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O. J. "Ike" Zeringue
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FEB 06 1992

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) - LOWER DRYWELL PLATFORMS AND MISCELLANEOUS STEEL SEISMIC CRITERIA

Reference: NRC letter dated December 12, 1991, "Request for Additional Information Regarding Browns Ferry Drywell and Miscellaneous Steel Design Criteria, Units 1, 2, and 3 (TAC NOS. M80618, M80619, and M80620)"

This letter is in response to the referenced request for additional information regarding BFN's criteria for the seismic qualification of the lower drywell steel platforms and miscellaneous steel. The enclosure to this letter provides a point by point response to each NRC request. There are no commitments contained in this letter. If you have any questions, please contact R. R. Baron, Manager of Site Licensing, at (205) 729-7566.

Sincerely,

O. J. Zeringue

O. J. Zeringue

Enclosure
cc: See page 2

A001

U.S. Nuclear Regulatory Commission

FEB 06 1992

Enclosure
cc (Enclosure):
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ENCLOSURE
BROWNS FERRY NUCLEAR PLANT (BFN)
CRITERIA FOR THE SEISMIC QUALIFICATION OF THE LOWER DRYWELL STEEL PLATFORMS AND MISCELLANEOUS STEEL

The NRC's December 12, 1991 request for additional information regarding the BFN criteria for the seismic qualification of the lower drywell steel platforms and miscellaneous steel was in response to TVA's June 12, 1991 letter. TVA's letter is hereafter referred to as the "Reference".

NRC Request:

1. "On Page 8 of the Reference, it is stated that "TVA has demonstrated compliance of the design criteria with the FSAR requirements."

   (a) Identify and provide the specific FSAR requirements."

TVA Response:

As part of the Browns Ferry Unit 2 restart effort, TVA performed a FSAR verification program that reconciled licensing commitments with the design criteria. This included a verification that the FSAR and design criteria were in agreement. The FSAR commitments related to the seismic qualification of the lower drywell steel platforms are located in FSAR Section 12.2.2.7.1 and in Table 12.2-16. The FSAR changes required to reflect the current criteria for the seismic qualification of the lower drywell steel platforms and miscellaneous steel have been made available for NRC review and will be incorporated into the next annual FSAR update. There are no explicit FSAR commitments for the seismic qualification of miscellaneous steel as a class of commodities. However, there are discussions of the seismic qualification of individual miscellaneous steel commodities in the FSAR. For example:

> FSAR Section 3.5, Control Rod Drive Housing Supports, states that the American Institute of Steel Construction (AISC) Specification was used in the design of the CRD housing support system. However, to provide a structure that absorbs as much energy as practical without yielding, the allowable tension and bending stresses were taken as 90 percent of yield, and the shear stress as 60 percent of yield. These are 1.5 times the corresponding AISC allowable stresses of 60 percent and 40 percent of yield.
>
> FSAR Section 12.2.2.3.3, Reactor Support Pedestal, states that the ring girder is designed according to AISC Code Specifications.

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FSAR Section 12.2.2.5, Reactor Building Crane, states that structural portions of the bridge and trolley were fabricated from A-36 steel, in accordance with section 1.23, Part I, of the "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings," as adopted by the American Institute of Steel Construction. Load combinations used in designing the crane, with corresponding stresses, are listed in Tables 12.2-14 and 12.2-15.

FSAR Section 12.2.2.6, Sacrificial Shield Wall, states that the AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings, adopted April 17, 1963, is used in the design of the steel in the sacrificial shield wall. (NOTE: A change to the FSAR has been initiated which will revise this section to allow the use of the eighth edition of the AISC Specification for structural re-design or re-evaluation.)

FSAR Section 12.2.2.7.2, Support Steel for Pipe Guides Inside Drywell states that the stresses in all components of the supports are less than 90 percent of yield for tension and bending and 60 percent of yield for shear. These are 1.5 times the corresponding AISC allowable stresses of 60 percent and 40 percent of yield. The pipe guides included in this section are for the Main Steam and Feedwater Systems. The guides protect the nozzles, attached to the drywell, after a rupture of the pipe inside the drywell.

FSAR Section 12.2.5.2, Flood Protection Doors, states that all steel fabrication for the doors for the two exterior openings in the Radwaste Building was in accordance with the applicable requirements of the American Institute of Steel Construction. Load combinations used in designing the doors with corresponding allowable stresses are listed in Tables 12.2-39 and 40.

FSAR Section 12.2.7.1.2, Personnel Access Doors, describes the doors that provide personnel access to the Residual Heat Removal Service Water (RHRSW) pump compartments. All steel fabrication was in accordance with the applicable requirements of the AISC. Load combinations used in designing the doors with corresponding allowable stresses are listed in Table 12.2-41.

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FSAR Section 12.2.8.2, Access Doors, describes the four doors that provide access to the diesel generator units and the one door that provides access to the CO_2 room. All steel fabrication was in accordance with the applicable requirements of the American Institute of Steel Construction. Load combinations used in designing the doors with corresponding allowable stresses are listed in Table 12.2-30.

FSAR Section 12.2.8.4, Portable Bulkhead, discusses the portable bulkhead that is part of the Diesel-Generator Building flood protection. Load combinations and corresponding allowable stresses used in designing the bulkhead are listed in Table 12.2-42. All steel fabrication was in accordance with the applicable requirements of the American Institute of Steel Construction.

FSAR Section 12.2.9.2, Doors, describes the equipment access lock doors that provide an air lock between the Reactor Building and outside entrance. Load combinations used in designing the structural portions of the doors with corresponding allowable stresses are listed in Table 12.2-33. All steel fabrication was in accordance with the applicable requirements of the American Institute of Steel Construction.

FSAR Section 12.2.9.3, Flood Gates, discusses the equipment access flood gate that is located on the outside face of the equipment access lock and is part of the Reactor Building flood protection. Load combinations and corresponding allowable stresses used in designing the gate are listed in Table 12.2-43.

These examples are not intended to be an all inclusive list of miscellaneous steel commodities discussed in the FSAR. However, they do represent a cross section of the types of commodities considered to be miscellaneous steel and the seismic design commitments and level of detail contained in the FSAR.

NRC Request:

(b) "Discuss if the FSAR requirements cover steel platforms as well as miscellaneous steel. If not, please provide the applicable requirements."

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TVA Response:

The FSAR commitments for the seismic qualification of the lower drywell steel platforms and miscellaneous steel are discussed in the response to Item 1(a) above. The detailed requirements for the seismic qualification of the lower drywell steel platforms and miscellaneous steel are provided in Attachment F to BFN General Design Criteria BFN-50-C-7100, Design of Civil Structures, Revision 2, dated May 15, 1991, which was included as an enclosure to TVA's June 12, 1991 submittal.

NRC Request:

(c) "Describe how the design criteria submitted in the Reference satisfy each FSAR requirement."

TVA Response:

Verification that the design criteria satisfy the FSAR commitments was based on an extensive comparison between the sixth and eighth edition of the AISC code. The conclusion of this comparison was that the overall margins embodied in the FSAR requirements had not been reduced. The major areas that show the overall margins have not been reduced are:

1) The stress allowables for the operating basis earthquake use basic AISC code allowables without any increase in the code allowable stress.

2) The stress allowables for the safe shutdown earthquake use an increase in the basic AISC code allowable stress of 50 percent but has an upper cap of nine tenths of yield.

The comparison between sixth and eighth editions of the AISC code has been made available for NRC review.

As previously stated, the basic allowable stresses for miscellaneous steel commodities as a class are not explicitly specified in the FSAR. However, the allowables currently used for the seismic qualification of miscellaneous steel commodities are in agreement with those used for the lower drywell steel platforms and envelope the FSAR commitments.

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CRITERIA FOR THE SEISMIC QUALIFICATION OF THE LOWER DRYWELL STEEL PLATFORMS AND MISCELLANEOUS STEEL (CONTINUED)

NRC Request:

(d) "Provide examples for key items demonstrating compliance of your proposed criteria with the applicable FSAR requirements."

TVA Response:

Refer to TVA's response to Question 1C.

NRC Request:

2. "Does miscellaneous steel mean structural steel other than lower drywell steel platforms at elevations 566' and 584' 9½"? If so, are the criteria shown in FSAR Table 12.2-13 the criteria for miscellaneous steel? If not, provide a comprehensive discussion as to what the miscellaneous steels are and where in the FSAR applicable criteria are provided."

TVA Response:

Miscellaneous steel includes structural shapes that range from main structural steel building features to items as small as ladders and hatch covers. The allowables shown in Table 12.2-13 are for the reactor building super structure, which is not a miscellaneous steel commodity. Pages 1 and 2 of Enclosure 1 to TVA's June 1991 letter includes a listing of typical commodities that are considered to be miscellaneous steel. Items not considered to be miscellaneous steel include equipment casings (e.g. pump and motor housings), tanks, and heat exchangers. In response to Item 1a, examples of miscellaneous steel commodities discussed in the FSAR are provided.

NRC Request:

3. "Do the discussions on Page 7 of the reference apply to both steel platforms and miscellaneous steel with regard to compliance with FSAR requirements? If not, provide compliance-related discussions and examples for the miscellaneous steel (see Question 1)."

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MISCELLANEOUS STEEL (CONTINUED)

TVA Response:

The discussions on Page 7 of the reference apply to both steel platforms and miscellaneous steel.

NRC Request:

4. "Provide a discussion for ductility ratio usage, including:

   (a) An exact definition with illustrative examples."

TVA Response:

The ductility ratio is defined as the ratio of deformation in a member to the deformation at yield. Ductility ratios are used for the evaluation of steel structures with thermal restraints to show that the thermal loads are secondary and self limiting in nature and that the material is ductile. Examples of the use of ductility ratios are discussed in Item 4C. These examples were previously reviewed by NRC .

NRC Request:

   (b) "Bases for use of ductility ratio in terms of physical test data and analytical demonstration regarding ductility ratio associated with collapse mechanism (or other failure mechanism of various structures). Describe how such ductility ratios are calculated and why the calculation methodology is reliable, including any experimental bases. Also discuss the impact of your ductility ratio usage on structural design safety margins compared to the margins which would be provided if the applicable FSAR requirements and criteria were strictly followed."

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TVA Response:

The usage of the ductility ratio of 3 was and is provided in General Design Criteria BFN-50-C7100, which is the long term design criteria for this issue. The inspections reviewed by NRC, which are documented in Inspection Report [illegible] used BFN-50-C7100 as the basis for acceptance. The use of a ductility ratio of 3 was explicitly reviewed and approved by NRC for long term use.

Supplement 2 to the Safety Evaluation Report on the Browns Ferry Nuclear Performance Plan - NUREG-1232, Volume 3, dated January 23, 1991, Section 2.4, Platform Thermal Growth, states:

> "TVA has also evaluated the effects of platform thermal growth outside the drywell. The staff reviewed TVA's evaluations and concluded in IR 50-260/89-42 that the inspection concerns of IR 50-260/89-29 were adequately resolved and that TVA's evaluation results and modifications were reasonable."

Physical testing was not performed for BFN and was not considered necessary since an appropriate non-linear analysis that models the members behavior was performed. There is no discussion in the FSAR regarding modeling of the behavior of structural steel features during a seismic event or the use of ductility ratios. Nor are ductility ratios specified in the codes and specifications contained in FSAR commitments. Consequently, the present design criteria requirements for an evaluation that includes the impact of ductility is greater than the level of detail specified in the FSAR.

Due to the limited industry guidance in the evaluation of the thermal behavior of constrained structural members in plants licensed prior to 1976, the acceptability of the ductility ratio of 3 was negotiated with NRC as part of the overall seismic upgrade of BFN. Its use is a separate issue from the two post- Unit 2 restart commitments identified in NUREG-1232:

1) The adequacy of using the 1978 edition of the AISC Specification in the restart evaluation in lieu of the 1963 edition specified in the FSAR, and

2) The review of the design criteria of determine if it conforms with the FSAR requirements.

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The acceptability of this ductility ratio must be considered in the context of the overall seismic upgrade performed during the previous Unit 2 outage. This overall seismic upgrade program included:

1) The development of an artificial ground motion time history which enveloped the smoothed design response spectra for all damping values used in the analysis of structures, systems and components as specified by the current Standard Review Plan,

2) Used improved modeling and seismic analyses of rock and soil supported structures, and the reanalysis of the following structures and systems:

   Large bore piping and supports,
   Small bore piping and supports,
   Torus structures and piping (both internal and external),
   Control rod drive piping and supports,
   Instrument tubing,
   Cable trays and supports,
   Electrical conduits and supports,
   Heating, ventilation, and air conditioning ductwork and supports,
   Drywell steel platforms,
   Miscellaneous steel,
   Effect of the failures of Seismic Class II features on Class I features,
   Mechanical and electrical equipment, and
   Secondary containment penetrations.

The restart of Unit 2 was based on the conservatism of the overall seismic analysis for each of these structures, systems, and components; from the seismically induced ground motion to the response of the specific structures, systems, and components.

NRC Request:

(c) "Provide any specific references where the NRC staff approved such usage in the past."

ENCLOSURE
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CRITERIA FOR THE SEISMIC QUALIFICATION OF THE LOWER DRYWELL STEEL PLATFORMS AND MISCELLANEOUS STEEL (CONTINUED)

TVA Response:

The issue regarding the ductility ration of 3 was initially identified on the Browns Ferry docket in Section 3.4.3, Thermal Growth of Steel Platforms Outside Drywell, of Inspection Report 89-30, dated September 20, 1989. It states:

> "The staff agreed to review the documentation and calculations presented by TVA at this meeting. The staff also stated that a ductility factor higher than 3 would not be acceptable because this is the limiting value that has been accepted by NRC, on a case-by-case basis. This item remains open. (CSG-34)"

The open item associated with ductility ratio was closed in Section 3.1.8, Thermal Expansion of Steel Structures Outside Drywell, of Inspection Report 89-42, dated February 26, 1990. It states:

> "IR 50-260/89-30 stated that a ductility factor of 3 was the limiting value previously accepted by the NRC staff on a case-by-case basis. To address the team concern about the allowable ductility factor, TVA design input memorandum DIM-BFN-50-C-7000-12 (B41 890505 003) specified the following limits:
>
> - for steel members, the maximum ductility factor equals 3;
> - for self-drilling concrete anchors, the maximum shear displacement equals 0.1D (where D = nominal diameter of anchor); and
> - for other types of concrete anchors, the maximum shear displacement equals 0.2D.
>
> The limit on concrete anchor shear displacement was based on TVA test data on concrete anchors (B04 890505 200). The team reviewed this TVA document and other test results and concluded that the TVA criteria are reasonable. Therefore, the team concern about the allowable ductility factor criteria is resolved. ...
>
> In summary, the team concluded that TVA's thermal growth evaluation of the structural steel outside drywell resolved all three team's concerns identified in IR 50-260/89-29, and the evaluation results and modifications are reasonable. This item (CSG-34) is closed."

ENCLOSURE
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CRITERIA FOR THE SEISMIC QUALIFICATION OF THE LOWER DRYWELL STEEL PLATFORMS AND MISCELLANEOUS STEEL (CONTINUED)

The usage of the ductility ratio of 3 was and is provided in General Design Criteria BFN-50-C7100, which is the long term design criteria for this issue. The calculations reviewed by NRC, which are documented in Inspection Report 89-42, used BFN-50-C7100 as the basis for acceptance. The use of a ductility ratio of 3 was explicitly reviewed and approved by NRC for long term use.

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