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Gentlemen:

In the Matter of	)	Docket No. 50-260
Tennessee Valley Authority	)	

BROWNS FERRY NUCLEAR PLANT (BFN) - UNIT 2 - RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION - FLEXIBLE CONDUIT - LETTER DATED DECEMBER 19, 1989 (TAC 62260)

As part of the staff's review of the BFN Flexible Conduit Program (Nuclear Performance Plan, Section III.13.3, Volume 3), additional information was requested of TVA by NRC letter dated December 19, 1989.

In response to that request for additional information, the following informaiton is enclosed.

If there are any questions, please telephone P. P. Carier, Browns Ferry Site Licensing Manager at (205) 729-3570.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

M J Ray for

E. G. Wallace, Manager
Nuclear Licensing and
Regulatory Affairs

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D030
1/1

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ENCLOSURE 1

RESPONSES TO NRC QUESTIONS
LETTER DATED DECEMBER 19, 1989

ITEM NO. 1

The definition of K as well as associated numerical values do not reflect the intent of the CEB-MA2-006 calculation. In the calculation, all equipment and devices are subject to thermal movement which is correct. However, the definition in your Program Plan seems to indicate otherwise. Please clarify the discrepancy.

RESPONSE

The values of K (K = 1 inch for floor-mounted equipment or 4 inches for pipe-mounted devices) is the maximum combined seismic/thermal movement in any direction at nuclear plants. NE/EE agrees that the Program Plan for flexible conduit and General Construction Specification G-40 implies that K = 1 inch (floor-mounted equipment) is for seismic movement and not for combined seismic/thermal movement. A Specification Revision Notice (SRN) revision to G-40 is being processed to clarify this discrepancy.

ITEM NO. 2

In obtaining resultant earthquake-induced displacement at the top of the Motor Control Center (MCC), the shaker table displacement is subtracted from the accelerometer derived displacement. The licensee had indicated that it agrees with the staff that the subtraction of the displacement is not correct. Subsequently, the licensee proposed to use the phase relationship of the two motions to sum displacements algebrically. The staff believes that the algebraic phase sum is not valid. An absolute sum of the two maximum displacements is more appropriate and conservative. Algebraic sum is not reliable because peak displacement of the equipment represents a displacement at resonance frequency. This displacement is obtained by applying a harmonic motion to the shaker table with the equipment's natural frequency. Any algebraic calculation at resonance is not valid because of the relatively large displacement associated with resonance. This violates Hadamard's principles (Reference 4), which states that, among other things, one should not rely on a calculation where a small change in an introduced parameter represents a large change in the result. Please provide justification for using a algebraic sum of the displacements for these calculations.

RESPONSE

In developing the response to this item, the I-T-E Imperial Motor Control Center test report was extensively reviewed and the data from accelerometer (6V) located at the top of the cabinet was evaluated. The top of cabinet displacement represents the maximum cabinet movement. Utilizing this accelerometer's information, a calculated single amplitude horizontal displacement of 0.434 inch resulted. Then by an absolute summation of the maximum cabinet displacement and the maximum test table displacement a resultant displacement of 0.613 inch is obtained (0.434" + 0.179" = 0.613"). Therefore, calculation CEB-MA2-006 will be revised to reflect the 6V accelerometer displacement and an absolute summation of this displacement with the test table displacement will be used to establish the maximum top of cabinet displacement.

This very conservative approach provides a value which is enveloped by the 1 inch maximum displacement previously established.

See response to Item No. 4.

ITEM NO. 3

Please provide the references for the sources of the maximum shaker table acceleration of 1.4g and the displacement of 0.137 inches and compare their significance to the FSAR (plant specific floor response spectra).

RESPONSE

TVA calculation CEB-MA2-006 defines the maximum worse case seismic and thermal movements for TVA nuclear plants. The maximum shaker table acceleration of 1.4g is based on the results of the original conservative seismic analysis of the soil supported diesel generator building at Watts Bar Nuclear Plant (CEB 841015 028).

At Browns Ferry Nuclear Plant (BFN), the maximum building floor acceleration applicable to the CEB-MA2-006 calculation is 0.52g (37% of the tested value of 1.4g) for the Design Basis Earthquake (DBE). This acceleration is from the seismic analysis using artificial ground motion time history and the structural models documented in NRC inspection reports 50-260/88-38 and 50-260/88-39. This acceleration occurs in the east-west direction of the Reactor Building at elevation 664.

The 0.179 inch calculated displacement is based on 1.4g acceleration and a 8.75 hertz frequency forcing function. (Note the 0.137 inch, in the staff's request for information appears to be a typographical error. The control displacement from CEB-MA2-006 is 0.179 inches). At BFN, the calculated displacement for 0.52g at 8.75 hertz is 0.066 inches. (37% of 0.179)

ITEM NO. 4

Accelerometers are assumed to be located at mid-point of the cabinet. Please provide verification and documentation for this assumption. Once displacement of the mid-point is assumed, it is multiplied by two to extrapolate the data to the top of the cabinet where the flexible conduit is attached. This is not a conservative extrapolation since the bottom of the equipment is anchored to the floor and the top is free thus acting as a cantilever. Free end displacement of the cantilever is more than twice the mid-point displacement.

RESPONSE

A review of the test data and ITE Imperial drawings 84-18297-98 (Watts Bar NP 74-84646) was performed. The exact location of accelerometer 4 originally assumed located at the cabinet mid-point was determined. Accelerometer 4 was actually located within 12-inches of the top of the enclosure, not 4-feet from the top as originally assumed. (Accelerometer 4 is located in the center of equipment-mounting panel A of cabinet number 3B and Panel 3A of the above referenced drawings). Extrapolation of the seismic movement from the actual location of the accelerometer to the top of the cabinet predicts a top-of-cabinet movement of 0.430-inch as opposed to the previous conservative 0.746-inch.

It was also found that accelerometer 6 was actually located at the top surface of the cabinet and that data was available from that instrument. Analysis of this data results in a predicted displacement of 0.434-inch, which is in agreement with the above extrapolated displacement.

See the response to Item No. 2.

ITEM NO. 5

TVA is currently updating piping calculations under the Browns Ferry I & E Bulletin 79-14/79-02 programs. This may affect results obtained in CEB-MA2-006 upon which flexible conduit inspection criteria are bases. Please discuss Tennessee Valley Authority's (TVA's) plan for possible future revision of the criteria.

RESPONSE

BFN has reviewed the 79-14 and torus attached piping stress analysis problems and it was determined that the maximum resultant pipe movement at any motor operated valve utilizing flexible conduit does not exceed 4 inches. Therefore, CEB-MA2-006 will not require revision due to BFN 79-14 programs.

ITEM NO. 6

In Reference 3 (CEB-82-0912-023 Rev. 0), thermal expansion and dynamic displacement of the main steam pipe are tabulated. However, there is no indication that dynamic displacement includes the seismic response of the pipe. Please discuss how the value of the dynamic displacement was developed and the load combinations considered.

RESPONSE

The flexible metal hose addressed by the referenced calculation was designed for relative movement between the MS and SRV piping and the building structure to which control air piping is attached. The MS-SRV piping undergoes movement due to deadweight, thermal expansion and dynamic loading conditions. Based on load definitions used by the Browns Ferry Long Term Torus Integrity Program, dynamic load sources that affect the MS-SRV piping are:

1. Seismic - Safety Shutdown Earthquake (SSE) including seismic anchor movement.

2. SRV Blowdown (pipe response due to hydraulic transient following valve actuation).

3. Loss of Coolant Accident (SRV pipe response due to hydrodynamic effects inside the wetwell torus).

Utilizing results from the piping analyses noted in Appendix A of the referenced calculation, maximum displacements from the three dynamic load sources noted above were combined by absolute sum to give the total dynamic movement at the SRVs . The total dynamic movement was added by absolute sum to an algebraic combination of the worst case thermal expansion of the MS-SRV pipe and the deadweight displacement to give the tabulated movements.

ITEM NO. 7

In Reference 3 (CEB 82-0913-023 Rev. 0), Appendix B, a response spectrum is presented. Please discuss how this pertains to the main text of the report (Reference 1).

RESPONSE

The response spectrum presented in the referenced calculation was developed to serve as the required dynamic load environment for qualification of the flexible metal hose which furnishes compressed air from the Control Air System to the MS-SRVs. This spectrum is an absolute sum of each frequency of individual spectra of the SSE and SRV Blowdown dynamic events based on response of MS-SRV piping at the valve (Loss of Coolant Accident induced acceleration is insignificant at the SRVs). It was used to produce the enveloping movements for thermal and dynamic displacements as used in G-40. As such, the spectrum is not applicable to the scope of flexible electrical conduit connecting equipment to rigid conduit addressed in the main text of the report.

ITEM NO. 8

TVA analysis considered only displacements of the equipment, devices and pipes. These represent only one end of the flexible conduits. The other end of the flexible conduit is supported most likely by a rigid conduit. Rigid conduit also is subjected to seismic/thermal movements. Please discuss why the final length of the flexible conduit does not consider displacements in both ends of the conduit.

RESPONSE

The original conduit installations at BFN were installed in accordance with TVA General Construction Specification G-3. This specification required that conduits terminating in fittings be supported not further than 12 inches from the rigid conduit end. The 12 inch cantilever would not produce an appreciable displacement; therefore, seismic and thermal movements of the conduit cantilever were neglected.

In September 1988, Nuclear Engineering issued conduit supports that allowed conduit cantilevers up to 2 feet for 3/4 inch diameter and 1 inch diameter conduit and 3 feet conduit cantilevers for 1-1/2 inch diameter and larger conduit. In response to this item an evaluation was performed to determine the maximum end displacement due to the cantilevered lengths. The maximum end displacements occurred for the 3/4 inch diameter conduit. This displacement (based on the floor response spectra at elevation 664 in the reactor building) was determined to be 0.35 inch. Considering the response to Item 3, the absolute displacement at the top of the cabinet for BFN would be 0.23 inch. The maximum displacement between a floor mounted item and the cantilevered conduit end would be 0.23" + 0.35" = 0.58". This absolute displacement is less than the G-40 K value of 1 inch. The thermal displacement would be 0.12 inch. Therefore, neglecting the conduit end displacement does not invalidate the G-40 requirements.

ITEM NO. 9

In considering MCC thermal movement, a four foot length of the cabinet is used. Please provide the basis for assuming a four foot length.

RESPONSE

Thermal movements in calculation CEB-MA2-006 are based upon an electrical cabinet, which is 9-feet high and 8-feet wide. Thermal expansion in the horizontal direction (8-foot direction) is assumed to occur equally, in each direction, about the centerline. Therefore, thermal expansion in the horizontal direction is based upon one-half the width of the cabinet, or 4-feet.

ITEM NO. 10

Terminals of the flexible conduits will be subjected to an inertia load from a seismic motion. Please discuss how this load is accounted for in the seismic qualification of the end connector.

RESPONSE

The flexible conduit end connectors are qualified for inertia loads resulting from seismic motion. This is documented in Wyle Laboratories Test Report No. 17831-1 (B41 870529 001).

The test program was developed to evaluate representative samples of PVC jacketed flexible conduit with the associated connectors and specific stainless steel flexible conduits and connectors.

The test fixture was designed to simulate a worst case installation. The flex conduit was used to connect from a cantilevered rigid conduit to a junction box mounted on a heavily weighted arm representing a valve operator. Electrical cables were installed in the flexible conduits. The entire assembly was mounted on a 3-axis seismic simulator and subjected to 5-OBEs and 1-SSE required response spectra (RRS). No failures of the flexible conduit end connectors were observed during the test program. Therefore, the flexible conduit end connectors are qualified for seismic loads.

ITEM NO. 11

It was stated in the program plan that approximately 500 flexible conduits have been identified which require inspection. Please provide a discussion on how this number demonstrates that all the flexible conduits are accounted for. For instance, it is not certain that flexible conduits between two buildings are considered. If they are considered, the conduits between the buildings should be included in the inspection criteria. If not, one should provide a justification not considering them.

RESPONSE

The Nuclear Performance Plan (NPP, Volume III, Section 13.3) provides our commitment scope for the flexible conduit issue at Browns Ferry. The Unit 2 restart flexible conduit evaluation program will inspect all flexible conduit which terminate at 10CFR50.49 equipment. This inspection program will encompass our commitment in the NPP, which is to inspect the following flexible conduits:

A. All 10CFR50.49 electrically operated, pipe-mounted devices where the expected motion is greater than 1 inch.

B. A random sample of 10CFR50.49 electrically operated, pipe-mounted devices where the expected motion is less than 1 inch.

C. All flexible conduit connected to floor-mounted cast or forged 10CFR50.49 equipment at a point 6 feet or greater above floor level.

The number of flexible conduit to be inspected will be determined by the final issue of the 10CFR50.49 list. Previous reported numbers (e.g., approximately 500, etc.) were based on earlier revisions to the 50.49 list.

Also the use of flexible conduit within an exposed conduit run at the expansion joints between two buildings was not a practice of construction during the construction phase that took place under General Construction Specification No. G-3 (prior to June 1986). The common practice is to use expansion-contraction conduit couplings. However, when General Construction Specification No. G-40 became effective for Browns Ferry, the use of flexible conduit at building expansion joints became an option for construction. Because these flexible conduits were installed and accepted under work plans that use the current G-40 installation practices, they are not subject to re-inspection.

ITEM NO. 12

On Page 5 of the CEB-MA2-006 calculation, the exponent -6 is missing at two locations. Please verify that the omission is an editorial error.

RESPONSE

The missing exponent of -6 at the two locations is an editorial error. This omission will be corrected during the next revision to CEB-MA2-006.

ENCLOSURE 2

LIST OF COMMITMENTS
FLEXIBLE CONDUIT RAI

1. A Specification Revision Notice (SRN) to General Construction Specification G-40 is being processed to clarify that K=1 inch applies to combined seismic/thermal movement and not seismic movement only.

2. Calculation CEB-MA2-006 will be revised to reflect the 6V accelerometer displacement. An absolute summation of this displacement with the test table displacement will be used to establish the maximum top of cabinet displacement.

   Also, missing exponent (-6) will be corrected in this calculation.