UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

June 9, 1988

Docket Nos. 50-259/260/296

APPLICANT: Tennessee Valley Authority

FACILITY: Browns Ferry Nuclear Plant, Units 1, 2 and 3

SUBJECT: SUMMARY OF MEETING HELD ON MAY 18, 1988 - SEISMIC QUALIFICATION

On May 18, 1988, members of the Office of Special Projects (OSP) staff met with representatives of the Tennessee Valley Authority (TVA or the licensee). Enclosed is a list of attendees (Enclosure 1). The purpose of the meeting was to address the attached list of NRC staff questions pertaining to the interim design criteria for the seismic design program (Enclosure 2).

The licensee presented a discussion of the staff's questions on the following topics: drywell steel platforms, miscellaneous steel, conduit and conduit supports, heating ventilation and air conditioning (HVAC) ductwork and supports, seismic Class II features over seismic Class I features, and masonry walls. The TVA supplied handouts are provided in Enclosure 3.

Several issues were identified by the staff which require further information. TVA agreed to provide the following:

1. Revise submittal on drywell steel platforms to:

   b. specify a maximum allowable stress of 1.6S.

   c. address the staff's concern regarding control of temporary modifications adding loads on the drywell steel during operation.

   d. delete the criteria summary table.

   e. commit to the use of absolute sum technique for the summation of reaction loads.

2. Provide a copy of the appropriate sections of the Browns Ferry FSAR, original safety evaluation, and Blume report to document the acceptability of the current seismic model used to analyze the drywell steel.

3. Revise submittal on miscellaneous steel to remove Table 2 of Enclosure 1.

4. Verify that the HVAC test report presented to the staff during this meeting had been previously docketed or formally docket this report.

5. Revise Section 4.2.1 of the design criteria to clarify that the allowable value of 12,000 psi specifically applies to the allowable bending stress.

6. Provide a submittal on the conduit program including:

    a. a review of conduits analyzed using 15% damping.

    b. screening analysis results using 7% damping and interim criteria to demonstrate functional capability of conduit systems which have already been evaluated using 15% damping and design criteria.

    c. documentation to support the original 8000 psi allowable stress value used in the design criteria documentation to support the current value of 13,000 psi, and a discussion of the acceptability of using the higher value instead of the lower value.

    d. a revision to the design criteria which deletes Note 2 on Page V-8.

7. Provide justification to demonstrate functional capability of trapeze-type supports for gang-hung conduits. This justification will include rigorous analyses which envelop worst case configurations.

8. Provide a forecast percentage completion estimate for all seismic programs as of July 1, 1988 and provide a forecast completion date for all these programs.

Items 6(a) and 7 were discussed further in a telephone conversation held on May 24, 1988. The staff agreed to the licensee's proposal to reanalyze critical case conduits using 7% damping and an operability criteria approved by the staff. For the outliers identified during this reanalysis, the staff will review each on a case-by-case basis. The staff advised TVA to begin this reanalysis as soon as possible in order to identify any outliers in the near future. This approach is contingent upon the assumption that there are only a few outliers. For Item 7 above, the staff agrees with the licensee's approach and will review the outliers on a case-by-case basis. In the case of trapeze hangers with lateral support, the staff advised TVA to consider this an outlier needing corrective action.

The staff indicated to TVA that the information contained in Items 1 through 7 above was needed to support the staff's safety evaluation on the interim criteria, scheduled to be completed by May 31, 1988. An inspection of the seismic design programs is tentatively scheduled for July, dependent upon TVA's completion of the various programs.

Original Signed by
Janet L. Kelly, Project Engineer
TVA Projects Division
Office of Special Projects

Enclosures:
As Stated

cc w/enclosures:
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ENCLOSURE 1

MAY 18, 1988 TVA/NRC MEETING
SEISMIC ISSUES

Name	Affiliation
M. J. Ray	TVA/Licensing
M. J. May	TVA/Manager/Licensing
S. M. Kane	TVA/Site Licensing
J. K. McCall	TVA/Chief Civil Engineer
J. R. Rupert	TVA/Lead Civil Engineer
M. G. Marwell	TVA/DNE
M. Durka	SWEC
R. D. Cutsinger	TVA/DNE
R. E. Gaines	TVA/DNE
R. Kroon	TVA/DNE
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E. F. Thomas	TVA/Project Manager
W. Wang	SWEC
S. Harris	EQE
S. Eder	EQE
A. Chen	SWEC
G. E. Gears	NRC/OSP
J. L. Kelly	NRC/OSP
T. Cheng	NRC/OSP
T. Tsai	NCT Engineering/NRC Consultant

REVIEW COMMENTS ON BFN

INTERIM CRITERIA FOR SEISMIC DESIGN PROGRAM (DISCUSSION TOPICS FOR MAY 18, 1988 MEETING)

I. Drywell Steel Platforms

References:

1. Letter from R. Gridley (TVA) to NRC, "BFN - Seismic Qualification of Drywell Steel," dated March 10, 1988.

2. Letter from R. Gridley (TVA) to NRC, "BFN - Seismic Qualification of Drywell Steel - (NRC TAC No. 00302)," dated April 28, 1988.

A. Enclosure 1 and Table 1 of Enclosure 1:

1. 3rd sentence of Item 2 under Resolution Section - How were these loads generated and applied to the platform model?

2. Items 3, 5 and 6, under Resolution Section - If modifications are needed as a result of evaluation, why are the interim operability criteria instead of long term criteria (or design criteria) to be used for the design of modifications.

3. Licensing Issue - Provide basis for changing the factor "1.6" to "1.7" (References 1 and 2).

4. Item 3 of "Justification" -

(i) NRC NUREG-0800, "Standard Review Plan," was issued after BFN was licensed. It is the staff's position that this document should be used as a whole package instead of piece by piece.

(ii) The staff treated the Mark I Torus Long Term Integrity Program as a case by case evaluation. Therefore, the criteria accepted under this program ~~are~~ not applicable for other evaluation, e.g., BFN Seismic Design Program.

5. Table 1 -

(i) The allowable stresses for steel and weld are given as a range because of the use of "up to." Specific allowable stresses should be explicitly defined for each of different load combinations to be considered in the re-start evaluation.

(ii) The "similar to" in the remark for the concrete anchor criteria is unspecified and should be clearly defined.

(iii) What are the allowables for steel members under compression and bending.

(iv) What are the allowable tension and shear stresses for bolts.

(v) Provide comparison of "1.7 x AISC" with "0.9 FY." Is there any possibility that 1.7 x AISC will be higher than 0.9 FY? If the answer is yes, what is the basis for allowing steel members to respond close to or beyond the elastic limit?

B. Enclosure 2:

1. Section 1.3.1 states that this criteria document applies only to steel members inside the drywell at Elevation 584'-11" and El. 563'-2" including miscellaneous steel for these elevations. What criteria (or document) will be applied to upper steel platforms at Els. 604', 616' and 628'?

2. Section 2.0 - Since the plant structures were designed in the laste 60's, why the 1978 AISC Specification instead of 1963 AISC Steel Construction Manual is to be used for the reevaluation or structural design?

3. Section 3.1.8 - Detailed explanation is needed for how this section will be applied to the steel platform evaluation. A meeting presentation is recommended.

4. Section 3.2 -

   (i) Define the relationship between Table 3.2.1 and Table 1 of Enclosure 1.

   (ii) This section equires evaluation of the potential for the radial platform support beams lifting off the beam seats. What are the safety factor (or factor of safety) against lift-off for the interim and long term evaluation criteria?

5. The current document does not consider jet impingement loads, Yj. This may have violated the original FSAR commitment, as pointed out during the 4/18/88-4/22/88 DBVP inspection by NRC staff and consultants.

6. First Paragraph of Section 4.0 - The AISC "Specification for Design,....of Structural Steel for Buildings," 8th Edition does not contain the analysis procedures, assumptions for boundary conditions, etc.

7. Page F-9 - Detailed explanation of the "BFN-50-C-7100 Discrepancies" discussed in this page is needed.

8. Section 3.1.1 - Compare the definition of "Dead Load" in this criteria document with the definition of "Dead Load" described in the FSAR and justify why the same dead load of 40 psf is specified in both this criteria document and FSAR.

9. Section 3.1.3 - Justify why the live load "L" is assumed to be zero for the purpose of the initial evaluation using this criteria?

II. Miscellaneous Steel

References:

1. Letter from R. Gridley, TVA to NRC, "Seismic Qualification of Miscellaneous Steel," dated March 10, 1988.

2. Letter from R. Gridley, TVA to NRC, "Seismic Qualification of Miscellaneous Steel - (NRC TAC No. 00296)," dated April 28, 1988.

A. Enclosure 1 and Tables 1 and 2 of Enclosure 1:

1. The scope of the program should be clearly defined, e.g., what are the 350 miscellaneous steel frames as mentioned in the first paragraph of "Resolution?"

2. For allowable bolt tension stress, the margin implied by the use of 0.7 Fu when Fy is not available is inconsistent with the margin implied by the use of Fy. To have a comparable margin, 0.7 Fu should be reduced to 0.6 Fu or lower.

3. What is the allowable shear stress for bolt?

4. The critical load F_{cr} should be clearly defined and the procedure for calculating F_{cr} should also be provided for review.

B. Enclosure 2:

1. Section 2, Scope - Which are the miscellaneous steel structural members to be qualified by the design criteria BFN-50-C-7100, Attachment G and which are the structural members to be qualified by this interim criteria?

2. It seems to us that there is only one load combination (Abnormal Accident & DBE) to be considered in this criteria document. How about other load combinations?

III. Conduit and Conduit Supports

References:

1. Letter from R. Gridley, TVA to NRC, "Seismic Design Issues - Response to Request for Additional Information," dated April 8, 1987.

2. BFN Program Document, "Inspection and Seismic Qualification of Existing Electrical Conduit and Conduit Supports," dated October 16, 1986.

3. BFEP-PI 85-02, "Seismic Qualification of Existing Electrical Conduit and Conduit Supports," dated October 15, 1986.

4. Design Criteria BFN-50-723, "Seismically Qualifying Conduit Supports, dated March 26, 1986.

5. Design Criteria BFN-50-C-7104 (RI), Section 5.0.

A. Reference 1: The 15% damping for size 0.5" to 1.5" aluminum conduit and 10% damping for size 2" to 3" aluminum conduit as specified in Page 2A-1, are not acceptable. The staff position is 7% damping for both aluminum and steel conduit in all sizes.

B. Reference 2: The use of earthquake experience data to qualify electrical conduit and supports as discussed in Section IV is not acceptable to the staff. Same approach taken for SQN Unit 2 restart should be applied for BFN conduit (including supports) evaluation.

C. Reference 3:

   1. This document requires that both Class IE and Non-Class IE conduit are to be inspected and seismically qualified. What are the criteria for Non-Class IE conduit and conduit supports?

   2. Section 4.6.4 of Appendix B state that torsion analysis of unistrut type framing members should be in accordance with the book, "Formula for Stress and Strain," by R.J. Roark. Does TVA intend to allow unistrut framing members to be subjected to significant torsional stress such as in the case of a double cantilever support? Unistrut type framing members are very weak for torsional stresses.

D. Reference 4:

   1. For aluminum conduit 6063-T1 or similar, a Sy = 13000 psi is specified in Page 5. This is inconsistent with the Sy = 9000 psi as specified in SQN design criteria DC-V-13.0 for the same material. The observed test results that the aluminum subjected to stresses greatly exceeding 13000 psi did not show visible damage or permanent distorsion, do not necessarily justify that 1300 psi may be considered as the yield stress.

   2. This document does not explicitly specify the criteria for junction boxes and, hence, should refer to the criteria specified in Subsection 4.6.5 of Appendix B to BFEP-PI 85-02 (Reference 2), i.e., junction boxes should be reviewed for adequacy as a 3-way support and, in such case adequacy cannot be established, a support should be installed within 12" of the box.

E. Reference 5:

1. Section 5.3.1 -

   (i) Justify why a 4-span model but not a 3- or 5-span model is the more conservative representation of the conduit system for the seismic analysis.

   (ii) In the footnote for minimally oversized fittings, provide the basis for the criteria that fittings or other concentrated weights not exceeding 15% of the span weight may be used without additional analysis or any span on any two consecutive spans but may not be used on cantilever ends or three conservative spans.

2. Section 5.3.1 - (See Question A)

3. Section 5.3.3 - Clarify the criteria that an attached box should be considered as a support point for the purpose of conduit span and load determination when the box is not attached to a building superstructure or other appropriately rigid structure.

4. Section 5.3.4 - The requirements discussed in this section are applied to aluminum conduit. What is the corresponding provision for line supported boxes on steel conduit?

5. Section 5.4.1 - (See Question D.1)

6. Note 2 on Page V-8 - Clarify the statement "designing to the above stress limits using load combination D+E will ensure adequate design for all conditions except that for vertical loads, D+E case governs for support design."

7. Appendix 5-C - This appendix applies to aluminum conduit cantilevers only. What is the corresponding provision for steel conduit cantilevers?

8. What is the criteria for conduit connected to piping systems or equipment?

IV. <u>Heating Ventilation and Air Conditioning (HVAC) Ductworks and Supports</u>

References:

1. Letter from R. Gridley, TVA to NRC, "Seismic Qualification of HVAC Ductwork and Supports," dated March 10, 1988.

2. Letter from R. Gridley, TVA to NRC, "Seismic Qualification of HVAC Ductwork and Supports," dated May 4, 1988.

4. Design Criteria BFN-50-C-7104(RI), Section 3.0.

A. References 1 and 2:

1. Table 1 of Enclosure 1

(i) What is the allowable shear stress for bolt?

(ii) 0.9Sy for the allowable compression stress as specified in the design criteria is not acceptable to the staff.

(iii)See Question II.A.2

2. Enclosure 2 -

(i) From reviewing this document, it seems to us that the test was done under a pure bending loading condition. If our understanding is true, the justification of using 1.5 factor is not acceptable, because the stress state for the real loading condition is much complicated than the pure bending case. It should be a combination of compression (or tension), shear, and bending.

(ii) The test report should be submitted for review.

3. What are the damping values used in the ductwork analysis for both interim and long term evaluation?

4. Describe the method for computing the sectional properties of ductworks in the analysis, to account for (a) rectangular vs. circular ducts, and (6) full section duct vs cut-out duct (e.g., registers)?

B. Reference 3:

1. Section 4.2.1

(i) (See Question A.2.i above)

(ii) Reference 7.1, which provides basis for the allowable bending stresses should be submitted for review.

(iii)What are the allowable shear stresses?

2. Section 4.2.2

(i) (See Question II.A.2)

(ii) (See Question A.1.i above).

C. Reference 4:

1. In the statement on Page III-2, "as a result of siesmic testing of representative duct specimens, it has been learned that actual duct spans respond more flexibly than...," do the duct specimens refer to only rectangular ones?

2. In 3.2.2, the minimum semi-rigid range frequency is defined as the frequency at which the seismic response spectrum curve exhibits a major change after the peak. It appears difficult for an engineer to apply this definition without using very subjective judgment, and a more specific criteria is needed.

   What is the criteria for computing the effective section properties for cut-out ducts (e.g., register, grille)?

V. Seismic Class II Features Over Seismic Class I Features

Reference: Letter from R. Gridley, TVA to NRC, "Seismic Class II Features Over Seismic Class I Features," dated March 29, 1988.

A. Based on the staff's understanding that the scope of NRC USI-A46 does not include the seismically induced physical interaction of piping to piping and piping to components. Therefore, the proposed approach to consider the interaction due to the seismic-induced fluid spray only before restart is not acceptable. The staff would like to suggest that same approach taken for the SQN restart should be applied for BFN evaluation.

VI. Masonry Walls

References:

1. Safety Evaluation Report by NRC dated January 16, 1984.

2. Design Criteria BFN-50-C-7100 (RI), Attachment B.

A. According to the 1/16/1984 SER, the only masonry walls at BFN remain to be resolve are Wall No. 3, 40, 74 and 75, which are all unreinforced solid shield blocks with non-mortared or partially mortared joints. The staff concluded that the sole use of the wall stability analysis to determonstrate the design adequacy of these four walls is not acceptable and that these walls should be upgrade such that they incorporate structural elements capable of resisting tensile stresses and can be analyzed by the use of the conventional working stress method...

Section 2.5.2 of the design criteria specifies that the non-mortared solid shield block walls will be evaluated for stability and, hence, is not acceptable.

B. The method for stability evaluation of the non-mortared solid shield block walls as specified in Section 2.5.2 is inadequate because (1) rotations of the block and hence the P-Δ effect are not considered, (ii) the frictional forces shown in Figs. 2.5.2-1 and -2 are not real forces and should not be included in the free body force diagram for checking equilibrium, and (iii) μ = 0.7 needs to be justified.

DRYWELL STEEL PLATFORMS

A. Enclosure 1 and Table 1 of Enclosure 1:

A.1 3rd sentence of Item 2 under Resolution Section--How were these loads generated and applied to the platform model?

Response: Attachments to the drywell floor were identified by plant walkdowns/drawing reviews. Loads were developed in accordance with design criteria and existing analysis. These loads were applied to a 360 degree model, results summed absolutely and the resulting stress evaluated. Based on FSAR Section 12.2.2.8.1, platform steel anchor displacements were not considered.

breaks were neglected. (See Figure 14.6-10.) Throttling from rated reactor pressure will superheat the containment atmosphere to about 320°F, whereas throttling from lower reactor pressures (<300 psia) will superheat the atmosphere to about 330°F. Thus, an upper limit of 340°F was used to evaluate the drywell vessel.

The containment stress analysis report was reviewed, and in no case did the effects of an increase of temperature from 281°F to 340°F result in calculated stresses higher than code allowable stress intensity values.

Jets that might impinge on the structure could produce local thermal effects wherein the local temperature would exceed the wall temperatures. The high conductivity in the drywell wall will relax the temperatures in the small affected area so that the temperatures are only slightly above the wall temperatures. The thermal stresses associated with these slightly elevated temperatures will be correspondingly small. Excessive stresses will be self-limiting by yielding of the material, but could lead to thermal ratcheting. However, thermal ratcheting from jets will not constitute a serious problem because of the anticipated small number of incidents expected in the life of the vessel.

The electrical penetrations were purchased with a specified short-term temperature rating of 325°F (for 15 min) and a long-term rating of 281°F. The pressure ratings for both temperatures were specified at 125 psig. (These ratings are for Units 1 and 2; Unit 3 has a higher temperature rating.)

The piping penetrations were investigated by conservatively analyzing the penetrations with the largest temperature movements in the upper part of the vessel and at the equator. The peak stresses in these penetrations were determined to be less than the stresses at the design conditions of 281°F and 56 psig. From this conservative examination, it was deduced that the stresses in the piping penetrations would be less than the allowable stress intensities for all penetrations on the vessel at a temperature of 340°F and a pressure of 30 psig. The vessel movements are definitely less than the constructional clearance built in between the penetrations and concrete pipe sleeves. Therefore, the piping penetrations in the vessel will not be a limiting factor at a condition of 340°F and 30 psig.

The safety components inside the drywell that must function following a LOCA have been sucessfully tested in a steam atmosphere at higher temperatures than the containment design temperature of 281°F.

12.2.2.8 Dynamic Earthquake Analysis

12.2.2.8.1 Reactor Building Structure

Discussion of Analysis

The dynamic analysis of the Reactor Building is performed using a lumped mass model. The model consists of eight masses lumped at the five floors, the roof, the elevation of the seismic support of the suppression chamber, and the crane rail of the superstructure. These masses are considered supported by weightless, elastic columns having flexural and shearing deformation characteristics. The equations of motion are generated in matrix form and solved using the normal mode approach. The resulting differential equations are then solved using the actual earthquake record for the El Centro, May 1940 earthquake N-S component normalized so that the maximum ground acceleration is 0.10g. A value of 5% of critical damping is used for all modes of vibration. Three modes of vibration are used in computing the response. These computations were performed by the consulting firm of John A. Blume and Associates for TVA. However, TVA performed a parallel dynamic analysis after developing the required computer programs. A very adequate check is obtained for the Operating Basis Earthquake (0.1g) as shown in Figures 12.2-26 through 12.2-33.

In order to check equipment attached to the building for seismic effects, the TVA consultant generated response spectra for each of the mass points. These spectra were developed in the following manner: (1) the model of the structure was subjected to the earthquake record as described above; (2) a time-history of floor acceleration was generated at the level of the floor in question; and (3) various one-degree-of-freedom lumped mass models were then subjected to this time-history of acceleration. The maximum response of these models yielded the floor response spectra when plotted against their respective periods. The integration interval used in the response calculations for the Reactor Building was 0.005 seconds. Six seconds of building motion were used in the analysis. The periods for response spectra calculations ranged from 0.05 through 2.0 seconds in increments of 1 radian per second of circular frequency. A spot check of a few of these spectra was made, and excellent agreement was obtained.

DRYWELL STEEL PLATFORM

A.2 Items 3, 5 and 6 under Resolution Section--If modifications are needed as a result of evaluation, why are the interim operability criteria instead of long term criteria (or design criteria) to be used for the design of modifications?

Response: At the time the modifications were designed, it was intended that the criteria used was adequate for long term. All design work based on the use of the criteria was completed. Subsequently, as a result of BFN's evaluation of SQN Lessons Learned, this criteria is now considered an operability criteria. Modifications designed after the R1 revision of design criteria BFN 50-C-7100 Attachment F (April 13, 1988) have been done to the long term design criteria allowable values. A significant portion of the modification work has been completed.

A.3 Licensing Issue: Provide basis for changing the factor "1.6" to "1.7" (references 1 and 2).

Response: Table 1 of Enclosure 1 was given as a "summary" to show the comparison of allowable stresses for the long term Design Criteria and allowable stresses used for operability criteria.

Actual designs conservatively limited the allowable stresses to a maximum of 1.6S for load combination G (Table 3.2.1; Lead Civil Engineer Instruction, BFEP-TI-C2). Table 1 will be deleted from the submittal.

DRYWELL STEEL PLATFORM

A.4(i) NRC NUREG-0800, "Standard Review Plan", was issued after BFN was licensed. It is the staff's position that this document should be used as a whole package instead of piece by piece.

Response: The use of NUREG-0800 "as a whole" would be appropriate for evaluations which would redefine the plant's design basis which is not the purpose of the operability criteria. For restart, reference to the NRC-NUREG-0800 is made only to emphasize an approach of using allowable stresses as factored AISC code allowable values for various load combinations.

The use of these allowable stresses with corresponding load combinations for restart evaluations is appropriate since they are representative of industry-wide acceptance standards.

DRYWELL STEEL PLATFORM

A.4(ii) The Staff treated the Mark I Long Term Torus Integrity Program as a case by case evaluation. Therefore, the criteria accepted under this program are not necessarily to be acceptable for other evaluation, e.g. BFN Seismic Design Program.

Response: The acceptability of the allowable stresses used in the operability criteria is discussed in the response to question 4(i). We feel the adequacy of those stresses stand on its own and is further supported by the staff's approval of similar allowable stresses for the LTTIP Program.

DRYWELL STEEL PLATFORM

A.5(i) Table 1:

The allowable stresses for steel and weld are given as a range because of the use of "up to". Specific allowable stresses should be explicitly defined for each of different load combinations to be considered in the re-start evaluation.

Response: Specific allowable stresses for interim operation are explicitly defined in Table 3.2.1 of the BFNP Operability Criteria for Drywell Steel Platform, Lead Civil Engineer Instruction (LCEI), BFEP-TI-C2. Table 1 will be deleted from the submittal.

DRYWELL STEEL PLATFORM

A.5(ii) The "similar to" in the remark for the concrete anchor criteria is unspecific and should be clearly defined.

Response: The operability factors of safety for concrete anchorages in the drywell are the same as for the pipe support operability criteria. For the drywell steel platform evaluations, there are no concrete anchorages at Platform Elevation 563 and 584.

DRYWELL STEEL PLATFORM

A.5(iii) What are the allowables for steel members under compression and bending?

Response: Allowable stresses under axial compression vary with the slenderness ratio and are computed in accordance with the AISC code. These allowable stresses are increased by the appropriate factors in the Operability Criteria LCEI-BFEP-TI-C2.

Allowable bending stresses are established in accordance with the AISC code. For combining axial compressive and bending stresses, the interaction equation with the limiting value of 1.0 is used (Reference Sections 1.5.1.4 of AISC).

DRYWELL STEEL PLATFORM

A.5(iv) What are the allowable tension and shear stresses for bolts?

Response: Allowable stresses for bolts for operability criteria are as follows:

For tension, maximum allowable = 1.6 x 0.6Fy* = 0.96Fy

For shear, maximum allowable = 1.6 x 0.4Fy** = 0.64Fy

*AISC Section 1.5.1.1

**AISC Section 1.5.1.2.1

5/19/88

DRYWELL STEEL PLATFORM

A.5(v) Provide comparison of "1.7 x AISC" with "0.9 Fy". Is there any possibility that 1.7 x AISC will be higher than 0.9 Fy? If the answer is yes, what is the basis for allowing steel members to respond close to or beyond the elastic limit?

Response: The 1.7 x AISC allowable stress was not used in the design. The controlling design case employed the 1.6 x AISC allowable stress. Comparison of 1.6 x AISC allowables with 0.9 Fy is shown below.

Bending	
Compact	S = 0.66 Fy
Sections	1.6S = 1.056 Fy
Bending	
Non-Compact	S = 0.6 Fy
Sections	1.6S = .96 Fy
Bending	S = 0.75 Fy
Weak Axis	1.6S = 1.2 Fy

Stresses exceeding yield occur only locally at the maximum bending moment location, and since plastic

A.5(v) (Con't)

moment capacities provide additional margins on the elastic moment capacities, the use of these SRP Load combinations and allowable stresses for Operability Criteria is acceptable. Steel members with localized extreme fiber stress levels resulting from the transient loads being considered in these designs perform in a stable and satisfactory manner.

DRYWELL FLOOR STEEL

B. Enclosure 2:

B.1 Section 1.3.1 states that this criteria document applies only to steel members inside the drywell at Elevation 584'-11" and El 563'-2" including miscellaneous steel for these elevations. What criteria (or document) will be applied to the evaluation of the upper steel platforms at El 604', 616' and 618'?

Response: Browns Ferry Design Criteria, BFN-50-C-7100 R1 attachment G (Miscellaneous Steel Components for Class I and II Structures) is used for the evaluation of the upper steel platforms in the drywell. An Operability Criteria was not used for the platforms at EL 604', 616' and 618'.

DRYWELL FLOOR STEEL

B.2 Section 2.0--Since the plant structures were designed in the late 60's, why the 1978 AISC Specification instead of 1963 AISC Steel Construction Manual is to be used for the re-evaluation of structural design?

Response: In consultation with AISC the following has been determined:

- Some facets of the 1963 AISC Code were determined to be conservative and some were determined to require additional emphasis.

- This was determined as a result of testing, analysis and inplace structural performance which reflected that some facets of the structures behaved differently than previously thought. As a result, ultimate behavior and performance were better defined.

- AISC reflected these results in the issuance of the 1969 and 1978 editions of the Code.

- In those instances where allowable stresses were increased due to the better definition of increased ultimate behavior, the previous margins between the allowable stress and ultimate were maintained.

- In those instances where it was determined that additional emphasis on various structural facets were required, the Code was revised to define additional requirements for evaluation of the structures. (These new requirements are identified in a report by Franklin Research Center for the Systematic Evaluation Program.)

  As noted in this report, the 1978 AISC Code with its new requirements can have a significant impact on previously established margins of plants that were designed to the 1963 AISC Code that did not contain these requirements. The issue here is that the structures may not be capable of meeting the new requirements of the 1978 Code and maintain the original margins or allowable stresses.

Based on the above, it is TVA's position that the 1978 AISC Code is a fully acceptable code in lieu of the Browns Ferry code of record, the 1963 AISC Code, for restart evaluations.

B.2 (Con't)

It is understood that use of the 1978 AISC Code on a long-term basis would require comparisons and evaluations of the code provisions with the 1963 AISC Code and NRC staff approval.

DRYWELL FLOOR STEEL

B.3 Detailed explanation is needed for how this section will be applied to the steel platform evaluation. A meeting presentation is recommended.

Response: The objective of section 3.1.8.1 of BFN-50-C-7100, Attachment F, Enclosure 2 to submittal dated April 28, 1988, is to provide a method of combining dynamic loads on the drywell steel platforms by the square root of the sum of the squares (SRSS). For this evaluation, however, the phasing was not considered and absolute summation of all loads was performed.

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DRYWELL STEEL PLATFORM

B.4(i) Define the relationship between Table 3.2.1 and Table 1 of Enclosure I.

Response: See response to Question A.5(i)

5/19/88

DRYWELL STEEL PLATFORMS

B.4(ii) This section requires evaluation of the potential for the radial platform support beams lifting off the beam seats. What are the safety factor (or factor of safety) against lift-off for the interim and long term evaluation criteria?

Response: Evaluation of beam lift off has been performed which indicates that lift off does not occur. There is not a required minimum factor of safety associated with this evaluation.

DRYWELL STEEL PLATFORMS

B.5 The current document does not consider jet impingement load, Yj This may have violated the original FSAR commitment, as pointed out during the 4/18/88-4/22/88 DBVP inspection by NRC staff and consultants.

Response: TVA's position is that there is no violation of the FSAR requirements. This question will be resolved under the DBVP Calculation Effort inspection response.

Primary emphasis for jet impingement protection inside the drywell for Browns Ferry and other similar vintage plants was directed toward protecting the drywell containment. This containment protection for both pipe whip and jet impingement is described in detail throughout the FSAR. The sacrificial shield wall was designed for "Jet loads" (pipe whip), since the whip restraints for the recirculation system piping are attached to the structure. However, jet impingement loading was not a design basis for the drywell access platforms.

FSAR section 12.2.2.7.1 identifies loading conditions which were applied to the drywell platforms. The term "jet" refers to the reaction force of mitigating devices (which could be attached to the platforms) subjected to pipe break loadings.

The main steam and feedwater pipe whip restraints at the drywell penetrations at 180 degrees azimuth are designed to transfer rupture loads from the process piping to the reactor pedestal and to the concrete at elevation 549.92 without significantly loading the drywell steel, thereby maintaining the design basis for the structure.

Attachment F to Design Criteria BFN-50-C-7100 establishes the criteria for the lower drywell access platforms consistent with the above. Yr is the equivalent static load on the structure generated by the pipe whip reaction from pipe rupture restraints attached to the drywell steel.

The AEC guidance for pipe rupture design for nuclear plants, prior to the issuance of the Giambusso letter in late 1972 for outside containment and Regulatory Guide 1.46 for inside containment in May 1973, was minimal. From our review of the BFN Safety Evaluation Report (SER), it is clear that AEC emphasis was being directed toward protecting the containment shell against the primary effects of pipe whip and jet

B.5 (Con't)

impingement. The AEC conclusion after review of the pipe rupture effort inside the drywell was that "the probability of violating the integrity of the containment is acceptably low."

DRYWELL STEEL PLATFORMS

B.6 First paragraph of Section 4.0--The AISC "Specification for Design of Structural Steel for Buildings", 8th Edition does not contain analysis procedures, assumptions for boundary conditions, etc.

Response: TVA agrees that the AISC does not contain detailed analysis procedures. The requirements of section 4.0 are that the analyses and designs be performed in a manner compatible with the requirements of the AISC code.

B.7 Page F-9--Detailed explanation of the "BFN-50-C-7100 Description" discussed in this page is needed.

Response: This page, F-9, was a listing of the findings identified during the development of the BFN long-term civil design criteria. These findings, along with others, were resolved in the development of the R1 version of the long-term criteria. The findings and their resolution were covered as a part of the NRC inspection of the DBVP calculation.

There is no impact of the Operability Criteria (LCEI-BFEP-TI-C2) Drywell Platform Steel.

DRYWELL STEEL PLATFORMS

B.8 Section 3.1.1--Compare the definition of "Dead Load" in this criteria document with the definition of dead load as described in the FSAR same dead load of 40 psf is specified in both this criteria document and FSAR.

Response: In the FSAR, the dead load of the beams and the grating are defined as 40 psf. In the operability criteria, the dead load is defined as the weight of the structural steel, permanent equipment and attached systems and is to be taken as a minimum of 40 psf. During the evaluation of the platform structures, the platforms were walked down and all attachments were identified. The major attachment loads were specifically applied to the structure and the smaller attachment loads were considered as a part of the 40 psf uniform dead load. Grating dead load was also included in the 40 psf. All attachment loads were considered in the design of the platform structure.

DRYWELL STEEL PLATFORMS

B.9 Section 3.1.3--Justify why the live load "L" will be assumed to be zero for the purpose of the critical evaluation using this criteria?

Response: In place attached loads have been accounted for in the evaluation of the drywell floor steel framing. Live loads (L) are assumed to be zero during operation, since the drywell is inerted with nitrogen and as such no activities will be occurring during operation of the plant.

Live loads are expected to occur during outage and maintenance activities. These live loads (Lo) are included in the appropriate load combinations.

MISCELLANEOUS STEEL

A. Enclosure 1 and Tables 1 and 2 for Enclosure 1:

A.1 The scope of the program should be clearly defined, e.g. what are the 350 miscellaneous steel frames as mentioned in the first paragraph of "Resolution?"

Response: Approximately 350 miscellaneous steel frames are structural steel frames provided specifically to support various piping systems associated with the 79-14 Program throughout the Browns Ferry Nuclear Plant - Unit 2. These frames are based on the typicals shown on drawing 48N1005 entitled "Miscellaneous Steel Pipe Support and Anchors - Typical Details.

MISCELLANEOUS STEEL

A.2 For allowable bolt tension stress, the margin implied by the use of 0.7 Fu when Fy is not available is inconsistent with the margins implied by the use of Fy. To have a comparable margin, 0.7 Fu should be reduced to 0.6 Fu or lower.

Response: For comparison purposes, Fu and Fy values for A325 and A307 bolts are as follows:

Bolt Diameter	Fu	Fy	Fy/Fu
A325 1/2" to 1"	120 ksi	92 ksi @ 2% Offset	0.77
1-1/8-1-1/2"	105 ksi	81 ksi @ 2% Offset	0.77
A307	60 ksi Min 100 ksi Max	Not defined	

Where Fy is not available, 0.7 Fu will be used in accordance with F-1335.1 of Section III, Division I Appendices of ASME Code.

MISCELLANEOUS STEEL

A.3 What is the allowable shear stress for bolts?

Response: Allowable shear stress for bolts for as follows:

Operability Criteria	0.6Fy
Long term Criteria	$0.9Fy/\sqrt{3}$

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MISCELLANEOUS STEEL

A.4 The critical load F_{cr} should be clearly defined and the procedure for calculating F_{cr} should also be provided for review.

Response: F_{cr} is defined as the Euler Buckling load for a column with appropriate boundary conditions. Evaluation of compressive stress allowables is done in accordance with Section 1.5.1.3 of AISC with the appropriate upper stress limitation of 0.9 F_{cr}.

MISCELLANEOUS STEEL

B. Enclosure 2, Section 2, Scope

B.1 Which are the miscellaneous steel structural members to be qualified by the design criteria BFN-50-C-7100, Attachment G and which are the structural members to be qualified by the interim criteria?

Response: All miscellaneous steel structural members are evaluated first for qualification using the design criteria, BFN-50-C-7100, Attachment G. Steel members which are not qualified using the design criteria are evaluated for adequacy using the operability criteria. Members which fail to qualify under the operability criteria will be modified to meet the long term design criteria.

MISCELLANEOUS STEEL

B.2 It seems to us that there is only one load combination (Abnormal Accident + DBE) to be considered in this criteria document. How about other load combinations?

Response: The Operability Criteria for miscellaneous steel members is used to assess the restart adequacy of steel members which do not meet long term design criteria. As such other load combinations are not considered as critical for operability determinations for safe shutdown of BFN Unit 2.

HVAC DUCTWORK AND SUPPORTS

A.1(i) What is the allowable shear stress for bolts:

Response: Allowable shear stress for bolts is as follows:

Operability Criteria	0.6Fy
Long-Term Criteria	$0.9Fy/\sqrt{3}$

HVAC DUCTWORK AND SUPPORTS

A.1(ii) 0.9 Fy for the allowable compressive stress, as specified in the design criteria, is not acceptable to the staff.

Response: The long-term design criteria allowable compressive stress is computed per AISC Specification 1.5.1.3 with an 1/3 increase for seismic loadings, but in no case will exceed .9 of critical buckling.

HVAC DUCTWORK AND SUPPORTS

A.1(iii) For allowable bolt tension stress, the margin implied by the use of 0.7 Fu when Fy is not available is inconsistent with the margins implied the use of Fy. To have a comparable margin, 0.7 Fu should be reduced to 0.6 Fu or lower.

Response: See response to Miscellaneous Steel question A.2.

HVAC DUCTWORK AND SUPPORTS

A.2(i) Enclosure 2

From reviewing this document, it seems to us that the test was done under a pure bending condition. If our understanding is true, the justification of using 1.5 factor is not acceptable, because the stress state of the real bending condition is much complicated than the pure bending case. It should be a combination of compression (or tension), shear, and bending.

Response: The TVA program tested duct specimens to failure or test machine limits.

The tests brought both shear and bending into play by tuning of the structural response and excitation of out-of-plant modes.

The full scale dynamic tests, instrumented with strain gages, have shown stresses in the order of 18 ksi without structural distress. The maximum calculated bending stress at the qualification level (6.4 g in test report) is equivalent to 2.25 times the allowable bending stress (8000 psi) from SMACNA. A factor of 1.5 was selected for operability criteria, resulting in a factor of safety of 2.25/1.5 or 1.5 relative to the qualification level for the conditions

A.2(i) (Con't)

of the test report. However, the Browns Ferry response spectra is much lower than that used in the test report. In conclusion, the 12 ksi operability stress limit still shows an additional 50 percent margin against the worst case measured stress found in the physical test program at which structural integrity was maintained.

HVAC DUCTWORK AND SUPPORTS

A.2(ii) The test report should be submitted for review

Response: Please find attached report MA2-79-1 dated June 16, 1979.