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JUL 15 1988

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Gentlemen:

In the Matter of	)	Docket Nos. 50-259
Tennessee Valley Authority	)	50-260
		50-296

BROWNS FERRY NUCLEAR PLANT (BFN) - ANTICIPATED TRANSIENTS WITHOUT SCRAM (ATWS) RULE (10 CFR 50.62) - DETAILED PLANT SPECIFIC DESIGN

The purpose of this letter is to provide the BFN ATWS detailed design criteria as requested in a letter from G. G. Zech to S. A. White dated April 13, 1988. At a June 2, 1988 meeting in Rockville, Maryland, with the NRC staff, it was decided this could be accomplished by answering the checklist included in the letter to S. A. White from G. E. Gears dated January 8, 1987. Enclosure 1 answers the checklist contained in the January 8, 1987 letter.

This approach is acceptable since NRC understands the BFN ATWS design of the standby liquid control (SLC) and recirculation pump trip (RPT) from TVA letter to NRC dated March 1, 1988, and the design review meeting on June 2, 1988. That letter and meeting described TVA's intentions to use the enriched boron solution for the SLC design, the Monticello design for the RPT, where the end-of-cycle breakers trip the recirculation pumps, and gave design information for the alternate rod injection (ARI) system. The March 1, 1988 letter referenced the Boiling Water Reactor Owner's Group (BWROG) Topical Report (NEDE-31096-P-A) for each aspect of the BFN ATWS design.

As a result of TVA's involvement in the BWROG, TVA understands NRC has expressed concerns pertaining to the diversity requirements between the analog trip unit (ATU) of the ARI system and the ATU of the reactor protection system. TVA's current design contains diversity between the ATUs of these systems and additional diversity (equipment and/or manufacturing) is not needed. Enclosure 2 presents TVA's reasons for this position.

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The BFN ATWS design conforms to the BWROG Topical Report and should be acceptable to NRC. If you need further information, please telephone M. J. May at (205) 729-3570.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

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ENCLOSURE 1

BROWNS FERRY NUCLEAR PLANT (BFN)
ANTICIPATED TRANSIENTS WITHOUT SCRAM
DETAILED DESIGN INFORMATION FOR THE ALTERNATE ROD INJECTION

DESIGN OBJECTIVE

Alternate rod injection (ARI) is a part of the Anticipated Transients Without Scram (ATWS) modification and is required by 10 CFR 50.62, "Requirements for Reduction of Risk from ATWS Events for Light-Water-Cooled Nuclear Power Plants."

In the unlikely event that the normal method of reactor shutdown does not properly function, the ARI system is designed as a backup system for the reactor protection system (RPS) in order to ensure safe reactor shutdown.

The BFN ARI system was designed to provide a path for safe reactor shutdown which is diverse and independent from the RPS. Following an ARI initiation signal, the air supply to the hydraulic control units (HCU) is isolated and depressurized utilizing vent valves, thus allowing individual scram valves to open. Opening of the individual scram valves will result in the control rods being inserted.

DESIGN BASIS

The basic requirements for ARI design are specified in the NRC ATWS Rule, 10 CFR 50.62, paragraph (c) (3), as shown in the following:

a. Each boiling water reactor (BWR) must have an ARI system that is diverse from the reactor trip system from sensor output to the actuation device.

b. The ARI system must have redundant scram air header exhaust valves.

c. The ARI system must be designed to perform its function in a reliable manner and be independent from the existing reactor trip system from sensor output to the final actuation device.

The automatic signal to initiate the ARI comes from high reactor vessel pressure or low reactor vessel water level. The setpoints for ARI initiation were chosen such that a normal scram should already have occurred. The ARI function was also designed to minimize the possibility of inadvertent actuation. Detail design information is described in the following section.

PLANT SPECIFIC REVIEW OF ARI SYSTEM

On January 14, 1986, General Electric, on behalf of the BWR Owner's Group, published a licensing topical report NEDE-31096-P, "Anticipated Transient Without Scram; Response to NRC ATWS Rule 10 CFR 50.62" which detailed conceptual designs to satisfy the 10 CFR 50.62 requirements for boiling water reactors.

NRC then issued a safety evaluation report (SER) dated October 21, 1986, to evaluate the acceptability of the proposed conceptual designs to meet the requirements of the ATWS rule. Based on the review, NRC concluded that the ARI design basis requirements stated in the topical report NEDE-31096-P in conjunction with the NRC staff requirements identified in the SER are in general compliance with the ATWS rule 10 CFR 50.62 paragraph (c) (3).

To facilitate prompt reviews of plant specific ARI designs, the NRC staff has developed a checklist for the SER which itemized the ARI features approved by the staff. BFN has fully implemented an ARI design incorporating these features covered in the checklist in order to be in conformance with the ATWS Rule 10 CFR 50.62 paragraph (c) (3) on ARI requirements.

Each item in the checklist is described in the following section for BFN design. The checklist shown as appendix A in the NRC SER, rather than the items in the SER main body, was used for this report per NRC/TVA meeting on June 2, 1988.

Item 1. ARI System Function Time

Rod injection motion will begin within 15 seconds and be completed within 25 seconds from ARI initiation.

BFN Design

According to the BWR Owner's Group Report, NEDE-31096-P, rod insertion should be defined on a plant-specific rod scram motion times.
Section 3.2
of the report states that the ARI design objective can be met provided full rod insertion occurs within approximately 60 seconds of the ARI initiation signal.

The BFN ARI system, however, is designed to achieve the 15- to 25-second rod insertion motion performance. In order to meet this criterion, it is necessary for BFN to depressurize the scram air header as fast as possible. Therefore, several vent valves as well as block/vent valves are installed on the air supply headers for the control rod drive (CRD) HCUs.

A study of the scram air header depressurization characteristics was performed in order to verify that the BFN ARI design meets the system function time requirement. A computer program was developed to calculate the air venting time.

The venting time calculation evaluates two cases: (1) Operation of all eight ARI valves (including two ARI block valves), and (2) Operation of only one channel of four ARI valves. The eight valve configuration is the ARI design approach which is used in most BWR plants.

The result of the analysis indicates that the air pressure in the HCU scram diaphragm valves will depressurize from the initial pressure of 70-75 psig to 23 psig in 11 seconds. The scram inlet and outlet valves will begin to open when the pressure is reduced to approximately 30 psig. Since the CRD fluid, water, is incompressible, beginning of the scram valve moving time equates the start of CRD motion.

For the scenario of four ARI valve operations, only one valve in each pair was designed to be energized to maintain the same venting locations for each HCU bank and scram discharge volume (SDV). The venting time calculation for four valve operation is for a failure scenario in one logic channel and is for a conservative case. Since it is necessary from ARI design to install at least a vent valve for each HCU bank, a vent valve for SDVs and a block valve, the four valve operation is the minimum requirement for BFN ARI design for one electrical channel. The depressurization time is slightly more (less than 1/4 second) than the eight valve case and thus also meets the ARI time requirement.

In summary, assuming that the time from ARI initiation (from the reactor sensors) to energization of ARI vent valves is less than 1 second, the control rod motion will begin less than 15 seconds after ARI initiation. BFNP control rods will be fully inserted well within ten seconds after the motion has begun and the ARI will be completed within the 25-second time requirement from ARI initiation. The operating time of the ARI vent and block valves is 0.25 seconds maximum and is negligible compared to the total required time of 15 seconds for the rod insertion motion to begin.

Item 2. Safety-Related Requirements

(a) Class 1E isolators are used to interface with safety-related systems.

(b) Class 1E isolators are powered from a Class 1E source.

(c) Isolator Qualification documents are available for staff audit.

BFN Design

(a) & (b) Whenever the ATWS (ARI/RPT) interfaces with the 1E components and systems, proper isolation devices are provided. The two instances where isolation was required and provided are:

(1) Emergency core cooling system (ECCS) cabinets where an isolation relay is provided between the trip output relays of the pressure and level transmitters and ARI/RPT systems.

(2) Two fuses in series were used as proper isolators between the Class 1E 250V DC supply and the ARI/RPT systems as required in section 6.2, item 9 of the NRC SER.

(c) The isolation relays are qualified as such and qualification reports will be available for staff audit.

Item 3. Redundancy

The ARI system performs a function redundant to the backup scram system.

BFN Design

The function of the BFN ARI system is fully redundant to the existing backup scram system which utilizes the identical reactor scram method. Following an ARI initiation signal, the air supply to the scram valves will be isolated and the scram air header will be vented to reduce air pressure in the header, thus allowing individual scram valves to open. The control rod drive units then insert the control rods to shut down the reactor.

Item 4. Diversity of Existing RTS

(a) ARI system is energize-to-function.

(b) ARI system uses DC powered valves.

(c) Instrument channel components (excluding sensors but including all signal conditioning and isolation devices) are diverse from the existing RTS components.

BFN Design

The ATWS (ARI/RPT) system as required by the 10 CFR 50.62 rule must be completely separate from the RPS. This provision has been provided in the design.

(a) Devices in the ARI/RPT systems are normally de-energized and will energize to function.

(b) The ATWS ARI/RPT systems are supplied by 250V DC power.

(c) Signal conditioning devices and isolation devices are diverse for RPS.

The instrument loops that have been utilized for ARI/RPT initiation have been selected such that any adverse interaction with any other instrumentation is avoided.

The analog trip units have been located in panels that are not utilized for any reactor trip functions. Applicable circuits and raceways have either been added or modified to be independent of the RPS.

Item 5. Electrical Independence from the Existing RTS

(a) ARI actuator logic separate from RTS logic.

(b) ARI circuits are isolated from safety-related circuits.

BFN Design

(a) The ATWS (ARI/RPT) system has its own actuation logic circuit. The circuit receives its signal from the ARI analog trip units.

(b) Wherever the ATWS (ARI/RPT) circuits come into contact with Class 1E safety-related circuits, proper isolation is provided.

Item 6. Physical Separation from the Existing RTS

(a) ARI system is physically separated from RTS.

BFN System

Physical separation is maintained between the RPS and ATWS (ARI/RPT) from the transmitters to the final trip devices.

Item 7. Environmental Qualification

ARI equipment is qualified to conditions during an ATWS event up to the time the ARI function is completed.

BFN Design

The ARI/RPT systems are not required to be safety-related based on the NRC SER.

Mechanical portions of the ARI/RPT modifications are nonsafety-related. Isolation of nonsafety-related electrical instruments from the safety-related equipment is achieved by using qualified isolation devices (relays and fuses). Equipment required for the ARI/RPT to function properly are qualified to the conditions during an ATWS event up to the time that the ARI/RPT function is completed in accordance with the NRC SER.

Item 8. Quality Assurance

(a) Comply with Generic Letter 85-06

BFN Design

The ATWS Rule does not require the ARI system to be safety-related and implementation of the ATWS system need not meet all aspects of 10 CFR 50 Appendix B, quality assurance requirements. NRC has recognized that existing industry practices applied to nonsafety-related equipment are acceptable for specific application for nonsafety-related ATWS equipment. This position is explicitly stated in NRC Generic Letter 85-06. Therefore, the organization and program, design control, procurement, installation, inspection, testing, maintenance, modification and other related works are in accordance with the guidance in the Generic Letter 85-06 for ARI/RPT systems. The BFN ATWS Quality Assurance program requirements are contained in the Nuclear Quality Assurance Manual Part I, Section 1.3.

Items 9. Safety-Related Power Supply

(a) ARI system power independent from RTS.

(b) ARI system can perform its function during any loss-of-offsite power event.

BFN Design

(a) The ATWS (ARI/RPT) system is supplied by Class 1E power from the 250V DC Shutdown Board batteries. The RPS is supplied by power from the battery boards.

(b) In the event of a loss-of-offsite power, power is supplied by the shutdown board batteries.

Item 10. Testability at Power

(a) ARI testable at power.

(b) Bypass features conform to bypass criteria used in RTS.

BFN Design

The ATWS (ARI/RPT) design conforms with the requirement that the system be testable at power. The use of two level transmitters and two pressure transmitters in a 2-out-of-2 logic, and the presence of two ARI/RPT initiation channels permit the testing of one channel while the other is still operable. It also permits the testing of one trip unit without initiating ATWS (ARI/RPT) since two trip units must operate at once to initiate ARI/RPT.

Item 11. Inadvertent Actuation

(a) ARI actuation setpoints will not challenge scram.

(b) Coincidence logic is utilized in ARI design.

BFN Design

(a) The setpoints for the ARI/RPT initiation are such that the normal scram from the RPS will take place prior to any ARI/RPT initiation. This has been accomplished by developing setpoint values for the ARI/RPT initiation that have a lower trip setting for the reactor vessel low level and a higher trip setting for the reactor vessel high pressure than those of the existing RPS normal scram trip settings.

(b) Two coincident signals of low reactor water level or high reactor pressure will initiate ARI/RPT. A single failure of a level sensor or pressure sensor will not initiate an ARI or preclude ARI/RPT operation. This is accomplished by placing two contacts in series to ensure that only coincident signals will send out a trip signal to initiate ARI/RPT.

Item 12 Manual Initiation

(a) Manual initiation capability is provided.

BFN Design

Manual initiation of ARI has been provided in the form of hand switches that can allow activation of manual ARI in the main control room utilizing hand switches. Manual initiation of ARI has been designed to ensure that trip outputs to the recirculation pump motor-generator sets are blocked out to ensure that the recirculation pump trip will not take place during manual initiation of ARI.

Item 13. Information Readout

(a) Information readout is provided in main control room.

BFN Design

Four annunciation windows are provided in the control room for ATWS (ARI/RPT).

(1) One window to indicate auto initiation of both ARI and RPT with input from two channels in parallel.

(2) One window to indicate ARI manual initiation with input from the two channels in parallel.

(3) One window to indicate that Channel A is under test.

(4) One window to indicate that Channel B is under test.

Item 14. Completion of Protective Action Once It Is Initiated

BFN Design

The ARI/RPT circuits are provided with a reset switch in the main control room and at the local ATWS panels. However, the circuits are provided with a seal-in feature that prevents the resetting of the circuit for the first 30 seconds after the automatic initiation of ARI/RPT or the manual initiation of ARI. The 30 second delay is provided to ensure that the rods have been fully inserted before the circuit can be reset, provided the initiation signals have been cleared.

ENCLOSURE 2

BROWNS FERRY NUCLEAR PLANT
ANTICIPATED TRANSIENTS WITHOUT SCRAM
POSITION ON 10 CFR 50.62 DIVERSITY REQUIREMENTS
FOR ALTERNATE ROD INJECTION

From industry contacts, TVA has learned that NRC does not think the present diversity contained in most Anticipated Transients Without Scram (ATWS) designs is adequate. Specifically, TVA understands that NRC will require equipment and/or manufacturing diversity between the analog trip unit (ATU) of the reactor protection system (RPS) and the ATU of the ATWS alternate rod injection (ARI) system. 10 CFR 50.62(c)(3) states "Each boiling water reactor must have an ARI system that is diverse (from the reactor trip system, from sensor output to the final actuation device." The Browns Ferry Nuclear Plant (BFN) ATWS design maintains diversity between the ATU of the RPS and the ATU of the ARI system and meets the 10 CFR 50.62 requirement for the following reasons:

(1) RPS is de-energized to function; ARI is energized to function.
(2) RPS is AC powered; ARI is DC powered.
(3) RPS is one-out-of-two taken twice logic; ARI is two-out-of-two logic.
(4) The RPS is completely independent and separate from the ARI.
(5) On scram signals, the RPS acts on the scram pilot solenoid valves to relieve air on the scram valves of each hydraulic control unit; on signals different from the RPS scram signals, the ARI acts on its own separate vent valves to depressurize the scram air header to relieve air on the scram valves.
(6) An ATU in the RPS is used in a reactor trip on low reactor water level and high reactor pressure trips; however, there are numerous other reactor trips that do not use an ATU.

The Statements of Consideration defines the ATWS diversity requirement by stating "Equipment diversity to the extent reasonable and practical to minimize the potential for common cause failure is required..." TVA considers the current BFN design to be diverse "to the extent reasonable and practical" for the following reasons:

(1) The ATUs that are presently available to the industry are similar in design. TVA uses the ATU which was determined to have the best design. To install a different ATU could potentially decrease the system's reliability.

(2) From the reanalysis of the BFN Probabilistic Risk Assessment, ATWS does not have a significant effect on the core damage frequency. Therefore, if manufacturing and/or equipment diversity eliminated all common cause uncertainty, which it would not, the core damage frequency would be only very slightly improved.

(3) TVA estimates that the cost of providing this additional diversity would cost over $500,000 per unit for the design, procurement, and installation. It is also estimated this additional effort would take several months to implement.

Since the ARI ATU and the RPS ATU are already diverse "to the extent reasonable and practical," TVA considers the NRC requirement of additional diversity to be counter productive and would add no safety benefit.