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OCT 06 1989

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) - SECONDARY CONTAINMENT PENETRATION PROGRAM COMPLETION (TAC 00316, 00317, 00318)

This letter provides notification that the design, testing and modifications required to resolve a discrepancy between Appendix F of the BFN Final Safety Analysis Report and the as-constructed configuration of secondary containment penetrations has been completed. The enclosure to this letter provides specific details. The discrepancy regarding the degree of seismic qualification of the penetrations is discussed in Revision 2 to the Browns Ferry Nuclear Performance Plan, Section III.3.11. A description of the program was submitted from R. Gridley to NRC on March 16, 1988. The Safety Evaluation which approved this program was sent by letter from G. G. Zech to S. A. White, dated April 11, 1988. There are no commitments contained in this letter.

TVA requests your review of this material and your concurrence regarding the closure of this issue. If you have any questions, please get in touch with Patrick Carier at (205) 729-3570.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

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Enclosure
cc: See page 2

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U.S. Nuclear Regulatory Commission

OCT 06 1989

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ENCLOSURE
BROWNS FERRY NUCLEAR PLANT
SECONDARY CONTAINMENT PENETRATIONS

Program Description

TVA's program for resolution of this issue ensures the secondary containment boundary would maintain sufficient integrity after a design basis earthquake (DBE). Accordingly, the standby gas treatment system (SGTS) would maintain the minimum one quarter inch of water negative pressure inside secondary containment which is required by Technical Specification 4.7.C.1.a. This approach provided sufficient confidence that the resulting pressure differential would prevent unfiltered radiological releases from the secondary containment. The program involved three steps:

1. Determination of the margin available for post-DBE inleakage flow.

2. Evaluation and quantification of the potential post-DBE inleakage flow rate into the secondary containment.

3. Modification of the potential flow paths if required to ensure that the total post-DBE inleakage flow was within the full flow SGTS flow rate.

Inleakage Flow Description

Inleakage flow through the secondary containment boundary arises from the airlocks, refueling floor roof and siding, piping penetrations, heating ventilating and air conditioning (HVAC) duct penetrations, electrical conduit penetrations and cable tray penetrations. These flow paths potentially presented two types of inleakage flow:

1. Normal inleakage.

2. Post-DBE inleakage flow increase.

Normal leakage is evaluated and measured periodically by the secondary containment/SGTS surveillance testing required by Technical Specification 4.7.C.1.a. The normal leakage plus any additional leakage due to normal inprocess plant activities (e.g., maintenance, modifications, etc.) is required to be less than 12,000 CFM. The full flow SGTS flow rate is that SGTS flow developed with two trains operable. Technical Specification 3.7.B.3 allows operation and fuel handling with a minimum of two trains of SGTS for seven consecutive days. The margin available for post-DBE inleakage flow increases is the difference between the full flow SGTS flow rate and the Technical Specification 4.7.C.1.a limit of 12,000 CFM.

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Full Flow Test Description

A special test was performed to determine the full SGTS flow rate that would be produced by two trains of the SGTS operating in parallel while maintaining all four zones of secondary containment as close as practical to one quarter inch of water negative pressure. Trains A and B were chosen since, historically, they have yielded the lower flow rates of the three trains and thus would yield a conservative full flow SGTS flow rate. This test was performed with all three units defueled and at a time when secondary containment was not required. The SGTS trains were operated at a maximum flow rate while the secondary containment pressure was regulated by opening doors that penetrate secondary containment in unit 3. The test demonstrated that the full SGTS flow is at least 16,200 CFM which provides a margin of 4200 CFM.

Post-DBE Response of Seismic Commodities

The airlocks and the Reactor Building roof and siding are seismically qualified and will not experience an increase in post-DBE inleakage flow rate. The programs to verify the seismic qualification of cable tray, conduit and HVAC are discussed in the Browns Ferry Nuclear Performance Plan, Sections III.3.3, III.3.4 and III.3.5, respectively. Thus, the cable tray, conduit and HVAC penetrations are not considered sources of increases in post-DBE inleakage. The seals for these types of penetrations were not considered to be sources of post-DBE inleakage since the item penetrating secondary containment was seismically qualified.

Post-DBE Piping Penetration Response

As stated previously, the piping penetrating the secondary containment boundary presents two potential types of secondary containment inleakage flow:

1. Normal inleakage.

2. Post-DBE inleakage flow increase.

Potential post-DBE inleakage flow increase for piping penetrations could arise from two different failure mechanisms. Inleakage area could be created by: 1) failure of the annular seal around the piping where the piping passes through the secondary containment boundary, or 2) if the piping itself failed such that a leakage path internal to the piping was created. The secondary containment piping program demonstrated earthquake resistant annular seals were at the secondary containment boundary and that the piping penetrating the boundary would survive the DBE.

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Annular Seal Types and Responses

The secondary containment penetration program confirmed or established an earthquake resistant seal around the piping at the secondary containment boundary. Through comparison of the Browns Ferry secondary containment annular seal types to an earthquake experience database, it was determined that some of the existing seals are earthquake resistant. These included penetration seals comprised of welded caps, bolted plates, no annular area, welded plates, caulk, fiberglass boots, rubber boots and lead oakum seals. A few small seals were assumed to totally fail and thus create a leakage area equal to the penetration seal area. This conservative approach was utilized for seals for which seismic response characteristics were not available. All other penetrations were sealed using flexible foam type seal materials (i.e., Promaflex and RTV silicone foam). The expected response of each seal type is discussed below:

Welded Caps and Bolted Plates

Some piping penetrations are not used and are capped off with either plates welded directly to the steel penetration sleeve or bolted to the secondary containment wall. These types of penetrations would not experience any increase in inleakage following a seismic event.

No Annular Area

This class of seal is characterized by a pipe which has the same outside diameter as the inside diameter of the penetration. Thus, this seal configuration has no potential for inleakage flow increase via the seal.

Welded Plates

Welded plates are typically bolted or welded to the secondary containment wall and then usually welded to the piping. For piping which will experience small seismic or thermal induced movement, no increase in inleakage was assumed. For piping experiencing large movement, the weld was assumed to fail for the purpose of this program only and create an annular flow area equal to the weld gap between the plate and the piping.

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Caulk

Caulk seals were assumed to totally fail if the piping was expected to have substantial movements and thus form a flow area equal to the annular gap between the wall and the piping. No increase in inleakage was assumed for caulk seals experiencing small pipe movement.

Fiberglass Boots

Sealed boots constructed of a fiberglass-like material are used to seal the annular area between the mainsteam/feedwater lines and the secondary containment blowout panels in the steam vault. Through plant walkdowns and dynamic modeling of the lines, it was determined that the seismic induced motion of the lines would be less than the slackness in the boot and would not experience any increase in inleakage following a seismic event.

Rubber Boots

Rubber boots are used for a number of piping penetrations throughout the plant as Appendix R fire seals. Piping using rubber boots was evaluated to determine its seismic induced motion. Based upon the evaluation results, the slackness in the boots was adjusted to ensure that boots would remain intact and would not experience any increase in inleakage following a seismic event.

Lead Oakum

One piping line penetrating the Reactor Building roof uses a lead and oakum seal. Evaluation of the expected piping movement coupled with experience data on the performance of such seals indicated that they would not experience any increase in inleakage following a seismic event.

Promaflex

Promaflex is an Appendix R fire barrier material distributed by the Promatec Corporation. It is a putty-like foam material which is poured into place using a back dam. Following cure time, the material remains as a soft putty-like foam substance which readily deforms and then returns to its original shape. Based on the results of the seal material tests described below, the material is able to withstand considerable piping deflections before any significant increase in inleakage would occur.

The material can detach from the piping surface and allow the piping to slide axially within the seal due to either thermal or seismic induced pipe motion. Once the piping motion ceases, the material reattaches to the piping and reestablishes its seal with a minimum amount of inleakage increase. The material can withstand both axial and lateral pipe movements. During small lateral deflections, Promaflex deforms and experiences very small increases in inleakage. Extreme lateral movements tend to leave a hole in the material as it detaches from the pipe surface and leaves a void in the seal material; however, under most geometries the seal is reestablished when the pipe is returned to near its original position.

The Promaflex material does not exhibit good sealing properties for penetrations with small annular gaps (e.g., 10-inch penetration with 8-inch piping yielding a 1-inch gap around the pipe). Geometries of this type tend to make the material roll out of the penetration and experience total failure; thus, this type of material was not utilized for penetrations with annular gaps which are small compared to the penetration radius.

RTV Silicone Foam

The RTV silicone foam Appendix R fire seals are made by using Type 3-6548 RTV silicone foam manufactured by the Dow Corning Company. The RTV foam is a spongy type material similar to the foam in a water ski life vest. Based on the results of the seal material tests described below, this material can withstand large axial piping movements but tends to tear due to combined lateral and axial pipe movements. As the piping oscillates axially from seismic induced lateral motion, the piping abrades the material leaving an open path through the seal. The expected lateral piping deflection was assumed to remove a corresponding area of RTV foam and the post-DBE flow area (and hence flow rate) determined accordingly. This material does not experience the total failure exhibited by Promaflex for small annular area configurations; thus, this material was used for piping with small annular areas or small lateral movements.

Seal Material Test

In order to demonstrate the expected post-DBE performance of the flexible foam piping seals (Promaflex and RTV silicone foam), a series of special tests were conducted. Mockups of piping and penetrations with the seal material in place were subjected to cyclical axial displacements of the piping. The magnitude of the displacements was increased stepwise until being in excess of both the

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rated displacement for the material and the expected seismic induced motion. With the seals subjected to a one quarter inch of water pressure differential, the seal leakage flow rate was measured before and after a specified number of displacement cycles. Similarly, the test apparatus was subjected to stepwise lateral displacements and the flow rate measured before and after. Multiple tests for each piping configuration were conducted to demonstrate the repeatability of the data. Piping penetration mockups were utilized which simulate the actual conditions in the plant in terms of both penetration and piping size.

Piping Displacements

Seismic and thermal induced pipe motions were estimated using experience based criteria along with limited dynamic analysis. The majority of the piping exhibited estimated axial and lateral deflections of less than one inch. The piping configurations with deflections exceeding one inch were generally rod hung flexible systems with little or no axial support. These were on piping systems such as service air, drains, fire protection and demineralized water.

Piping movements were determined using field walkdowns in which the piping configuration and seal on both sides of each penetration were inspected and equivalent span lengths determined. Estimates of piping movement at each penetration were determined using the overall support configuration and deflection estimation screening charts which were based on the bounding configuration for simply supported span cases.

Lateral displacement estimations did not take credit for any restraint capability of the seal material. If displacement estimates were greater than the gap between the pipe and the sleeve, the total displacement was considered equal to 100 percent of the gap dimension. Also, if deflection estimates resulted in deflections which were very small (i.e., less than 1/8 inch), they were considered to be essentially fixed and a zero-inch movement was assumed.

The piping on each side of the penetration was reviewed to determine the potential for plastic deformation of a support resulting in a permanent offset of the piping within the penetration. Piping supports were reviewed to determine if the failure of any particular support would result in permanent piping displacement.

The procedure utilized for field estimation of piping system deflections was verified by limited dynamic analysis bounding typical piping layout configurations. Response spectrum analyses utilizing simple span piping layouts were used to obtain seismic induced deflections. These calculated deflections were then compared with the deflections obtained using the screening charts. It was shown that the screening charts over-estimated the seismic induced deflection compared with that depicted by detailed analyses in all cases but two. In two cases, the simple screening chart under-estimated deflection by less than 1/10 of an inch. Since field estimated deflections were typically rounded up to the nearest 1/2 inch, use of the screening charts was conservative in all cases.

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Thermal growth estimates were determined by estimating the length of piping which could contribute to growth in a particular direction. Using length and temperature range on the thermal deflection screening charts, the total piping thermal induced movement was determined.

Throughwall Failure Evaluations

Secondary containment inleakage can be created if the piping which passes through the secondary containment boundary fails such that a leakage path internal to the piping is created. This failure mechanism requires a throughwall path on both sides of the secondary containment boundary. For piping which is open to the atmosphere either inside or outside the secondary containment, only one throughwall piping failure on the other side of the wall is required to breach the secondary containment boundary. For piping closed both inside and outside secondary containment, a throughwall failure of the piping on both sides of the boundary is required.

In order to determine the anticipated structural response of the piping, the piping was divided into two categories. Piping for which pressure boundary integrity is being verified by other programs such as the IE Bulletin 79-02/79-14 or small bore piping programs or piping already covered by the seismic class II/I water spray hazard walkdowns were considered acceptable (i.e., not expected to form throughwall piping failures). If an operability issue is identified on a particular piping component during the performance of these programs, an evaluation of the situation will be performed and appropriate actions taken. The remaining piping was evaluated using the deflection estimation walkdown data and associated analyses. Terminal ends of the piping were inspected to ensure that unanchored equipment would not result in loss of pressure boundary integrity. This could be caused by unanchored equipment (or other large unanchored masses) dragging or displacing the piping during an earthquake.

These evaluations used seismic experience data and were based on the ability of the piping to maintain pressure boundary integrity either inside or outside the secondary containment boundary. These evaluations considered the presence of any existing isolation device (e.g., automatic valve, check valve, loop seal, etc.). For piping which does not contain isolation devices, the entire system either inside or outside the secondary containment was reviewed to ensure that no throughwall paths would be created on that side of the boundary. The evaluations did not identify any piping systems which would form a leakage path through the secondary containment boundary.

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Program Acceptance Criteria

Using data from the seal material tests, the inleakage flow response for various penetration/pipe configurations versus axial/lateral pipe movements was correlated. The expected post-DBE response of the other seal designs (e.g., weld plates, caulk, etc.) were correlated for various penetration/piping configurations. These correlations were used to determine the total expected post-DBE inleakage flow increase. The total expected post-DBE inleakage flow increase was determined to be approximately 3280 CFM which is less than the available margin (i.e., 4200 CFM).

Conclusions

The Browns Ferry Secondary Containment Program has been implemented. The secondary containment/SGTS is be capable of maintaining a one quarter inch of negative pressure following a DBE and will prevent unfiltered radiological releases from secondary containment. As stated in the March 16, 1988 letter from R. L. Gridley to NRC, TVA intends to revise the BFN FSAR to clarify the performance and design of the secondary containment.