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

November 27, 1984

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

Dear Ms. Adensam:

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

By your letter dated August 29, 1984 to H. G. Parris, TVA was requested to provide additional information with respect to 10 CFR 50, Appendix R, Compliance of Watts Bar Nuclear Plant. Enclosed is TVA's response to this request designated as NRC Question 010.40 on associated circuit analyses.

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 27th day of Nov. 1984
Paulette H. White
Notary Public
My Commission Expires 8-24-88

Enclosure
cc (Enclosure):
U.S. Nuclear Regulatory Commission
Region II
Attn: Mr. James P. O'Reilly Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

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ENCLOSURE
WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
RESPONSE TO NRC QUESTION 010.40 REGARDING REVIEW
OF PLANT FIRE PROTECTION PROGRAM TO PROVISIONS
OF 10CFR50, APPENDIX R

NRC Question

010.40 (9.5.1) Address the means provided for assuring the function of the safe shutdown capability when considering fire-induced failures in associated circuits. Attachment 1 provides guidance that you need to review associated circuits of concern and requests information to be provided for our evaluation. You should specifically respond to part II.C of the enclosure.

Specific Request

II.C.1 The following information is required to demonstrate that associated circuits will not prevent or cause maloperation of the shutdown method:

a. Describe the methodology used to assess the potential of associated circuits adversely affecting the shutdown capability. The description of the methodology should include the methods used to identify the circuits which share a common power supply or a common enclosure with the shutdown system and the circuits whose spurious operation would affect shutdown. Additionally the description should include the methods used to identify if these circuits are associated circuits of concern due to their location in the fire area.

b. Show that fire-induced failures (hot shorts, open circuits, or shorts to ground) of each of the associated circuits of concern will not prevent operation or cause maloperation of the shutdown method.

TVA Response

The methodology for the analyses of the Watts Bar Nuclear Plant associated circuits of concern is divided into three types. Each type corresponds to the NRC's concern for common power supply (type I), spurious operation of equipment (type II), and common enclosure (type III). The methodologies identified below have been used to perform analyses for both common power supply and common enclosure. The analyses for the spurious operation of equipment that could adversely affect the shutdown capability is still in progress as part of TVA's efforts to meet Appendix R guidelines.

The methodology for these analyses is as follows:

Type I - The common power supply analyses identify the power supplies and distribution equipment necessary to operate the safe shutdown equipment and documents the selective coordination of non-shutdown circuits powered from these required power sources for any fault current. If the postulated fault are cleared by the non-shutdown circuit load protective device without degrading the required power source availability, then an Associated Circuit of Concern does not exist. However, where non-shutdown circuits did not have adequate protective devices, corrective action was required, or the circuit was treated as a required circuit. Attachment 1 gives the criteria for listing the information tabulated in these analyses.

Type II - The spurious operation analyses identify all components that (1) are inline valves in required flow paths, (2) can divert flow from a require flow path, or (3) can cause a design basis event when the required equipment to mitigate this event is damaged by fire. Additionally, these analyses document the review to ensure that a safety injection, phase A containment isolation signal, and Phase B containment isolation signal does not cause equipment to operate or realign and defeat a safety function. The design basis events are reviewed to determine which events can be caused by a fire. For those events either the mitigation system must be available or the equipment whose spurious operation caused the event is identified and treateas a required shutdown component. Their cables are either separated or protected in accordance with Section III.G.2 of Appendix R, or other corrective actions are taken as required to eliminate the possibility of spurious operation of equipment affecting both shutdown paths.

Type III - The common enclosure analyses identify each electrical protective device for cables that may be routed in structures that contain redundant safe shutdown equipment and circuits. These analyses document the evaluation to ensure that each cable is adequately protected (i.e., the protective device for the cable clears any fault before auto-ignition of the cable's energy to damage the cable insulation were not evaluated (e.g., instrumentation and signal circuits). Corrective action was initiated for any inadequately protected cable. Attachment 2 gives the criteria for listing the information tabulated in these analyses.

Specific Request

II.C.2 The residual heat removal (RHR) system is generally a low-pressure system that interfaces with the high-pressure primary coolant system. To preclude a loss of coolant accident (LOCA) through this interface, we require compliance with the recommendations of Branch Technical Position RSB 5-1. Thus, the interface most likely consists of two redundant and independent motor-operated valves. These two motor-operated valves and their associated cables may be subject to a single fire hazard. It is our concern that this single fire could cause the two valves to open resulting in a fire initiated LOCA through the high-low pressure system interface. To assure that this interface and other high-low pressure interfaces are adequately protected from the effects of a single fire, we require the following information:

a. Identify each high-low pressure interface that uses redundant electrically controlled devices (such as two series motor-operated valves) to isolate or preclude rupture of any primary coolant.

b. For each set of redundant valves identified in (a), verify the redundant cabling (power and control) have adequate physical separation as required by Section III.G.2 of Appendix R.

c. For each case where adequate separation is not provided show that fire-induced failures (hot short, open circuits, or short to ground) of the cables will not cause maloperation and result in a LOCA.

TVA Response

Reference L. M. Mills' letter to E. Adensam dated January 17, 1983.

As stated in the reference, the high-low pressure interfaces that use redundant electrically controlled devices to isolate or preclude rupture of any primary coolant are:

a. Reactor vessel head vent system valves: FSV-68-394, FSV-68-395, FSV-68-396, and FSV-68-397.

b. Chemical and volume control system normal letdown path valves: FCV-62- FCV-62-69 and FCV-62-70.

c. Excess letdown heat exchanger valves: FCV-62-54 and FCV-62-55.

d. Residual heat removal system valves: FCV-74-1, FCV-74-2, FCV-74-8, and FCV-74-9.

e. Reactor coolant system pressurizer (PORV and block valves): PCV-68- PCV-68-334, PCV-68-340A, FCV-68-333, and FCV-68-332.

In the event of a prolonged loss of RCP seal cooling, a depressurization path could be created through the seals. Seal cooling is not assured by any set of redundant valves but relies on the operation of several systems; therefore, no valves are provided for this path. This function is specifically identified on the shutdown logic diagram.

The power and control cables for the identified valves are under review. The current study for spurious operation will document the adequacy of the physical separation as required by Section III.G.2 of 10CFR50 Appendix R, or corrective action will be initiated.

ATTACHMENT 1

Association Due to Common Power Source Connection

A circuit, whether safety related or not, is classified as a potential Associated Circuit of Concern if it is supplied by a power source that also supplies an Appendix R "Required Circuit."

Tabulation of Circuit Data

a. List by unique identifier all power supplies and distribution panels which supply Appendix R "Required Circuits." This shall be done for both auxiliary power and instrumentation and control (I&C) power supplies.

b. Identify all circuits (except those signal circuits which lack sufficient energy to cause failure of "Required Circuits") supplied from the equipment listed in step a. (above) which are not Appendix R "Required Circuits" and which penetrate fire-zone barriers, shown as Type I in Figure 1.2-1.

c. For the circuits identified in step b (above), list the cable identifier, the cable type (mark letter) and size (AWG), and the protective device rating, manufacturer, and model number.

d. For all power sources listed in step a. (above), provide a conservative (shortest) cable length from the protective device to the closest point of possible interaction with equipment or a cable of the other safe-shutdown path(s).

Acceptance Criteria For Both Auxiliary Power and I&C Power Cables

The electrical protection shall be selectively coordinated such that fire induced branch circuit faults will be cleared by at least one of the branch circuit's protective devices without opening the main board protective device or upstream feeder protection. The fault maximum current should be calculated based on an assumed fault at the load terminals of the branch protective device. An alternate approach is to assume a fault on the nonshutdown cable at the point closest to the distribution panel where the nonshutdown cable could be involved in a fire without also involving shutdown cables or the distribution panel itself.

ATTACHMENT 2

Association Due to Sharing a Common Enclosure

A circuit (except for those signal circuits which lack sufficient energy to cause failure of "Required Circuits"), whether safety related or not, is classified as an Associated Circuit of Concern if it shares a common Appendix R "Required Circuit;" and,

a. is not adequately protected by circuit breakers, fuses, or similar devices; or

b. could allow propagation of the fire into the common enclosure.

Tabulation of Circuit Data

1. List all enclosures which contain Appendix R "Required Circuits." This includes both auxiliary power and I&C power circuits.

2. Identify all cables (except for those signal circuits which lack sufficient energy to cause failure of "Required Circuits") that are in the common enclosure with the circuits listed in step 1 (above) and which penetrate fire-zone barriers shown as Type III of Figure 1.2-1.

3. For each circuit identified in step 2 (above), list the cable identifier cable type (mark letter), and the protective device's manufacturer, mode number, and rating.

Acceptance Criteria

A. Instrumentation and Control Power Cables

I&C power cables and their protective devices must meet both of the following criteria to be adequately protected:

1. The continuous current rating of the cable must be greater than the trip rating of the protective device. If the cable's continuous current rating is between two standard protective device ratings, the higher rated device will provide adequate protection (reference National Electric Code, 1984 edition, articles 240-3 and 240-6).

2. The protective device must clear or limit the fault current such that the conductor temperature is not elevated to the auto-ignition temperature of the cable insulation given in Table 3.3.2-1. For copper conductors, the following equation (reference ICEA P-32-382) may be used to make this determination:

$$\frac{I}{A} t^2 = 0.0297 \log \frac{T_2 + 234}{T_1 + 234} \qquad \text{Equation 1}$$

where,

I = maximum short circuit current (assuming a fault at the point closest to the distribution panel where a cable could be involve in the fire without also involving the distribution panel)

A = conductor area in circular mils

t = duration of fault in seconds

T = maximum operating temperature in C

T = auto-ignition temprature of insulation in C

Table 3.3.2-1

Cable Insulation - Auto-Ignition Temperatures

Insulation Material	Temperature, C
Polyethylene (PE)	455
Cross-Linked Polyethylene (XLPE)	530
Ethylene-Propylene Rubber (EPR)	530
Silicon Rubber	570
Teflon/Tefzel	530

The maximum continuous current, I_R, that the conductor can carry without cable insulation damage can be determined as follows:

$$I_{TR} = \left[\frac{T_R - T_A}{\text{F.L. Temperature Rise}} \right]^{1/2} \times \text{F.L.} \qquad \text{Equation 2}$$

where,

I_{TR} = The maximum continuous current that the conductor can carry without damaging the cable insulation in amps

T_R = Cable insulation damage temperature in ^oC (see Table 3.3.2-2)

T_A = Ambient temperature in ^oC

F.L. Temperature Rise = The conductor temperature at rated current in $C - T_A$

F.L. = Continuous current rating of the cable in amps

Table 3.3.2-2

Cable Insulation - Damage Temperatures

Insulation Material	Temperature, C
Polyethylene (PE)	125
Cross-Linked Polyethylene (XLPE)	250
Ethylene-Propylene Rubber (EPR)	250
Silicon Rubber	300
Teflon	270
Tefzel	250

Using the cable auto-ignition damage curve (Figure 3.3.2-1) and the electrical protective device(s) operating characteristics, the circuit will be adequately protected if the protective device(s) prevents the cable insulation from reaching its auto-ignition temperature. If at least one of the circuits protective devices prevents the cables insulation from reaching its auto-ignition temperature, then no further evaluation of the subject circuit is required. Otherwise, corrective action is required.

B. Auxiliary Power Cables

Adequate electrical protection for cables that share a common enclosure with Appendix R "Required Circuits" exists where the electrical protective device(s) will function to interrupt the circuit before the cable's insulation reaches auto-ignition temperature. The currents requred to elevate the cable insulation to auto-ignition temperature shall be developed by using Equation 1 above, with one variation. The current, I, is defined as the current relative to time for auto-ignition of the cable insulation. Assuming no heat transfer occurs and by selecting sufficient time intervals beginning at t = .01 second, currents can be calculated and used to develop a cable auto-ignition curve. The curve shall be extended to the point where it intersects a vertical line defined to be the maximum continuous current, I_{TR}, that the conductor can carry without cable insulation damage. See Figure 3.3.2-1 below.

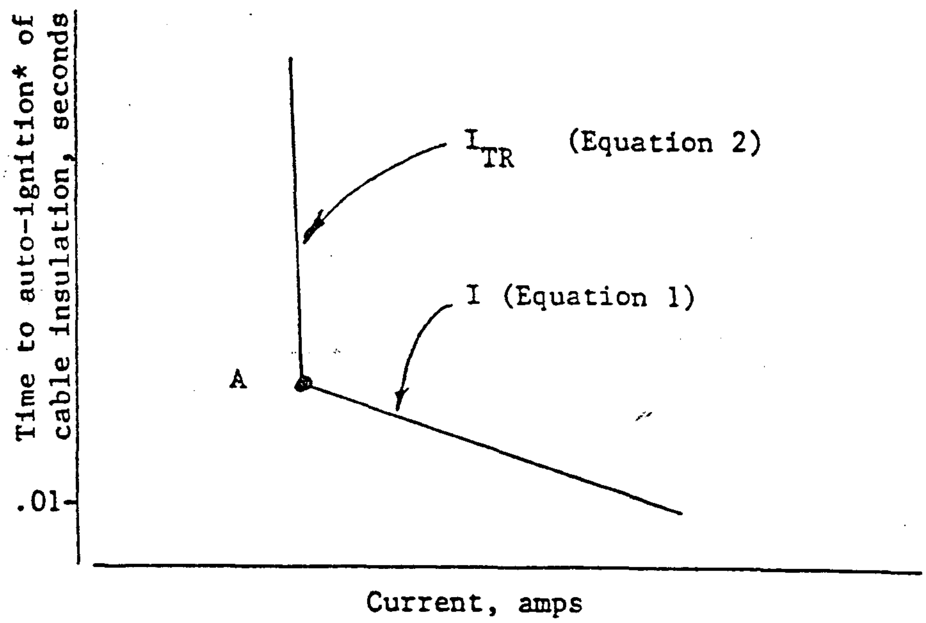


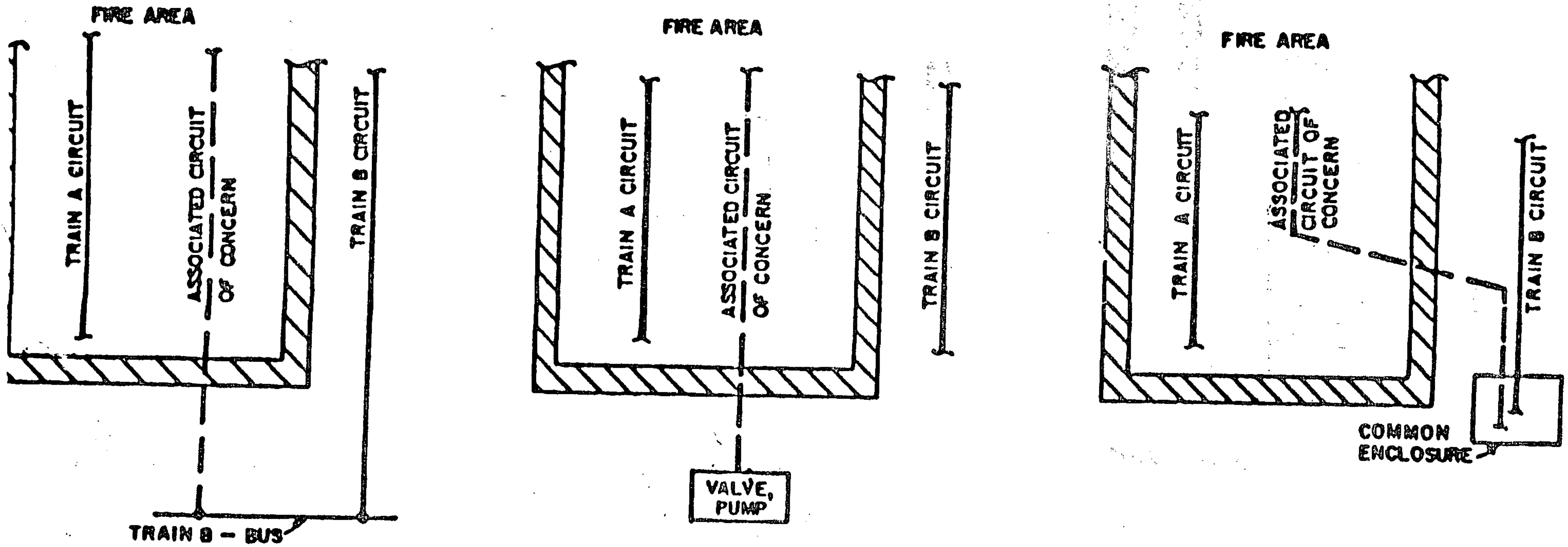
Figure 3.3.2-1 Plot of Current Versus Time to Auto-Ignition* of The Cable Insulation.

*Applicable only to the portion of curve between .01 seconds and the time corresponding to point A.

APPENDIX R ASSOCIATED CIRCUITS OF CONCERN

NOTES:

1. THIS EQUIPMENT SHALL BE IDENTIFIED IN NEB'S FUNCTIONAL CRITERIA, AND APPROPRIATE ACTION TAKEN TO PREVENT SPURIOUS OPERATION OF REQUIRED EQUIPMENT. FOR THE PURPOSE OF THIS CRITERIA, TYPE II CIRCUITS ARE CONSIDERED TO BE REQUIRED CIRCUITS.
2. THE AREA BARRIERS SHOWN IN THESE THREE VIEWS MEET THE APPROPRIATE SUB-PARAGRAPHS (A-F) OF SECTION III, G-2 OF APPENDIX R.



ENTIAL ASSOCIATED CIRCUIT
CONCERN SHARING A COMMON
VER SUPPLY

TYPE I

EQUIPMENT WHOSE SPURIOUS OPERATION COULD AFFECT SHUTDOWN (NOTE 1)

TYPE II

POTENTIAL ASSOCIATED CIRCUIT OF CONCERN SHARING A COMMON RACEWAY OR ENCLOSURE

TYPE III

FIGURE 1.2-1

WATTS BAR NUCLEAR PLANT