS) WITH 100 DEMANDS DURING THAT TIME WITH NO REPAIR WAS ASSUMED.
- THE CIRCUIT 2 RELIABILITY (R_2) WAS CALCULATED
- DUE TO UNAVAILABILITY OF SPECIFIC FAILURE RATE DATA - CIRCUIT 1 RELIABILITY (R_1) COULD NOT BE CALCULATED DIRECTLY. INSTEAD THE MAXIMUM DIFFERENCE IN THE TWO CIRCUITS RELIABILITY ($(R_2-R_1)_{MAX}$) WAS CALCULATED
- MINIMUM CIRCUIT 1 RELIBILITY ($(R_1)_{MIN}$) WAS DETERMINED $\left[R_2-(R_2-R_1)_{MAX}\right]$
- THE WORST CASE COMPARISON OF CIRCUIT 1 TO CIRCUIT 2 WAS DETERMINED $\left[\frac{R_{1MIN}}{R_2}\right]$

RESULT

CIRCUIT 1 IS A MINIMUM OF 98.19% AS RELIABLE AS CIRCUIT 2

SYMBOLS

CT - UNRELIABILITY OF CURRENT TRANSFORMERS

RLY - UNRELIABILITY OF RELAY

BATT - UNRELIABILITY OF BATTERY

SOL - UNRELIABILITY OF SOLENOID

BKR - UNRELIABILITY OF MECHANICAL PORTION OF BREAKER

SOL+BKR - UNRELIABILITY OF THE BREAKER (ELECTRICAL + MECHANICAL)

λ - FAILURE RATE (FAILURES/HOUR)

t - MISSION TIME = 240,000 HRS

R - RELIABILITY

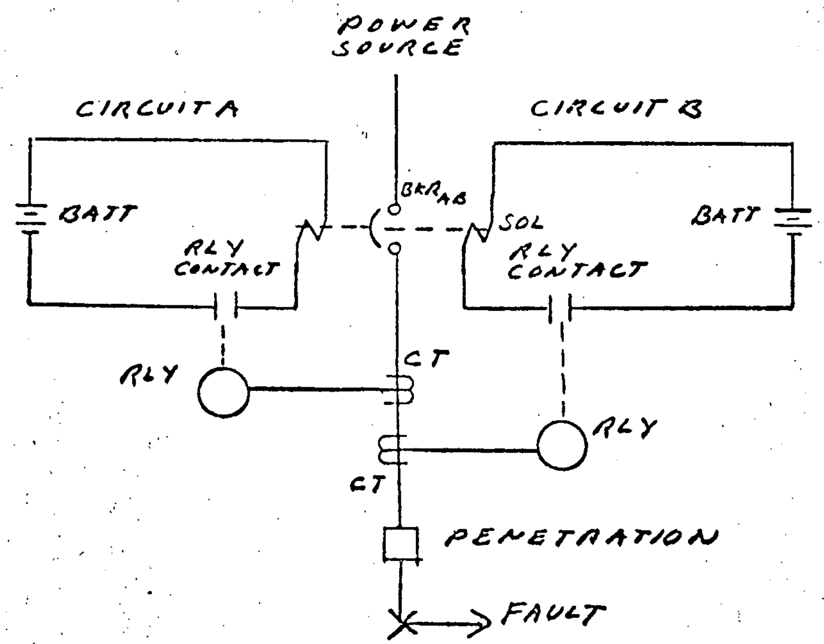
$\bar{R}$ - UNRELIABILITY

TVA 489E (EN DES-12-76) TENNESSEE VALLEY AUTHORITY SHEET 2 OF 4

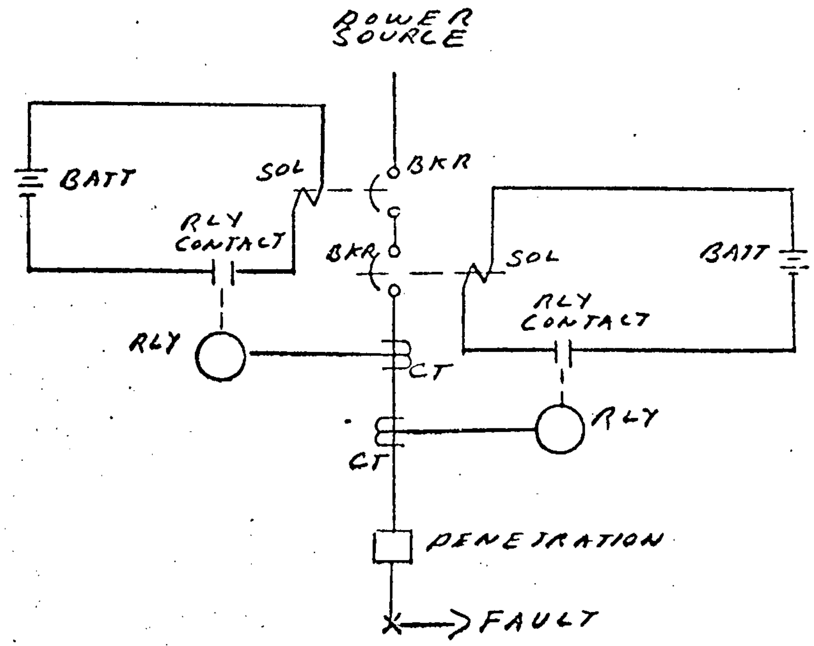
SUBJECT ______ PROJECT WBNP

COMPUTED BY ______ DATE ______ CHECKED BY ______ DATE ______

CIRCUIT #1 - SINGLE BREAKER/DUAL TRIP COIL



CIRCUIT #2 DUAL BREAKER/SINGLE TRIP COILS



SUBJECT ______ PROJECT WBNP

COMPUTED BY ______ DATE ______ CHECKED BY ______ DATE ______

PROBABILITIES

CT- CURRENT TRANSFORMER UNRELIABILITY

FAILURE RATE(λ) = .302 FAILURES/10^6 HOURS
SOURCE: IEEE 500-1977, P375

$CT = \lambda t$

$CT = (.302/10^6)(240{,}000\ HRS)$

$CT = 7.248 \times 10^{-2}$ ⟵

RLY- RELAY UNRELIABILITY

FAILURE/DEMAND = 1×10^{-4}
SOURCE: NUREG-0492, P XI-9

RLY = (FAILURES/DEMAND)(# OF DEMANDS)

$RLY = (1 \times 10^{-4})(100)$

$RLY = 1 \times 10^{-2}$ ⟵

BATT - BATTERY UNRELIABILITY

BATT = ZERO
REF IEEE STD 446-1980, P71.

SOL- BREAKER SOLONOID UNRELIABILITY

NO DATA AVAILABLE ⟵

BKR- MECHANICAL PORTION OF BREAKER UNRELIABILITY

NO DATA AVAILABLE ⟵

BKR+SOL - BREAKER UNRELIABILITY

FAILURES/DEMAND = 226.5×10^{-6}
SOURCE: IEEE 500-1977, P148

BKR+SOL = (FAILURES/DEMAND)(# OF DEMANDS)

$BKR{+}SOL = (226.5 \times 10^{-6})(100)$

$BKR{+}SOL = 2.265 \times 10^{-2}$

SUBJECT ________ PROJECT WBNP

COMPUTED BY ______ DATE ______ CHECKED BY ______ DATE ______

CALCULATIONS

CIRCUIT 2 UNRELIABILITY

$\overline{R_2} = (CT_A + RLY_A + BATT_A + SOL_A + BKR_A)(CT_B + RLY_B + BATT_B + SOL_B + BKR_B)$

$\overline{R_2} = (7.248 \times 10^{-2} + 1 \times 10^{-2} + ZERO + 2.265 \times 10^{-2})^2$

$\overline{R_2} = (10.513 \times 10^{-2})^2$

$\overline{R_2} = 1.105 \times 10^{-2}$

$R_2 = .9889$

CIRCUIT 1 UNRELIABILITY

$\overline{R_1} = (CT_A + RLY_A + BATT_A + SOL_A)(CT_B + RLY_B + BATT_B + SOL_B) + BKR_{AB}$

THIS EXPRESSION CAN NOT BE EVALUATED DIRECTLY BECAUSE BKR_{AB} IS UNKNOWN.

DIFFERENCE IN CIRCUIT 1 & CIRCUIT 2 RELIABILITY

$R_2 - R_1 = BKR_{AB} - BKR_A(CT_B + RLY_B + BATT_B + SOL_B + BKR_B) - BKR_B(CT_A + RLY_A + BATT_A + SOL_A + BKR_A)$

$R_2 - R_1 = BKR - 2\,BKR(CT + RLY + BATT + SOL + BKR)$

THIS EQUATION CAN NOT BE EVALUATED DIRECTLY BECAUSE "BKR" IS UNKNOWN

HOWEVER "BKR+SOL" IS KNOWN

THE EQUATION WILL BE A MAXIMUM WHEN SOL = ZERO ∴ $BKR = 2.265 \times 10^{-2}$

$(R_2 - R_1)_{MAX} = 2.265 \times 10^{-2} - 2(2.265 \times 10^{-2})(10.513 \times 10^{-2})$

$(R_2 - R_1)_{MAX} = 1.789 \times 10^{-2}$

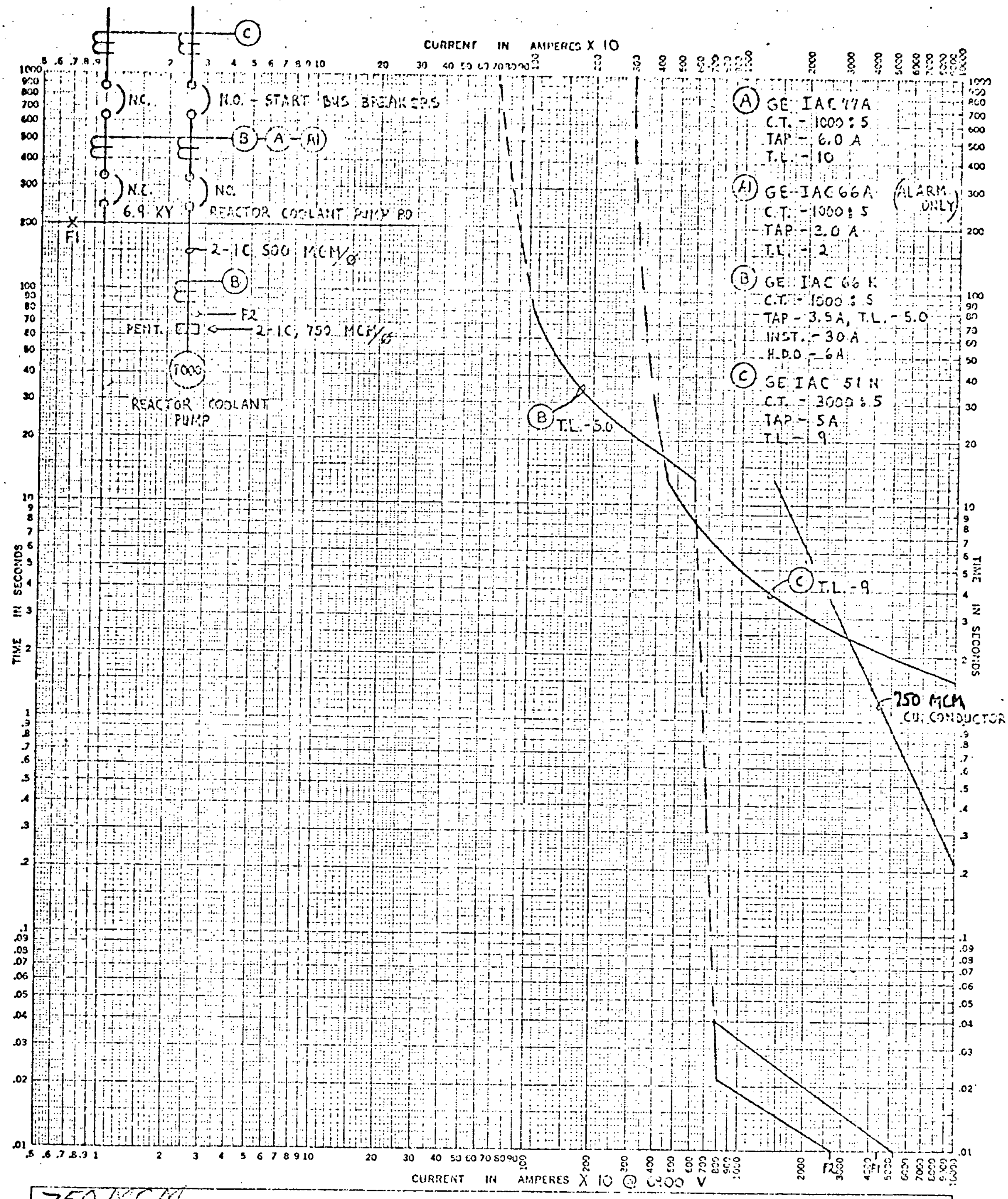
MINIMUM CIRCUIT 1 RELIABILITY

$R_{1MIN} = R_2 - (R_2 - R_1)_{MAX} = .9889 - 1.789 \times 10^{-2}$
$= .9711$

WORST CASE COMPARISON

$R_{1MIN} / R_2 = .9711 / .9889 = .9819$

Attachment 11B



750 MCM OVERCURRENT TIME-CURRENT CHARACTERISTIC CURVES

For WBNP REACTOR COOLANT PUMP Fuse Links. In

BASIS FOR DATA Standards Dated

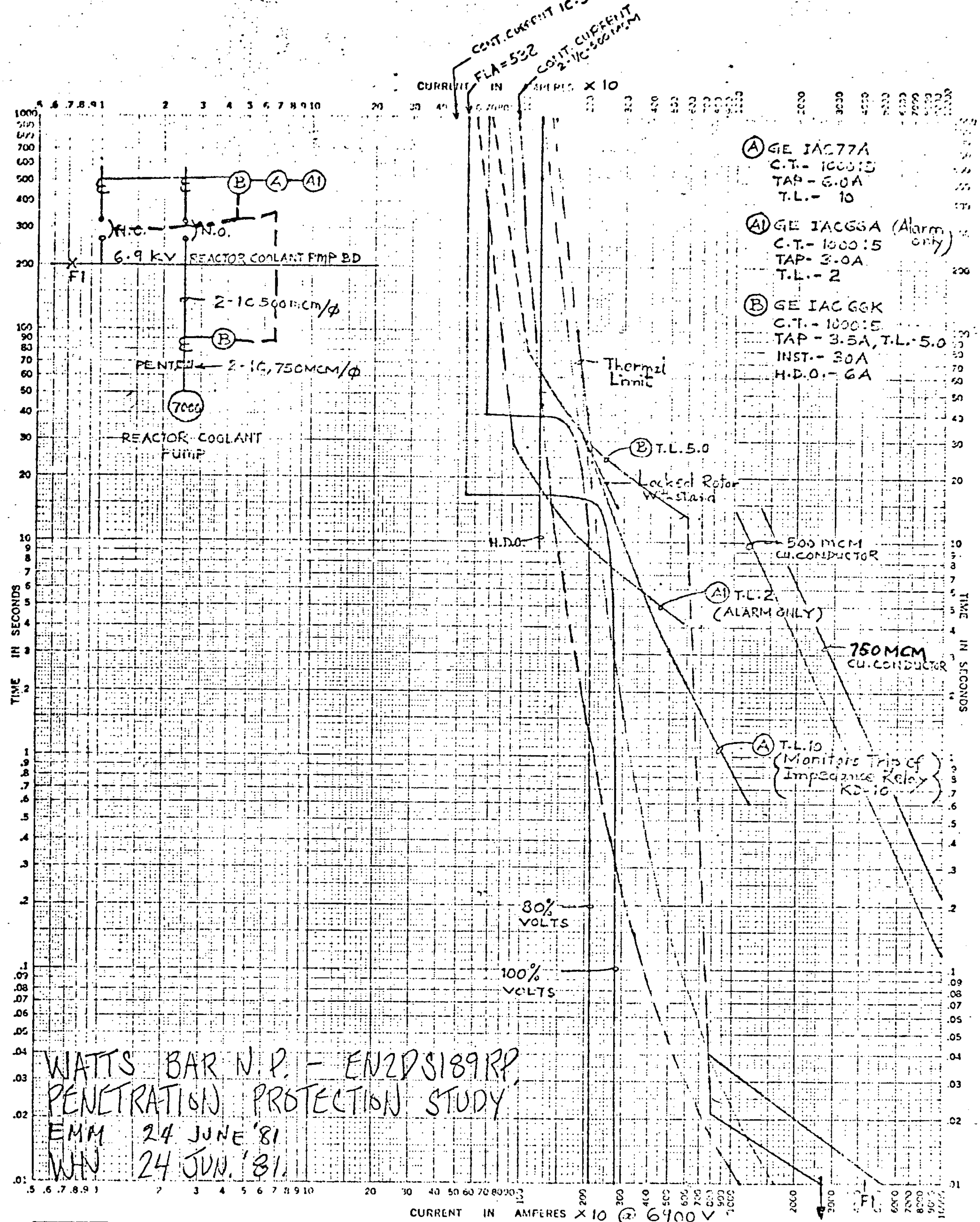
1. Tests made at Volts a-c at p.f., starting at 25C with no initial load.

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

No. LNH

Date

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



750 MCM OVERCURRENT TIME-CURRENT CHARACTERISTIC CURVES FAULT & PENETRATION

For WBNP REACTOR COOLANT PUMP Fuse Links, In

BASIS FOR DATA Standards Dated

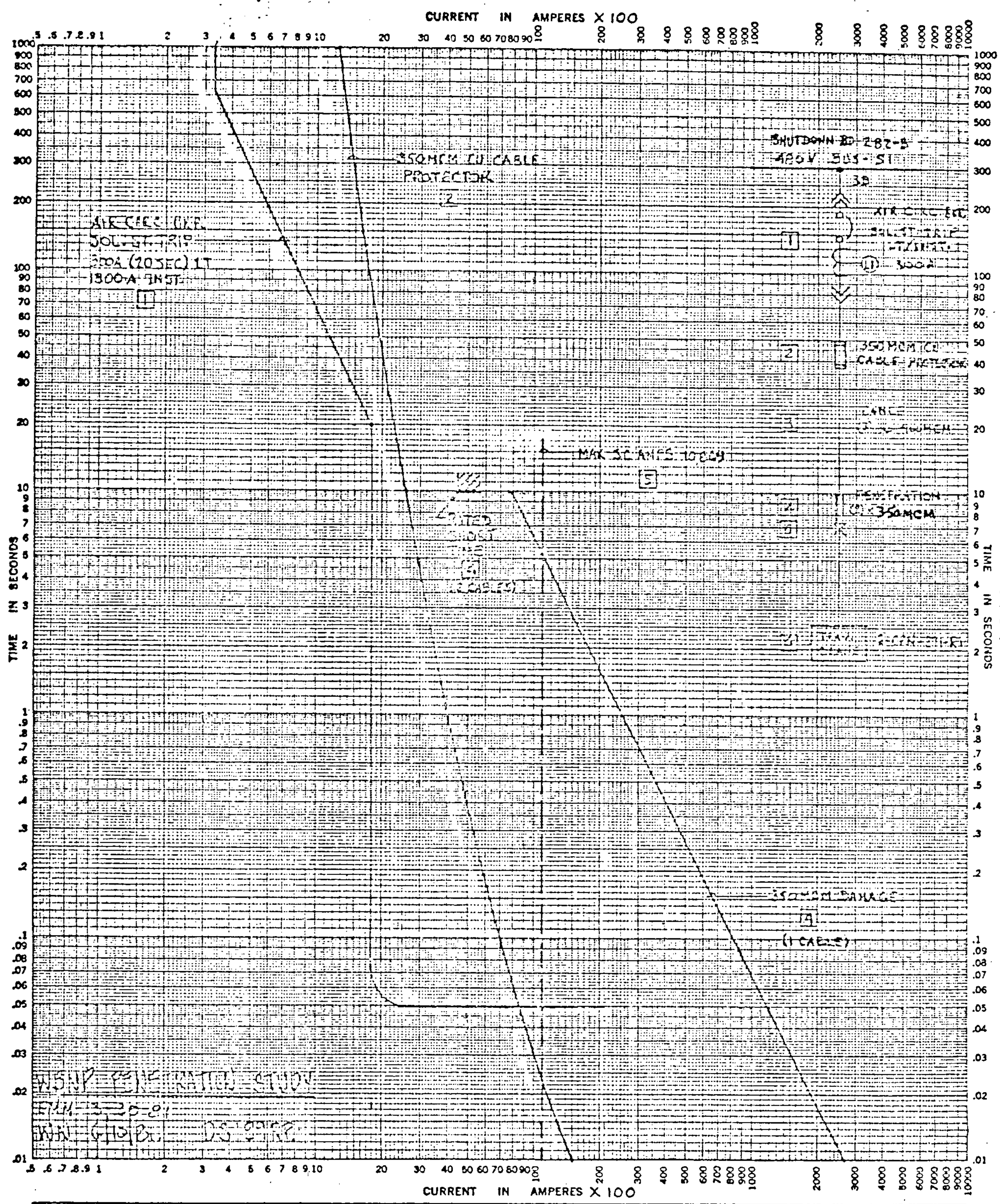
1. Tests made at Volts a-c at p.f., starting at 25C with no initial load

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

No.

Date LEP 6/18/80

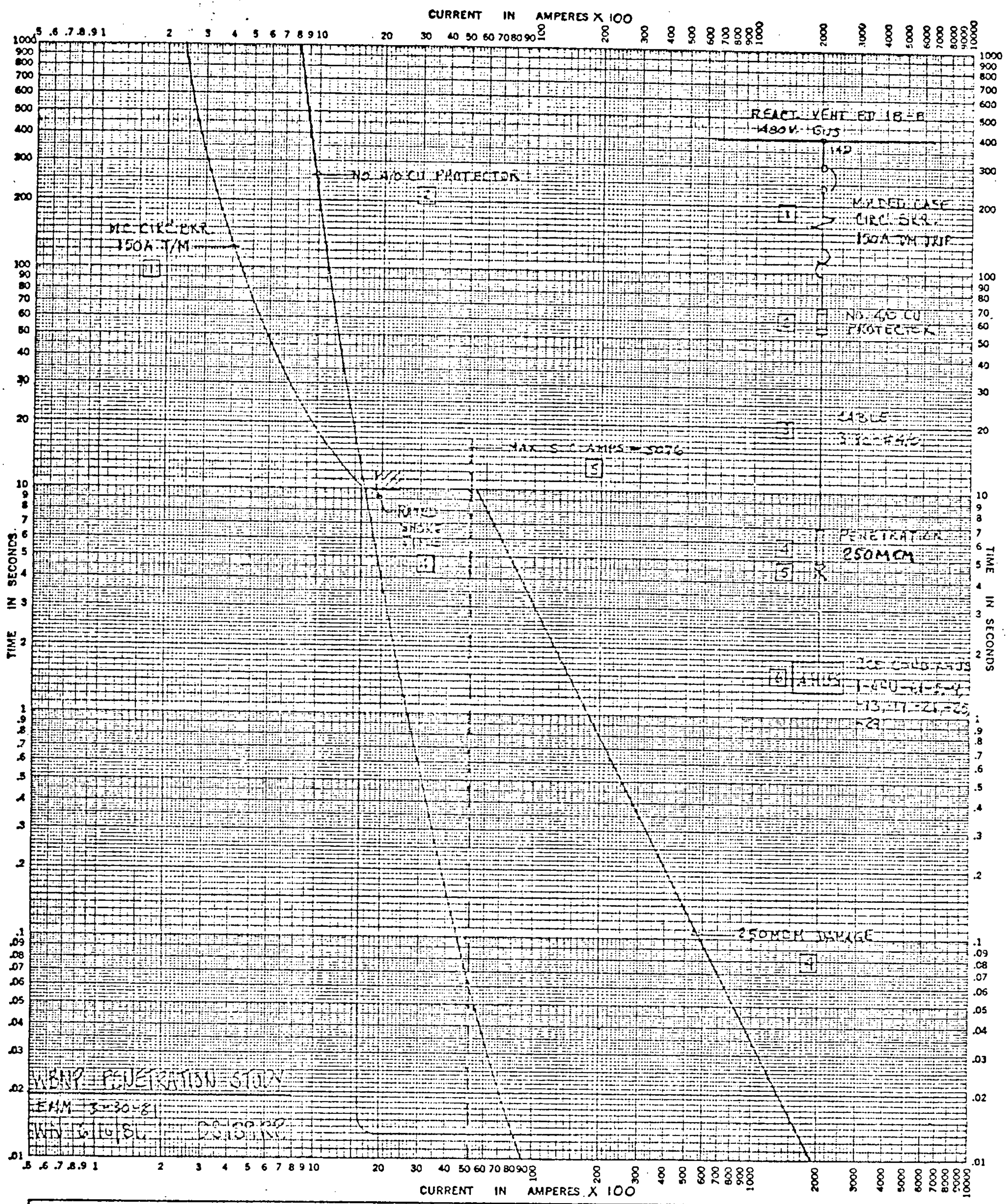
Attachment 11B



15 of 37

For *350 MCM*	TIME-CURRENT CHARACTERISTIC CURVES
	Fuse Links. In
BASIS FOR DATA Standards	Dated
1. Tests made at ____ Volts a-c at ____ p-f., starting at 25C with no initial load	No.
2. Curves are plotted to ____ Test points so variations should be ____	Date

K·E TIME-CURRENT CHARACTERISTIC KEUFFEL & ESSER CO. MADE IN U.S.A. 46 5258



17 of 37

For 250 MCM ______ TIME-CURRENT CHARACTERISTIC CURVES

______ Fuse Links. In ______

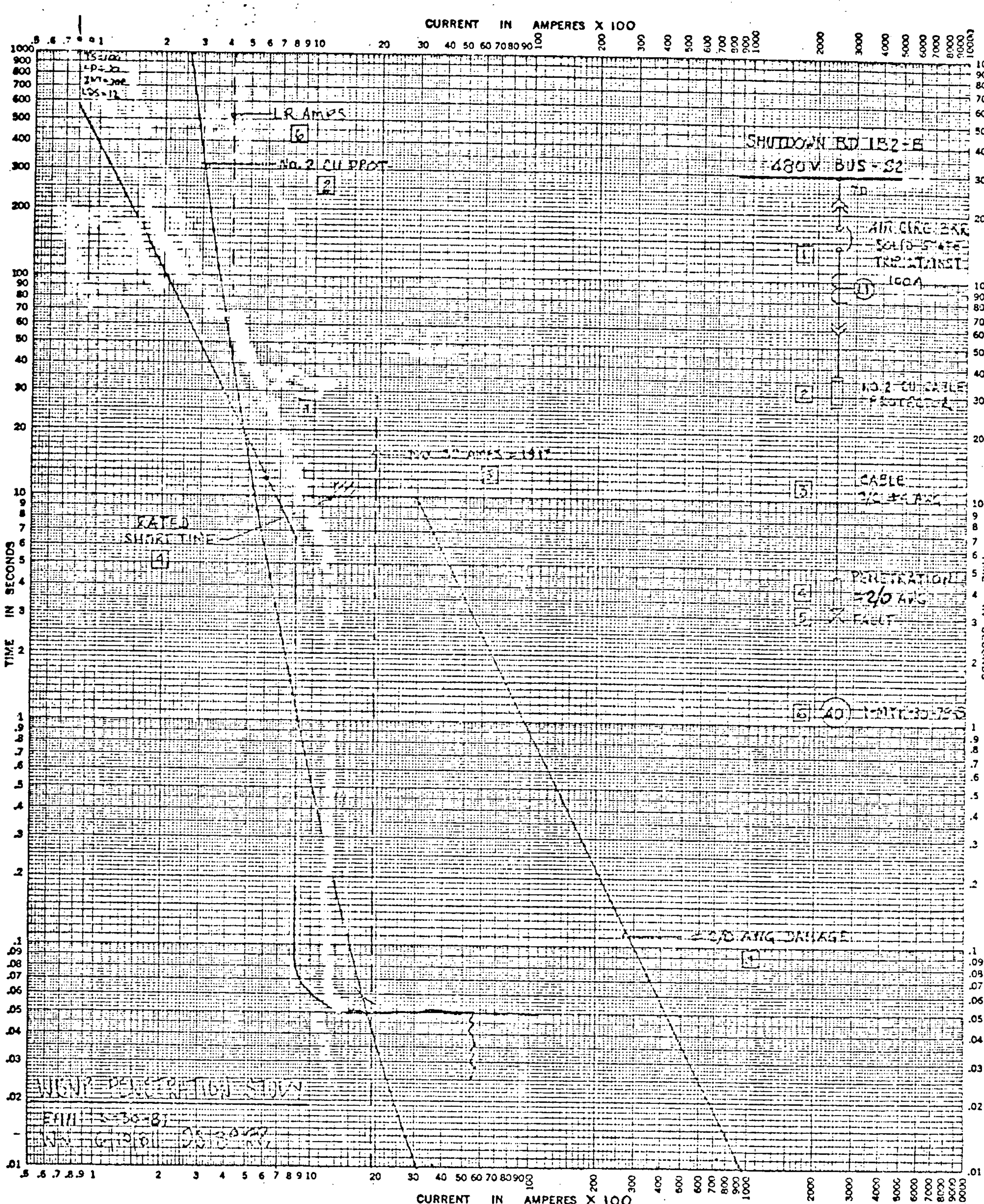
BASIS FOR DATA Standards______ Dated ______

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

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

No. ______

Date ______



23 of 37

For #2/0 ________ TIME-CURRENT CHARACTERISTIC CURVES

________ Fuse Links. In ________

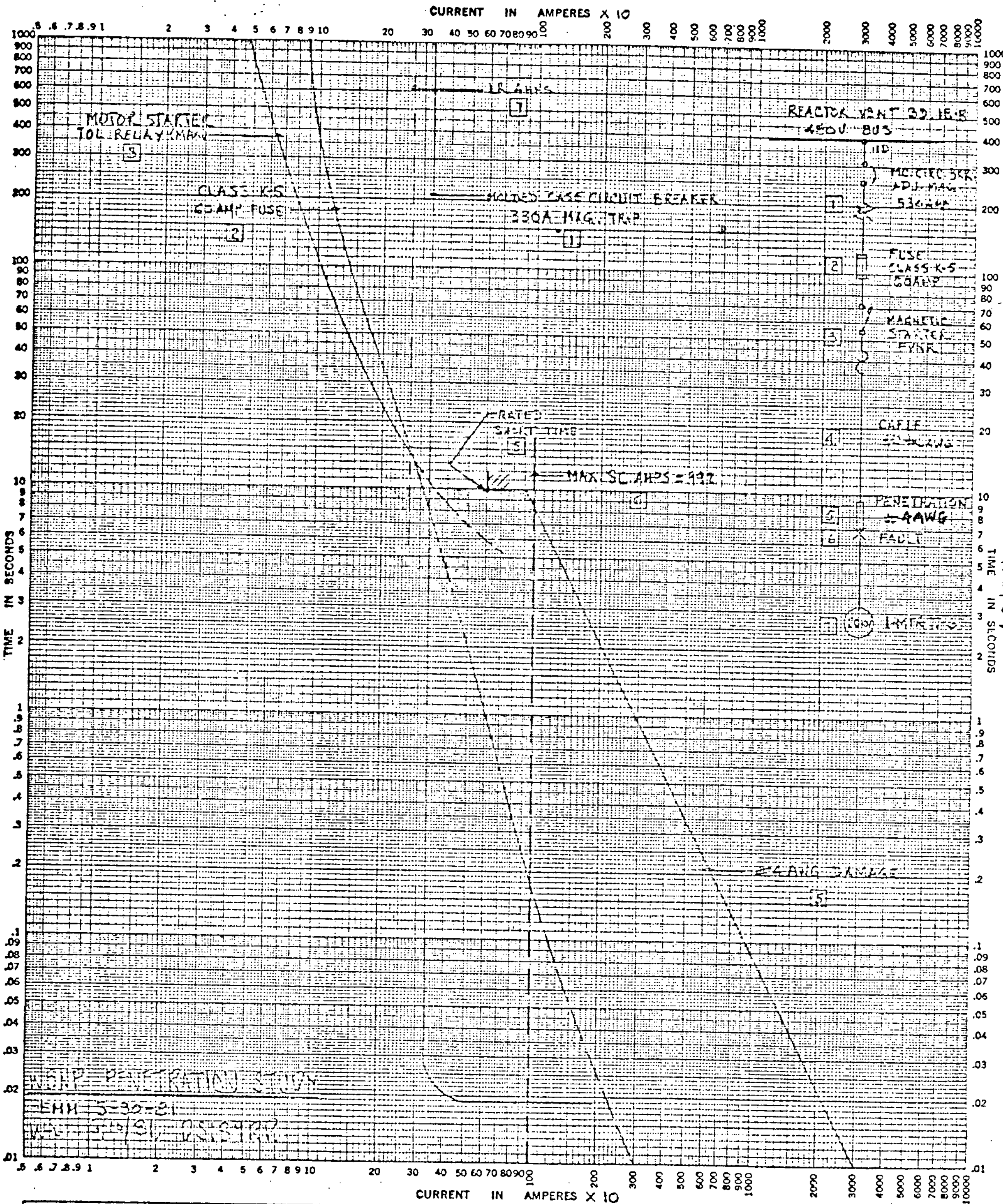
BASIS FOR DATA Standards ________ Dated ________

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

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

No. ________

Date ________



For *# 4 AWG* TIME-CURRENT CHARACTERISTIC CURVES

Fuse Links. in

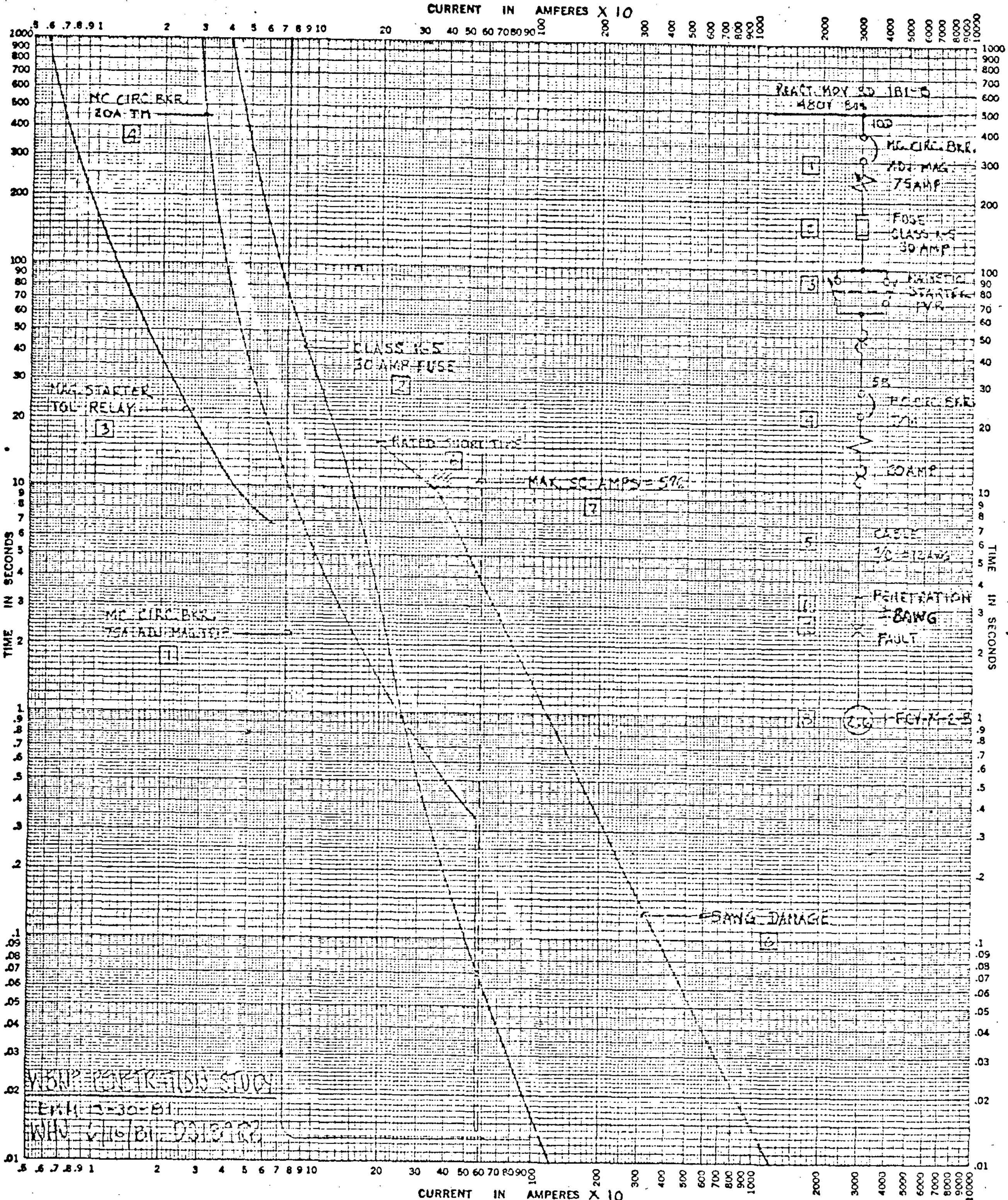
BASIS FOR DATA Standards ____ Dated ____

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

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

No. ____

Date ____



26037

For # 8 AWG ______ TIME-CURRENT CHARACTERISTIC CURVES

______ Fuse Links, In ______

BASIS FOR DATA Standards ______ Dated ______

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

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

No. ______

Date ______

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

operating bases earthquake. The overcurrent protection system meets the single failure criteria of IEEE 279 and have the same testability as the Class 1E overcurrent protection systems.

Position C.2

The WBNP penetrations were purchased using IEEE Std. 317-1972 which did not include the x/r ratios of this guide. The short circuit ratings were based on ANSI C37.9-1953. The current indicated in 1PCEA P-32-382 for a duration of 10 cycles were the values specified for WBNP penetrations.

C.3 (See position C.2)

C.4

A dielectric-strength test based on ANSI C68.1-1953.

C.5

No aging tests were required by standards in effect at the time WBNP penetrations were specified.

C.6 N/A

C.7 N/A

<u>Section 8.3.3.3 - Submerged Electrical Equipment As a Result of a LOCA</u>

The Watts Bar FSAR (section 8.3.1.2.3, page 8.3-33) will be revised as follows:

8.3.1.2.3 - Safety-Related Equipment in Potentially Hostile Environment

Electrical equipment located inside containment has been designed to maintain equipment safety functions and to prevent unacceptable spurious actuations. All power cables feeding equipment inside containment are provided with individual breakers to protect the power sources (both IE and non-IE) from the effects of electrical shorts. Additionally, each power cable is provided with a cable protector fuse which, in the event of a breaker failure, is designed to protect the containment penetration. These breakers and protector fuses ensure that should an electrical short occur inside containment, the electrical power source will not be affected.

A listing of major nonsafety-related electrical components located inside containment that may be inundated following a LOCA appears in Table 8.3-28 along with an explanation of the safety significance of the failure of the equipment due to flooding. In addition to the electrical equipment listed in the table, the water level inside containment may also flood nonsafety-related local control stations, electrical sensors, electric motors for motor-operated valves, and electric solenoids for air-operated valves. The following paragraphs illustrate how the flooding of this equipment does not affect the plant safety. All local control stations located inside containment are provided with manual throw switches located outside containment at the motor control center. These manual switches are used to remove control power from the local control stations during normal operation. In order to utilize the local control stations during operating conditions where containment access is permitted, the manual switch must be closed to provide power to the local stations. Indications are provided in the main control room whenever the manual throw switches are in the closed position. Thus, spurious operation of safety-related equipment due to post-LOCA submergence of the local control station is prevented.

There are no electric motor-operated valves located inside containment below the maximum LOCA water level that are required to function for other than containment isolation. Valves used for containment isolation will receive a signal to close on the initiation of the accident signal. The valves will close in 10 seconds and will remain closed since failure of the control circuitry can only yield operation in the closed direction from the motors before the flooding takes place. Therefore, these valves will not be required to operate during or after the flooding.

The control air supply is automatically isolated outside containment in the event of a LOCA. Therefore, the submergence of electric solenoids serving air-operated valves cannot affect the safe positioning of these valves.

The plant operators are instructed to rely on the qualified postaccident monitors following a LOCA so that any spurious indications from nonqualified electrical sensors that could become submerged would not jeopardize appropriate operator actions.

The safety-related electrical equipment that must operate in a hostile environment during and/or subsequent to an accident is identified below.

<u>Section 8.3.3.6 (Page 38) - Compliance with GDC 18</u>

The Watts Bar design complies with all of the positions of Regulatory Guide 1.108, revision 1, except as follows:

a. Position C.1(5) - This guide was issued too late to incorporate surveillance system to indicate which of the diesel generator protective trips is active first (first out annunciation). However, on all diesel generator protective trips such as differential overcurrent, targets have been provided to indicate which protective device operated. In addition, the status of protective devices installed to shut down the diesel generator unit for generator or engine trouble are alarmed in the main control room.

b. Position C.2.a(2) - We understand this requirement to mean that the emergency loads be sequenced onto the diesel generator unit (DGU) with each load operating at its full load rating (that is a pump would be operating at full flow). This will be done as part of the preoperational testing program. For periodic testing done after preops, the loads will be sequenced on as designed except the pumps will be operated with their miniflow connection open and not at full flow. At all times the voltage and frequency will be monitored to assure they are within design limits.

Section 8.3.3.7 - Testing of One of Two Class 1E Power Trains Versus One of Four Systems

System Testing

Located adjacent to each 6.9-kV shutdown board is a test panel equipped with the necessary selector switches, pushbutton switches, and indicating lights for testing the automatic load stripping and load sequencing logic for that particular power train. The tests are to be performed on only one of the four power trains of the plant at any one time. Testing of one power train does not prevent the remaining power train from performing its intended safety function.

Testing of the onsite power distribution system is divided into three categories:

1. Simulated 'Loss of Preferred Power' test.

2. Group tests for equipment that can be tested during power operation.

3. Group tests for equipment that cannot be tested during power operation.

Section 8.3.3.8 (Part A) - Sharing of Raceway Systems Between Units

Justification

Shared safety-related systems are described in the compliance response to GDC 5 of section 3.1.2.1 of the FSAR. The design of these systems is based on a functional requirement of either train A or train B. For example, the ERCW system (section 9.2 of FSAR) has two 100 percent capacity redundant flow systems for the plant, either of which is capable of performing its safety function. Likewise, the electric systems (section 8.3 of FSAR) are divided into the number of redundant load groups required for a given function. Distribution circuits to redundant equipment are physically and electrically independent of each other. The sharing of raceway systems between units is restrictive to circuits that have the same characteristics such as power supply, voltage level, and channel or train identity.

In the unit 1 area, 6.9-kV shutdown boards 1A-A and 2A-A (units 1 and 2, respectively) are located in the same room but are separated from the redundant 6.9-kV shutdown boards 1B-B and 2B-B located in the unit 2 area. The circuits between the diesel generators and these 6.9-kV shutdown boards are designed for a two divisional separation (train A and train B). Redundant circuits for a required function have been separated or otherwise protected to prevent a common mode failure of the redundant cable system.

Unit 1 and unit 2 cables of the same division share that portion of the raceway which occurs between the power source and its connected load. This sharing generally occurs for that short portion of the raceway where cables for unit 1 and unit 2 loads are routed in opposite directions from the equipment power source. In the unlikely event that an electrical short occurs in a cable of a shared raceway, the fault will not propagate to cables in the redundant raceway. From our analysis, we conclude that the sharing of raceway systems between units will not inhibit the capability to safely shutdown one unit while the other unit is experiencing an accident.

Section 8.3.3.8 (Part B) - Possible Sharing of DC Control Power to AC Switchgear

The surveillance period for the dc bus transfer switch will be seven days.

Section 8.3.3.8 (Part D) - Sharing of Structures and Ventilation Systems Between Units

The major areas of the plant which share structures and ventilation systems in which major electrical equipment is located are as follows:

1. Main control room - See FSAR, section 9.4.1.3

2. Auxiliary Building - See FSAR, section 9.4.3

3. Diesel Generator Building - See FSAR, section 9.5.8

Included in this area are the shutdown board room, the auxiliary board room, and the shutdown transformer room.

For a failure modes and effects analysis, see table 9.4-4 (Diesel Generator Ventilation System), table 9.4-5 (Auxiliary Board Room Air Conditioning System), table 9.4-6 (Shutdown Transformer Room Ventilation System), table 9.4-7 (Control Building HVAC System), table 9.4-9 (Shutdown Board Room A/C System).

Section 8.3.3.8. (Part E) - Sharing of Loads Between Units

The following is a list of loads which are shared between units:

a. Denotes engineered safety features (ESF-Systems which take automatic action to isolate the reactor and/or mitigate reactor accident for both LOCA or blackout condition.)

Component Cooling System Pump C-S 480V Shutdown Bd 2B2-B 480V Shutdown Bd 1A2-A

b. Denote essential supporting auxiliary system (ESFAS - Those systems and components required for safe operation and control of the reactor during a blackout condition or for support in mitigating LOCA.)

Spent Fuel Pit Pump C-S	480V Shutdown Bd 1A1-A*	480V Shutdown Bd 2B1-B*

c. Denote a component neither a nor b

24V CAP Sys Bat Chgr	Reactor MOV Bd 1A1-A	Reactor MOV Bd 2A1-A
24V CAP Sys Bat Chgr	Reactor MOV Bd 1B1-B	Reactor MOV Bd 2B1-B

*These boards are neither the normal nor alternate supply but are the available boards from which the loads can be supplied.