TVA

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JUN 0 5 1995

U.S. Nuclear Regulatory Commission
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Gentlemen:

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

WATTS BAR NUCLEAR PLANT (WBN) - SUPPLEMENTAL INFORMATION CONCERNING ELECTRICAL SEPARATION REQUIREMENTS FOR WBN (TAC M89109 AND M89110)

This letter provides supplemental information concerning electrical separation design requirements at WBN. TVA previously submitted information on this subject for review by the NRC staff in letters dated July 29, 1994, and January 11, 1995. The supplemental information is intended to resolve the remaining issues on electrical separation as discussed between the NRC staff and TVA in a site visit on April 6, 1995, and in a conference call on April 12, 1995.

WBN's electrical separation design requirements were described in detail in the letter dated July 29, 1994. This letter also provided justification for WBN's separation requirements by referring to applicable industry standards and test results. The letter dated January 11, 1995, answered questions that resulted from the NRC staff's review of the earlier letter. TVA continued to respond to further questions and concerns from the NRC staff during the site visit on April 6, 1995, and the conference call on April 12, 1995. At the conclusion of these various interactions, TVA understood that the principal remaining NRC staff issue was for TVA to provide an acceptable justification for WBN's minimum allowable separation between a conduit and a cable tray. The design criteria for WBN permit any separation greater than 1 inch between a conduit and a cable tray without the need to install a special barrier.

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The enclosure to this letter addresses the above issue of conduit-to-tray separation. In summary, WBN's separation requirement is justified based on the very low probability that a fault could propagate damage from one electrical train to the other and the very high reliability of the protection devices that are available to clear any postulated fault.

If you have any questions about the information provided in this letter, please telephone John Vorees at (615) 365-8819.

Sincerely,

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ENCLOSURE

SUPPLEMENTAL INFORMATION CONCERNING
ELECTRICAL SEPARATION DESIGN REQUIREMENTS
AT WATTS BAR NUCLEAR PLANT (WBN)

BACKGROUND

The design requirements for Class 1E electrical equipment at WBN provide physical separation, redundancy, and protection to limit damage that could threaten the safe shutdown of the reactor. WBN's General Design Criteria WB-DC-30-4, "Separation/Isolation," defines the minimum separation distances that are necessary to provide physical and electrical isolation for redundant divisions of Class 1E cables. TVA previously submitted a letter dated July 29, 1994, to describe the individual electrical separation requirements in WB-DC-30-4 and to provide a basis for each one by referring to IEEE Standard 384 and/or industry test data.

The separation distances at WBN were selected to prevent an electrical fault that is generated internally within a raceway (i.e., conduit, tray, etc.) of one division from propagating to a raceway containing cables associated with the redundant division during any design basis event (DBE) in conjunction with a single credible active failure. It is assumed that the DBE does not cause or initiate additional failures to electrical equipment. A locked rotor or broken shaft for a reactor coolant pump (RCP) is the only DBE (per General Design Criteria WB-DC-40-64, "Design Basis Events Design Criteria") that specifically involves a motor going to its locked-rotor condition as a result of the DBE. Other than the case of a locked RCP rotor, there is no credible event sequence that could cause a locked-rotor condition. A locked-rotor condition could, however, be postulated as a single active failure that occurs in conjunction with a DBE. Evaluation of a DBE requires considering the consequences of the event initiator such as a piping rupture that results in pipe whip, jet impingement, environmental consequences, flooding, etc. Safety-related motors are protected from credible damage related to a pipe break (i.e., pipe whip and jet impingement) for scenarios in which they would be required to operate.

MEETING THE INTENT OF REGULATORY GUIDE (RG) 1.75

WBN was not designed in accordance with RG 1.75, "Physical Independence of Electric Systems," since much of the design work for WBN predates issuance of the RG. This has previously been stated in Final Safety Analysis Report Section 8.1.5.3 and in letters dated December 17, 1993, June 29, 1994, and July 29, 1994. However, WBN's design features meet the intent of RG 1.75 to achieve independence and redundancy between Class 1E circuits and other Class 1E circuits and between associated non-Class 1E circuits and Class 1E circuits.

Tray and conduit systems located in Seismic Category I structures have seismic supports. Non-divisional associated circuits that are routed in cable trays designated for Class 1E cables are treated the same as Class 1E cables (e.g., they have the same flame retardance provisions, cable derating requirements, splicing restrictions, and cable tray fill limitations). Furthermore, non-Class 1E cables are generally of the same construction and manufacturer as Class 1E cables and are evaluated as having adequate circuit protection.

To meet the intent of RG 1.75, WBN takes credit for cable protection. WBN's design provisions ensure that Class 1E and associated non-Class 1E cables which are located in or routed through Seismic Category I structures are adequately protected from auto-ignition for credible low-impedance faults and motor locked-rotor conditions. An exception to this criterion is that the energy produced by a postulated electrical fault in a cable routed through raceways containing either low-level or medium-level signal cables is considered insignificant and poses no challenge to Class 1E cables. The cable protective devices installed at WBN are of high quality commensurate with their importance to safety. Class 1E cables are protected by Class 1E breakers and/or fuses. Associated non-Class 1E cables are protected by Class 1E or non-Class 1E protective devices. Protection of Class 1E and associated non-Class 1E cables is provided by one of the following protective schemes:

1. A circuit breaker and a fuse in series,
2. Two circuit breakers in series,
3. A single fuse,
4. A single circuit breaker.

Because some non-Class 1E cables are protected by a single non-Class 1E breaker, WBN's current plant procedures require the following periodic testing to enhance breaker trip function reliability.

1. Primary current injection testing is performed at 18-month intervals on at least 10% of each type of breaker. This includes molded-case circuit breakers and 480-volt switchgear breakers protecting Class 1E buses from non-Class 1E loads, primary containment penetrations, and non-Class 1E cables which could be associated circuits.
2. 6.9-Kv reactor coolant pump penetration overcurrent protective relay calibration is performed at 18-month intervals.

EVALUATION OF WORST-CASE SCENARIOS

There are two postulated scenarios that comprise the worst-case conditions for WBN. Each of these scenarios is evaluated below.

1. **Design basis accident with a single active failure of a stalled Train A motor** -- The protective device for the stalled motor will trip the load circuit breaker and clear the high-current condition prior to the supply cable conductor reaching the temperature at which its insulation could ignite. Redundant division cables routed in accordance with the allowable separation distances specified in WB-DC-30-4 would not be damaged or degraded as a result of this event and single failure.

2. **Stalled Train A motor with a single active failure of its load protective device (a single circuit breaker)** -- The backup protective device (i.e., the board main feeder breaker) would not trip in response to the failure of the primary protective device because the overcurrent setting for the backup device is set above the expected fault current for a locked-rotor condition on a motor. As a result, the faulted Train A cable

could ignite and damage redundant division cables routed in accordance with the allowable separation distances specified in WB-DC-30-4. However, this is a non-accident scenario and the resulting cable raceway fire would be considered an exposure fire within the scope of 10 CFR 50.49, Appendix R.

The results for postulated Scenario 2 above are extreme and have a very low probability of occurring at WBN. Analyses using probabilistic risk assessment (PRA) techniques determined that the probability for a motor failure concurrent with a failure of its load protective device is on the order of 2.7×10^{-7}. This is a very conservative PRA result in that the individual component failure probabilities include other types of motor and breaker failures in addition to the specific failures of interest (i.e., motor locked rotor and breaker failure to open under fault conditions). The risk associated with the PRA result is acceptably low because even for the worst-case scenario the resulting exposure fire does not prevent safe shutdown of the reactor.

Furthermore, it is unlikely that a continuous-duty motor could sustain a locked-rotor condition for a long enough time to ignite its supply cable. It is much more credible that either the motor or its pigtail cable will ignite prior to the supply cable. For a locked-rotor condition, the motor windings will heat up rapidly and exceed the insulation temperature rating (typically 85°C). Then, the windings will open and disconnect the flow of current or cause a phase-to-phase and/or phase-to-ground fault. Under fault conditions, the instantaneous setting for the backup protective device will generally trip the breaker in 0.5 second or less. It is unlikely that ignition of the cable insulation could occur in that short a period of time, even though the copper conductor may reach the insulation ignition temperature.

EVALUATION OF CASE-BY-CASE EXCEPTIONS TO WBN SEPARATION REQUIREMENTS

Where it is not possible to satisfy the minimum separation distances required by WB-DC-30-4 due to physical restrictions in the plant, TVA performs case-by-case evaluations to justify, if possible, the acceptability of reduced separation distances. Specifically, raceway separation criteria are evaluated to determine whether or not the worst-case fault on a circuit cable in one raceway can propagate and damage cables in an adjacent raceway. If fault propagation is possible, the effect of such postulated damage is evaluated to determine whether or not the loss of all cables in both raceways could result in failure of a safety-related function. The evaluations consider a worst-case single active component failure in addition to the initiating fault. The following acceptance criteria are used to decide if a reduced separation distance is acceptable.

1. Redundant electrical protection devices, each of which is sized to protect the cable from auto-ignition, are adequate to prevent fault propagation even allowing for the failure of one of these protective devices.

2. Worst-case fault currents in signal circuits for Voltage Levels 1 and 2 are of sufficiently low energy that they do not pose a threat to cables in adjacent raceways.

3. The effects due to loss of power on all circuits fed from the protective device that operates to clear a fault must be evaluated to determine if a safety-related function is lost. This includes considering an assumed failure of a cable's primary protective device and the clearing of the fault by the next higher level of protection.

4. Determining if functional redundancy exists includes more than verifying the availability of the same component in the opposite train. It also requires the availability of supporting components such as in-line valves, instrumentation, and area cooling. Synergistic effects of a postulated cable failure must be considered.