TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

400 Chestnut Street Tower II

May 19, 1982

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

In L. M. Mills' letter to you dated April 15, 1982, TVA provided proposed revisions to chapter 8 of the Watts Bar Nuclear Plant Final Safety Analysis Report (FSAR). At the request of the NRC Power Systems Branch, enclosed are oversized copies of figures 8.1.2A, 8.2-1A, 8.2-1B, and 8.2-1C. Also enclosed are additional revisions to section 8.3. Please note that the information provided by this letter and the letter dated April 15, 1982 is in addition to power systems information provided in Amendment 46.

If you have any questions concerning this matter, please get in touch with D. P. Ormsby at FTS 858-2682.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

R. H. Shell

R. H. Shell
Nuclear Engineer

Sworn to and subscribed before me
this 19th day of May 1982

Paulette H. White
Notary Public
My Commission Expires 9-5-84

Enclosures

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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 external overloads, (5) metering and alarm circuits to monitor the charger output.

battery charge-discharge current,

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.~~ 46

Prior to 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.

There are two alarms in the MCR for each DGU. One is labeled "Diesel Generator Control Power Failure." This alarm not only alerts the operator to a loss of control power, it indicates a complete loss of the diesel generator dc power supply. The other alarm is labeled "Diesel Generator Battery Trouble." This alarm indicates (1) loss of the battery charger ac supply, (2) loss of battery charger output, and (3) diesel generator battery system overvoltage.

certified to operate within the environmental requirement called for in the design criteria. (Refer to Section 3.11). The arrangement of circuit interrupters and switches permits easy isolation of the installed assemblies for future test and maintenance purposes.

8.3.1.2.3 <u>Safety-Related Equipment in Potentially Hostile Environment</u>

Electrical equipment located inside containment has been designed
to maintain equipment safety functions and to prevent 28
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 fueses ensure that,
should an electrical short occur inside containment, the
electrical power source will not be affected. ADD INSERT 8.3.1.2.3-1

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 35
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 40.61
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 28
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 46
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

INSERT 8.3.1.2.3-1 (Page 8.3-35)

(See Appendix 8A and 8B)

A failure analysis has been made on the ability of the electrical power (both AC and DC) systems to withstand failure of submerged electrical components from the postulated LOCA flood levels inside containment. Some of the identified components are automatically deenergized in event of a LOCA, and other components are disconnected during normal operation. The remaining components, powered from a Class 1E source or sharing a raceway with Class 1E circuits, were assumed to be electrically shorted for the analysis. Cables and cable splices are qualified for submergence. The results of the evaluations indicate that the submergence of electrical components will not prevent the Class 1E electric (either AC or DC) systems from performing their intended safety function for the postulated submerged condition.

passed tests conforming to IEEE Standards for Electrical Penetration Assemblies in Containment Structures for Nuclear Fueled Power Generating Stations, IEEE 317-~~[illegible]~~ 1976

Electrical Penetrations

The electrical penetration assemblies (see section 8.1.5.3, "Compliance To Regulatory Guides and IEEE Standards") are designed to maintain containment integrity during all design basis events including temperature rise under fault-current conditions. To assure that electric power is continuously available to operate required equipment, penetrations for redundant cables are located in two or more separate areas in the containment structure.

System Description

There are three basic types of electrical penetations: ~~high~~ medium voltage (power), low voltage (power and control), and instrumentation types. Modular type penetrations are used for all electric conductors passing through the primary containment. A double pressure seal is formed within each module through which the conductors pass. The modules are 35
inserted into header plates with factory attached field weld rings that are field welded to the outboard end of each containment nozzle. The modules are retained in the header plate by a threaded midlock capnut and are sealed to the header plates with a dual midlock ferrule arrangement except for the high voltage modules which use a double "O" ring seal. 40.58

To provide suitable termination of cables at the penetration, junction boxes or dead-ended covered cable trays are provided inside containment. These enclosures serve as an electrical splicing box for field connection of conductors or for mounting of connectors. 35 40.58

The penetration assemblies are designed, fabricated, and inspected in accordance with the latest edition at time of contract of the ASME Boiler and Pressure Vessel Code, Section III, subsection NE for Class MC vessels, and are code stamped.

Medium ~~High~~ Voltage Power Penetration Assemblies

The ~~high~~ medium voltage penetrations have six 8KV ~~X~~Kerite insulated, 750 mcm conductors each supported in a sealed 2 1/2" tube which is 35
attached to the back of the header plate on the outboard end and a support plate on the inboard end. The conductors are terminated in ceramic bushings at each end. The conductors are sealed at the ends of the bushings with a midlock ferrule. There is a separate Kapton insulated 2/0 conductor for carrying cable shields through the penetration. The pressure retaining boundary includes the weld ring, header plate, bushings, bushing extension tubes, "O" rings, and midlock ferrules. 40.58

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And Control

Low Voltage Power ^And Control Penetration Assemblies

Each low voltage power ^and control penetration is suitable for 600 volts AC or less. The cables pass through the header plate and extend beyond each end of the nozzles as pigtails. Wire sizes 2/0 and larger terminate with bolted spade-type connectors while smaller sizes terminate with crimp type in line splices. All low voltage power conductors are insulated with Kapton and are sealed in the steel module shells by dual polysulfone seals.

Instrumentation Penetration Assemblies

Each assembly has either multiconductor, twisted, shielded cables, triaxial cables, coaxial cables, thermocouple cables, or a combination thereof. The multiconductor cables and thermocouple cables are insulated with Kapton and are rated at 600 volts AC or less. They pass through the header plates and support plates and extend beyond each end of the nozzle as pigtails. The shields are carried through the header plate ungrounded. The multiconductor cables and thermocouple cables are terminated with insulated in line cable splice. The coaxial and triaxial cables are insulated with Kapton and polysulfone. They are carried through the penetration assemblies maintaining their concentric configuration. The two shields of the triaxial are not grounded or tied together through the assembly. 35 40.58

<u>Qualification Tests and Analyses</u>

Each penetration assembly is capable of maintaining containment integrity when subjected to the maximum emergency environmental
1.1 conditions listed below plus a total accumulated radiation dose of (1) x 10^8 rad. The leak rate does not exceed 1 x 10^{-2} standard cubic centimeters per second of dry ~~helium~~ nitrogen.

First ~~15~~ 20 Minute <u>Parameter</u>	Inside <u>Containment</u>
Temperature	340 F ~~300 F (rise time 10 seconds)~~
Pressure	70 psig ~~0.5 to +15 psig (rise time 10 seconds)~~
Relative Humidity	20% to 100%

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Next 10-Day <u>Parameter</u>	Inside <u>Containment</u>
Temperature	260 F ~~250 F (decay time 5 minutes from 300 F)~~
Pressure	20 psig ~~0.5 to +15 psig~~
Relative Humidity	20% to 100%

35

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Vital instrument cables for the generating station protection system (GSPS) which includes the RPS and ESF may be routed in the same conduits, wireways, or cable trays provided the circuits have the same characteristics such as power supply and channel identity (I, II, III, or IV).

Automatic actuation and power circuits for the generating station protection system which includes the RPS and ESF may be routed in the same conduits, wireways, or cable trays provided the circuits have the same characterisitcs such as power supply and train identity (train A or train B).

Unit 1 analog circuits and Unit 2 analog circuits may be routed in the same conduits, cable trays, or wireways provided the circuits have the same characteristics such as power supply and channel identity (I, II, III, or IV). In like manner, Unit 1 train A cables may be routed in the same conduits, cable trays, and wireways as Unit 2 train A cables. Unit 1 train B cables may be routed in the same conduits, cable trays, or wireways as Unit 2 train B cables.

Cables for non-safety-related functions are not run in conduit used for essential circuits except at terminal equipment where only one conduit entrance is available. The non-safety-related cable is separated from the safety-related cable as near the device as possible. Cables for non-safety-related circuits may be run on cable trays with those for essential circuits with the following restrictions. When a non-safety-related cable is routed in a tray with essential (GSPS) cables, that cable or any cable in the same circuit has not been subsequently routed onto another tray containing a different division of separation of essential cables. All conduit systems located in Category I structures have seismic supports, and are described in Section 3.10.2.

There are certain safety-related components which are powered from two redundant divisions (channels or trains) through manual transfer devices. These components include the component cooling system pump C-S, the spent fuel pit pump C-S, and the steam turbine driven auxiliary feedwater pumps 1A-S and 2A-S. The output feeder cables from the transfer device to the component require special separation and are routed in separate conduit(s) with no other circuits. These circuits are identified by a

Nondivisional associated cables that are routed in cable trays designated for Class 1E cables have been treated the same as the Class 1E cables. The nondivisional cables are subject to the same environmental qualification, flame retardance, cable derating, splicing restrictions, and cable tray fill as the Class 1E cables. Also, the nondivisional cables have the same circuit protection and short circuit rating as divisional cables. Based on the results of the analysis of associated circuits (see appendix C) TVA has demonstrated that Class 1E circuits are not degraded.

APPENDIX 8A

Analysis of Submerged Electrical Equipment (During Post LOCA) Powered from Auxiliary Power System

Purpose

The purpose of this analysis was to evaluate the response of the Class 1E Auxiliary Power System (APS) to the submergence and subsequent fault of electrical equipment inside the containment vessel during post-LOCA flooding. The effect of flooding on the non-Class 1E power system was not analyzed since its failure would not affect the Class 1E power system or any electric equipment required to mitigate the accident.

Assumptions

1. Conductivity of the water used in flooding the containment vessel is high enough to cause the equivalent of bolted 3-phase faults on submerged circuits.

2. Power outlets and receptacle boxes are deenergized.

Reference

Letter from L. M. Mills (TVA) to Ms. E. Adensam (NRC), dated March 3, 1982, which included additional information concerning power systems at Watts Bar Nuclear Plant.

Procedure

The Class 1E devices of the APS located below the anticipated maximum flood level were identified. These devices were examined to determine if they would be tripped (deenergized) due to the plant's operating mode. The remaining devices will be energized and faulted due to flooding. The effect to submersion on the energized devices was studied as follows:

1. The relationship fo the faulted Class 1E equipment to the APS was typically sketched.

2. The 480V system fault currents were calculated or taken from the issued Containment Penetration Protection Study. The 120V system fault currents were calculated.

3. These currents were plotted along with the protective devices response curves to show proper coordination.

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Analysis

Where there was only one submerged component connected to the power system below the 6900-480-volt transformer, the protective relaying adequately isolates the faulted device from the remainder of the system without loss of the upstream board. This is the design basis for the protective system. The ability of each circuit's redundant protective devices to clear faults inside containment was verified in the issued containment penetration protection study.

In no case were there more than two submerged components connected to a common bus below the 6900-480 volt transformer. In that instance the described procedure was followed to verify that the protective relaying for each device adequately isolates the faulted devices from the remainder of the system without loss of the upstream board.

The effect of submerging hand switches, level switches, and annunciation contacts fed from single phase control transformers is not considered significant. These transformers have fuse protection in their secondary circuits. A short or ground fault of the circuit element fed by these transformers has no adverse effect on the Auxiliary Power System.

Conclusions

The post-LOCA flood will not cause breakers to trip out of sequence or degrade the 6900V or 480V voltage levels of the Class 1E Auxiliary Power System.

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WATTS BAR NUCLEAR PLANT

APPENDIX 8B

Aanalysis of Submerged Electrical Equipment
(During Post LOCA) Powered from Instrumentation
and Control Power System

Purpose

The purpose of this analysis was to evaluate the response of the Class 1E instrument and control (I&C) power system (125 volts dc and 120 volts ac) to the submergence and subsequent fault of certain electrical equipment inside containment during post-LOCA flooding.

Assumptions

1. The conductivity of the post-LOCA flood water is high enough to assume a zero impedance ground fault.

2. All components are submerged at the same time; therefore, the worst case condition will be imposed on the I&C power system.

3. A loss of offsite power condition is assumed, therefore, all submerged electrical components powered from the Class 1E I&C power system will be supplied from the DC power systems.

4. Only the submerged I&C components powered from the Class 1E I&C power system were evaluated.

5. The fault current (I_{SC}) for the components powered from the 125-volt vital dc power system was calculated at 120 volts dc (initial battery voltage upon loss of ac power), this will impose the worst case condition on the batteries.

6. The fault current (I_{SC}) for the components powered from the 120-volt vital ac power system was calculated at 120 volts ac (nominal output voltage of UPS), which will impose the worst case conditions on the UPS.

Reference

Letter from L. M. Mills (TVA) to Ms. E. Adensam (NRC), dated March 3, 1982, which included additional information concerning power systems at Watts Bar Nuclear Plant.

Method of Analysis

The Class 1E devices of the (I&C) power system located below the anticipated maximum flood level were identified. These devices, powered from the Class 1E systems, were categorized into three groups:

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A. Equipment that must operate for accident mitigation. (This equipment will be relocated above the flood level or environmentally qualified for this condition. Final response, for this equipment, will be provided in TVA's analysis of NUREG 0588 for WBNP).

B. Equipment not required to operate for accident mitigation but must not fail in a critical mode.

C. Equipment not required to operate for accident mitigation and whose failure is not critical to plant safety or accident mitigation.

Each submerged component was evaluated in the following manner (except the solenoid valves that are deenergized upon a loss of coolant accident or safety injection signal and junction boxes associated with response time testing which are not energized during unit operation):

1. For each submerged component, equivalent electrical models were constructed from TVA schematic and connection diagrams identifying the circuit power source; primary and secondary (if applicable) protective devices; and intermediate cables, if any, from power source to the submerged component, point of fault.

2. The components identified as elements of instrument loops, temperature sensors, neutron monitoring circuits, radiation monitoring circuits and loose parts monitoring circuits were evaluated and found (because of the circuit design) to contribute no fualt current to the Class 1E I&C power system.

3. For the remaining components, conductor sizes and cable lengths were obtained from appropriate cable routing schedules. Assuming a conductor-to-conductor fault for ungrounded systems and a conductor-to-ground fault for grounded systems, the fault current for each of these components was calculated as the ratio of power source voltage to the sum of cable resistances from power source to the point of fault. Mathematically,

$$I_{SC} = \frac{V_{source}}{\sum R_{cables}}$$

4. For each value of fault current computed, a protective device clearing time was determined from manufacturer's time-current curves. The protective devices (primary and backup) were then evaluated to verify they would clear before the main breaker on the associated distribution panel tripped. This evaluation and the time-current curve for each protective device was evaluated.

5. The effect of the submerged components' fault current on the power system was also evaluated to verify the combined fault currents would not exceed the capacity for the Class 1E I&C power system during this condition. (Where two or more submerged components are powered from the same system; it was assumed all shorts occurred at the same time).

Conclusion

The results of this analysis show that the submergence of the electrical components will not prevent the Class 1E 120-volt ac and 125-volt dc I&C power systems from performing their intended safety functions. All faulted components (where applicable) will be isolated by their primary or backup protective devices without tripping the main breaker on the associated distribution panel. In addition, the submergence of multiple components from the same power system will not exceed the Class 1E I&C power system's capacity rating.

APPENDIX 8C

Fault Analysis of Associated Cables

Purpose

The purpose of this analysis was to verify that the electrical faults, caused by the failure of the associated cables, will not compromise the independence of the redundant cable systems.

Reference

Letter from L. M. Mills (TVA) to Ms. E. Adensam, dated March 3, 1982, which included additional information concerning associated cable analysis at Watts Bar Nuclear Plant.

Method of Analysis

For each associated cable identified, an equivalent electrical model (block diagram form) was developed from TVA schematic and connection diagrams identifying the circuit power source, applicable protective devices, and intermediate cables, if any, from power source to origin of associated cable. Conductor sizes and cable lengths were obtained from appropriate cable routing schedules.

Assuming a conductor-to-conductor fault for ungrounded systems and a conductor-to-ground fault for grounded systems, the fault current was calculated as the ratio of power source voltage to the sum of cable resistances from power source to the point of fault. Mathematically,

$$I_{SC} = \frac{V_{source}}{\sum R_{cables}}$$

Calculations of this nature were performed at appropriate fault locations, where minimum and maximum fault currents were determined for each circuit; i.e., worst case fault conditions were ascertained.

For each value of fault current computed, a protective device clearing time was determined from manufacturer's time-current curves. The fault condition thermal energy (I^2 t) was calculated and was compared to the associated cable rated I^2t.

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Conclusion

The results of this analysis demonstrate that electrical faults, caused by the failure of the associated cables, will not compromise the independence of the redundant cable systems. This was determined by verifying the cable's associated protective device will clear the imposed fault condition (in an acceptable time period) without exceeding the I^2t rating for this cable.