TVA

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

MAY 08 1991

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

Gentlemen:

In the Matter of the Application of	)	Docket Nos. 50-390
Tennessee Valley Authority	)	50-391

WATTS BAR NUCLEAR PLANT (WBN) - RESPONSES TO REQUESTS FOR ADDITIONAL INFORMATION (RAIs) ON NRC REVIEW OF WBN FINAL SAFETY ANALYSIS REPORT (FSAR) AMENDMENTS 54 THROUGH 64, JANUARY 4, 1991

The NRC safety evaluation report for the review of WBN FSAR Amendments 54 through 64 categorized several issues as open, and correspondingly documented several requests for additional information. The purpose of this submittal is to transmit information on a number of these items to the staff.

Included as enclosures to this letter are TVA's responses on the following open issues:

1. Verification of consideration of mass eccentricities in the Set B and Set C analysis model for the steel containment

2. Safety classification of cable trays and conduits

3. Conduit damping

4. Equipment qualification (IEEE 344-1975 and IEEE 344-1971)

5. Structural and geosciences issues

6. Number of Operational Basis Earthquake (OBE) Events

A053
1/1

U.S. Nuclear Regulatory Commission

MAY 08 1991

The remaining RAIs have been addressed by separate submittals or will be discussed further with the staff in scheduled meetings as follows:

7. Use of multi-mode factor of 1.2 versus 1.5 - subject to further staff discussion regarding calculation

8. Basis for Design Basis Accident (DBA) spectra for the steel containment vessel - response submitted January 29, 1991, M. J. Burzynski to NRC Document Control Desk

9. Revised response to NRC RAI on Bulletin 79-02 - submitted January 31, 1991, M. J. Burzynski to NRC Document Control Desk

10. Feedwater Check Valve Slam Reanalysis - NRC plant walkdown anticipated during May 1991

11. Minimum Load Study for Category I Supports - submitted April 18, 1991, R. H. Shell to NRC Document Control Desk

12. Category I(L) Piping Verification - Information provided to staff in FSAR audit of November 1990

13. Pressure Relief Devices - Information provided to staff in FSAR audit of November 1990

As previously discussed with the staff, the transmitted issue resolutions will be incorporated into a subsequent FSAR amendment. No new commitments are contained in this submittal

If there are any questions, please telephone P. L. Pace at (615) 365-1824.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

Mark J. Burzynski for

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

Enclosures
cc: See page 3

MAY 08 1991

Enclosures
cc (Enclosures):

Ms. S. C. Black, Deputy Director
Project Directorate II-4
U.S. Nuclear Regulatory Commission
One White Flint, North
11555 Rockville Pike
Rockville, Maryland 20852

NRC Resident Inspector
Watts Bar Nuclear Plant
P.O. Box 700
Spring City, Tennessee 37381

Mr. P. S. Tam, Senior Project Manager
U.S. Nuclear Regulatory Commission
One White Flint, North
11555 Rockville Pike
Rockville, Maryland 20852

Mr. B. A. Wilson, Project Chief
U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

ENCLOSURE 1

VERIFICATION OF CONSIDERATION
OF MASS ECCENTRICITIES

Date:
Item No: CAS016A

NRC FSAR MEETING
Seismic and Civil Issues Program

Program Element: Seismic

NRC Reviewer(s): Tom Cheng/Tom Tsai/Ahmet Unsal

TVA Responsible Person: Husein Hasan

Issues Discussed/Information Presented:

Page Number: 3.7-7C Table 3.7-5B Section: 3.7.2.1.2

Mass eccentricities used in Set B and Set C analysis model for the Steel Containment Vessel.

Open Issue(s)/Request(s):

Verify whether or not mass eccentricities were actually included in the Set B and Set C analysis model for the Steel Containment Vessel.

TVA Planned Action/Position:

The steel containment is an axisymmetric structure with no eccentricity except at some localized locations such as equipment hatch and lock where minor eccentricities existed. Set A analyses of SCV included these minor eccentricities as shown in table 3.7-5B of the FSAR (revised table attached).

During the analysis of Set B and Set C, it was determined that the 5% accidental eccentricity will yield much higher eccentric responses than from the actual eccentricities which were used in Set A analysis. Therefore, the actual eccentricities were neglected in Set B and Set C analyses.

The comparison of Set A and Set B torsional moments, shown in figure A-16 (attached) of RIMS #B26 900801 162, confirmed that the actual eccentricities have negligible effects on Set B and Set C results. WAm 5/1/91

FSAR Section 3.7.2.1.2 and Table 3.7-5B will be revised to clarify the use of mass eccentricities in Set A, B, and C analyses.

Item Closed

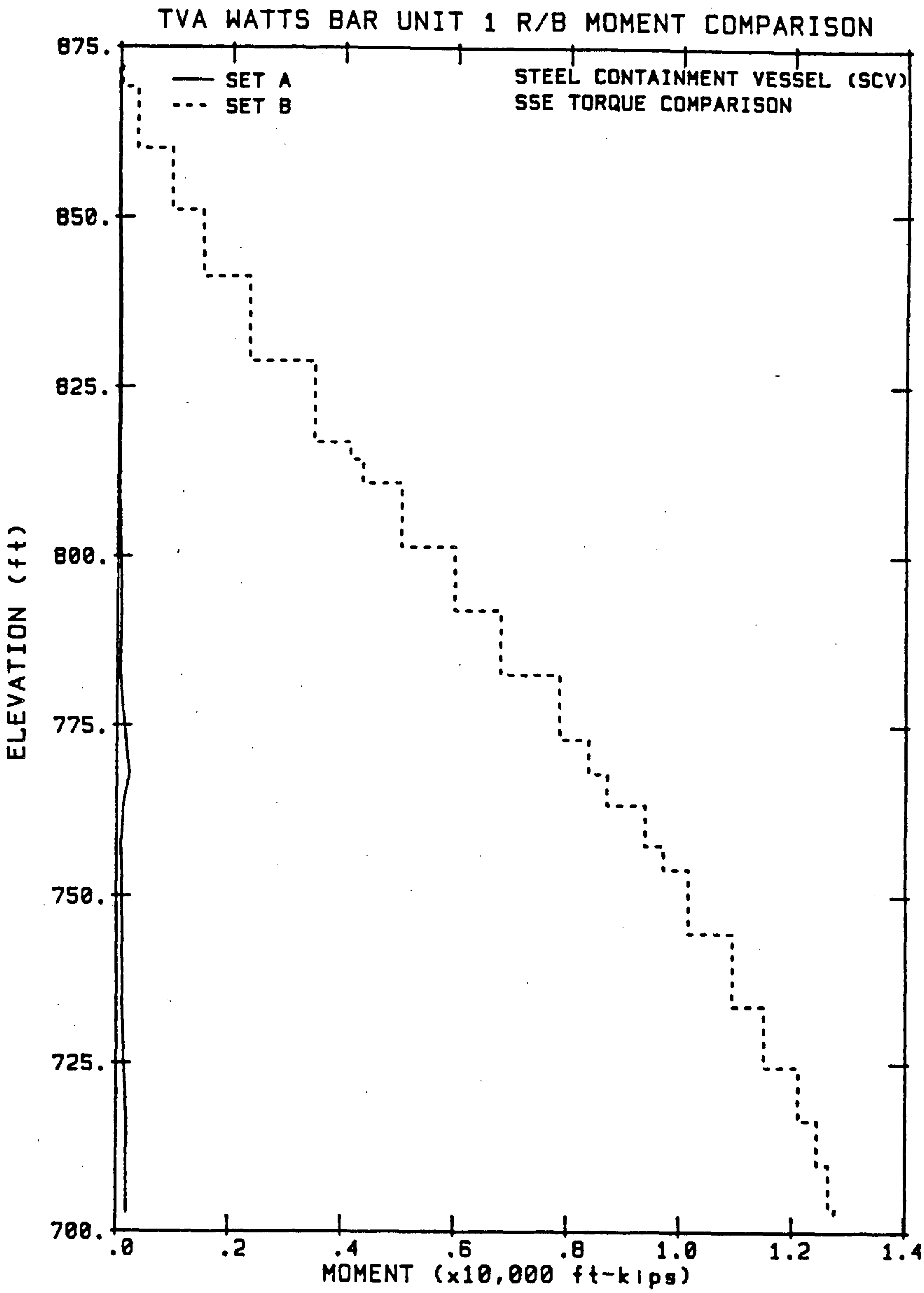
Prepared By: Husein A. Hasan 4/11/91

Reviewed By: L. E. [signature] 4/12/91

Approved By: [signature] 4/15/91

2470M

Figure A-16 SSE TORSIONAL MOMENT COMPARISON



properties, except the axial area, located at the centers of rigidity for shear and torsional deformations. The final configuration of the 3-D stick model for the ICS is shown in Figures 3.7-8A, and 3.7-8B.

Mass and member element properties are summarized in Tables 3.7-6A and 3.7-6B. Mass properties are unchanged from those of the original analysis (See Table 3.7-7).

Steel Containment Vessel (SCV)

The dynamic model for the SCV Set B and Set C analyses is represented by a 3-D lumped mass, concentric single stick model as shown in Figure 3.7-7A. The model consists of 23 lumped masses interconnected with 23 elastic beam elements and a vertical SDOF system located at the dome spring line elevation (El. 814.5') to represent the fundamental vertical mode of the dome. Mass and member element properties are defined in Table 3.7.5C. Except for the SDOF vertical model, the model configuration, lumped masses, and elastic beam element properties are the same as those used in the original design basis seismic analyses (Set A analyses). The SDOF vertical dome model for SCV was developed by matching the frequency and effective modal mass of the SDOF system with those of the fundamental vertical mode of the dome obtained from a separate finite element modal analysis.

Auxiliary Control Building (ACB)

The Set B and Set C three-dimensional lumped parameter fixed-base model of the Auxiliary Control Building is shown in Figure 3.7-9A. The centers of mass and centers of rigidity were modeled at their actual geometric locations as defined in Table 3.7-9A. The element properties and masses are unchanged from the original analysis, and they are listed in Tables 3.7-9 and 3.7-10.

The dynamic analysis was performed by the time-history modal analysis technique. Structural responses were computed and floor ARS were generated for the same locations as Set A. For Set C, since the structure damping ratios for OBE and SSE are the same (5%), the OBE responses were computed and the SSE responses were obtained by doubling the OBE responses. Separate OBE and SSE analyses were performed for Set B using structure damping ratios of 4 percent for OBE and 7 percent for SSE.

Essential Raw Cooling Water Intake Pumping Station (IPS)

The ERCW Intake Pumping Station original analysis model is updated to consider torsional effects. It incorporates rotatory inertia and the eccentricities between the centers of mass and centers of rigidity. No lateral soil springs were included as these had been determined from previous analyses to produce a negligible soil-structure interaction effect. The highest water level was used for both the SSE and OBE earthquakes, since this condition yields the lowest frequency and hence would produce the highest response levels. The Set B and Set C IPS model is shown in Figure 3.7-11A. Table 3.7-15A presents the element properties. Tables 3.7-16A and 3.7-16B define the weight properties and coordinates of centers of mass and centers of rotation, respectively.

INSERT AA

During the analysis of Set B and Set C, it was determined that the 5% accidental eccentricity will yield much higher eccentric responses than from the actual eccentricities which were used in Set A analysis. Therefore, the actual eccentricities were neglected in Set B and Set C analyses. However, 5% accidental eccentricity was used to calculate torsional moments.

TABLE 3.7-58

STEEL CONTAINMENT VESSEL
MASS POINT PROPERTIES

Elevations, Ft	Total Horizontal Weight, Kips	Total Vertical Weight, Kips	Weight of Inertia WR^2 $K\text{-}Ft^2$	Eccentricity Used in ~~Structural Response Calculations~~ Dynamic Analysis's, Ft	~~Eccentricity Used in Response Spectra Calculations, Ft~~ *
703.78	91.87	91.87	305×10^3	0.0	~~5.75~~
710.00	147.60	147.60	491×10^3	2.43	~~5.75~~
716.50	227.64	227.64	754×10^3	0.995	~~5.75~~
724.50	393.44	393.44	$1,301 \times 10^3$	0.0	~~5.75~~
733.50	335.23	335.23	$1,108 \times 10^3$	-0.033	~~5.75~~
[illegible]44.50	424.10	409.28	$1,402 \times 10^3$	0.57	~~5.75~~
[illegible]	220.28	190.94	728×10^3	-1.53	~~5.75~~
[illegible]	158.12	137.75	523×10^3	-0.82	~~9.60~~
[illegible]	310.98	288.44	$1,028 \times 10^3$	0.99	~~5.75~~
768.00	145.52	125.07	481×10^3	1.23	~~5.75~~
773.00	222.08	191.02	734×10^3	0.25	~~5.75~~
782.50	407.87	367.35	$1,349 \times 10^3$	-0.13	~~5.75~~
792.00	295.51	254.97	977×10^3	-0.105	~~5.75~~
[illegible]1.50	318.18	283.31	$1,052 \times 10^3$	-0.052	~~5.75~~
[illegible]1.50	216.89	205.01	717×10^3	-0.075	~~5.75~~
814.50	69.60	64.17	229×10^3	-0.036	~~5.75~~
817.00	192.21	185.28	630×10^3	0.0	~~5.75~~
829.00	302.84	302.84	933×10^3	0.0	~~5.74~~
841.46	183.10	183.10	485×10^3	0.0	~~5.56~~
851.00	114.66	114.66	227×10^3	0.0	~~5.08~~
860.00	155.67	155.67	192×10^3	0.0	~~4.44~~
867.00	84.00	84.00	386×10^2	0.0	~~3.52~~
872.00	23.25	23.25	186×10	0.0	~~1.83~~
					~~0.0~~

~~* These values were used in Set B and Set C analyses to calculate the torsional moments.~~

64

ENCLOSURE 2

CLASSIFICATION OF CABLE TRAYS
AND CONDUIT

Item No: CG0005A
WF0001A
WF0002A

NRC FSAR MEETING
Seismic and Civil Issues Program

Program Element: Cable Tray and Conduit

NRC Reviewer(s): Paul Besler and Joe Braverman

TVA Responsible Person: John Ellis and Tom Cureton

Open Issue(s)/Request(s):

FSAR sections 3.10.3.2 and 3.10.3.3 require clarification regarding qualification approach for safety related cable trays and conduit.

TVA Planned Action/Position:

The required FSAR change is presented in the following sheets.

This supercedes any previously submitted FSAR change for these sections.

Prepared by: John Ellis

Reviewed by: Thomas Cureton Jr [signature] 4-15-91

Approved by: [signature] 4/15/91

10.3.2 Cable Trays and Supports

10.3.2.1 Cable Trays

Cable trays are designated by TVA as Seismic Category I (L) (limited structural integrity). The cable trays are designed and constructed so preclude failure, which could reduce the ability of the Category I structures, systems, or components to perform their intended safety function. The cable tray acceptance criteria is derived from the capacity envelope by limiting the allowable vertical bending moment to 80% of the ultimate capacity and the allowable horizontal bending moment to a value corresponding to a ductility factor of 3. In order to maintain ductile connections the trays are reviewed to ensure that a minimum factor of safety of 3 is maintained for the dead load effects. Cable trays are designed for the load combination of dead load plus SSE.

Replace with Attachment A

3.10.3.2.2 Supports

All cable tray supports located in Category I structures are designated seismic Category I and designed to resist seismic forces applied to the weight of trays and cables. Each support in Category I structures is designed independently to support its appropriate length of tray. Seismic load inputs are based on the methods described in Section 3.7 and the damping requirements described in Table 3.7-2.

...ays 18 inches in nominal width are normally designed for a dead load of 45 ...nds per linear foot plus an additional construction live load of 50 pounds ... linear foot. Lower trays in the tier are designed for the dead load only. ...ays 12 inches in nominal width are designed for two thirds of the above load. However, actual tray loading may be used on a case-by-case basis. The supports consist of horizontal brackets supporting each tray at approximately eight feet.

64

Replace with Attachment C

For dead loads combined with live loads and for dead loads combined with OBE loads the designs are based on the allowable stresses of the AISC Specification on Structural Steel for Buildings. For dead loads combined with SSE loads the stresses are limited to 90 percent of yield stress for the material involved.

Welding for structural supports was in accordance with the American Welding Society, "Structural Welding Code," AWS D1.1-72 as implemented by TVA General Construction Specification G-29C when specified on the drawings. Nuclear Construction Issues Group documents NCIG-01, Revision 2, and NCIG-02, Revision 0, may be used after June 26, 1985, to evaluate weldments that were designed and fabricated to the requirements of AISC/AWS. When invoked, NCIG provisions ...l be implemented as indicated in Section 3.6A.1.1.4.

3.10.3.3 Conduit and Supports

3.10.3.3.1 Conduit

...duit located in Category I structures is designated as a Seismic Category I ... The conduit is designed and constructed to preclude a failure which ...ld reduce the ability of Category I structures, systems, and components to

Replace with Attachment B

perform their intended safety function. Conduit is designed to resist gravity and SSE forces applied to the conduit and cable. A stress intensification factor is used for threaded joints.

Replace with Attachment E

3.10.3.3.2 Supports

All conduit supports in Category I structures are designed to resist gravity and SSE forces applied to the conduit and cables. Supports for conduit containing Class 1E cables are designated Category I and stresses are limited to 90 percent of the yield stress of the material involved. Seismic load inputs are based on methods described in Section 3.7 and damping requirements are defined in Table 3.7-2. Supports for conduit containing only non-Class 1E cables are designated Category I(L) and designed and constructed to preclude a failure which could reduce the ability of Category I structures, systems, and components to perform their intended safety function. 64

Welding for structural supports was in accordance with the American Welding Society, "Structural Welding Code," AWS D1.1-72 as implemented by TVA General Construction Specification G-29C when specified on the drawings. Nuclear Construction Issues Group documents NCIG-01, Revision 2, and NCIG-02, Revision 0, may be used after June 26, 1985, to evaluate weldments that were designed and fabricated to the requirements of AISC/AWS. When invoked, NCIG provisions will be implemented as indicated in Section 3.6A.1.1.4.

3.10.3.4 Conduit Banks

The Category I underground electrical conduit banks, which run from the Auxiliary Building to the Diesel Generator Building and to the Intake Pumping Station were analyzed for seismic loads by the method outlined in Section 3.7.2.1.3. The conduit banks are designed in accordance with ACI 318.71.

3.10.4 Operating License Review

3.10.4.1 TVA Supplied Instrumentation and Electrical Equipment

The results of the seismic qualification program for the Watts Bar Nuclear Plant described in Section 3.10.1, 3.10.2, and 3.10.3 are summarized by the following listing for Class 1E equipment and by Tables 3.10-1, 3.10-3, and 3.10-4. 64

	Equipment	TVA Contract No.
AC Auxiliary Power System	6.9Kv Switchgear	74C2-84376
	6.9Kv Shutdown Logic Relay Panels	75K2-85354
	6.9KV/480V Transformer	74C2-84647
	480V Switchgear	74C2-84647
	480V Motor Control Centers	74C5-84646

Attachment A

3.10.3.2.1 <u>Cable Trays</u>

Cable trays containing Class IE cables located in Category I structures are considered safety related and are designed to resist gravity and SSE forces.

Cable tray acceptance criteria are derived from testing. A factor of safety of 1.25 against the tested capacity, is maintained for the vertical moment. A ductility factor of 3 (based on test data) is used to set loading limits in the transverse direction. These limits are used in an interaction equation to evaluate tray sections for the SSE loading condition. In addition, all trays are evaluated to ensure a minimum factor of safety of 3 against test capacity, for dead load only.

Cable tray X and T fittings are evaluated for vertical loading to ensure a minimum factor of safety of 1.25 against the formation of a first hinge.

All other cable tray components are evaluated using AISI or AISC allowables (as applicable) with increase factors as allowed by Standard Review Plan section 3.8.4. Where test data is used to establish capacities, a factor of safety of 1.5 is maintained against the ultimate test load, for the SSE loading condition.

Attachment B

3.10.3.3.1 Conduit

Conduit containing Class 1E cables located in Category I structures are considered safety related and designed to resist gravity and SSE forces applied to the conduit and cable. The seismic qualification utilizes the same analysis methods as seismic Category I subsystems described in Section 3.7.3 and limits allowables stress to 90 percent of the yield stress of the conduit material. The applicable damping requirements are defined in Table 3.7-2.

Attachment C

Trays are assumed to carry a design load of 30 pounds per square foot and an additional, construction load of 30 pounds per linear foot on the top tray. Actual tray loading may be used on a case by case basis.

For load combinations and allowables applicable for cable tray supports, see Table 3.7-27.
10 5

~~Attachment 4~~

TABLE 3.~~7~~10-~~27~~5

ALLOWABLE STRESSES FOR CABLE TRAY SUPPORTS

Load Case	Allowable Stress	Load Combination
Case I	AISC Allowable	D + L
Case IA	AISC Allowable	D + E
Case IB	1.5 x AISC Allowable*	D + E + T_o
Case II	1.5 x AISC Allowable*	D + E'
Case IIA	1.5 x AISC Allowable*	D + E' + T_o
Case III	1.5 x AISC Allowable*	D + E' + P_a + T_a

* Note: Allowable stresses are limited not to exceed 0.9 F_y except for shear which is limited not to exceed 0.52 F_y and buckling which is limited not to exceed 0.9 F_{cr}.

Where

D = Deadweight

L = Live loads

E = Operating Basis Earthquake (OBE) loads

E' = Safe Shutdown Earthquake (SSE) loads

T_o = Thermal effects and loads during normal operating or shutdown conditions based on the most critical transient or steady-state condition.

T_a = Thermal effects and loads during conditions generated by the design basis accident (DBA) transient condition and including T_o.

P_a = Pressure load effects from a DBA, such as steel containment vessel (SCV) dynamic movements and cavity pressurization.

Item No: WF0001A

RESPONSE TO NRC QUESTIONS

Program Element: Cable Tray

NRC Reviewer(s): Paul Besler

TVA Responsible Person: John Ellis

In the January 29, 1991 meeting with the NRC, the NRC staff requested that TVA address the following issues:

1. Identify if Unistrut members are still installed in cable tray supports at Watts Bar.

2. Justify the applicability of the cable tray interaction (transverse-to-vertical) formula for different ductility ratios.

3. Review available literature, including the paper Mahin and Bertero, "An Evaluation of the Inelastic Seismic Design Spectra", ASCE Spring Convention, April 1978, provided by the staff during the meeting, to determine whether the limitations expressed in the paper are relevant to TVA's planned application.

4. Justify the bases for using a ductility of 3 for inelastic seismic analysis in light of the recommendations provided in NUREG/CR-1161.

5. Address how TVA's proposed use of the inelastic response spectra for cable trays conforms with the recommendations in NUREG/CR-1161 which apply to inelastic building response.

TVA Responses:

Refer to the following sheets.

Prepared by: Jorma Arros JAE

Reviewed by: John Ellis [signature] 4-15-91

Approved by: [signature] 4/15/91

QUESTION #1:

Identify if Unistrut members are still installed in cable tray supports at Watts Bar.

RESPONSE:

Unistruts are not used in the Category I cable tray supports.

QUESTION #2:

Justify the applicability of the cable tray interaction (transverse-to-vertical) formula for different ductility ratios.

RESPONSE:

The applicability of the cable tray allowable transverse vs. vertical moment interaction formula for different ductility ratios is illustrated by the following discussion on the inelastic design methodology developed by Newmark and Hall (Reference 1). In this discussion it is emphasized that the allowable ductility, not the ductility achieved during actual response, determines the "reduction factor" defined in the method.

Newmark and Hall developed a method for the design and analysis of structures whose response can reasonably be modeled by a simple elastic-perfectly plastic (EPP) oscillator (Reference 1). Instead of employing a detailed non-linear analysis, this methodology utilizes linear elastic analysis combined with an inelastic response spectrum derived by multiplying the elastic response spectrum by a reduction factor (RF) which is dependent on the inelastic deformation capability of the structure. RF is calculated based on the allowable ductility, μ_a. The allowable ductility is typically defined by reducing the available ductility established by tests or analysis, as required by functional considerations. Elastic response spectrum analysis is performed using the inelastic response spectrum; if the yield limits of the EPP model of the structure are not exceeded, the structure is considered to be qualified.

If an inelastic structure with an allowable ductility of μ_a were subjected to the elastic response spectrum, the resulting structural displacements would approach the allowable inelastic displacements, or equivalently, the allowable ductility μ_a would be approached. Such excitation is the highest that the structure can be subjected to, without the allowable ductility being exceeded. If the level of excitation is lowered, the displacements (and actual ductility demand) are reduced. Thus, the level of excitation that results in the allowable ductility demand of μ_a envelops the levels of excitation that result in smaller displacements, and therefore, is the critical level of excitation.

All tray connector hardware that may have non-ductile failure modes, such as, splice plates, riser connectors and the associated bolts, as well as the tray hold down clips and the associated welds and bolts are evaluated using 1.2 times elastic peak spectral accelerations; no reduction for inelastic response is accounted for.

QUESTION #3:

Review available literature, including the paper by Mahin and Bertero, "An Evaluation of the Inelastic Seismic Design Spectra", ASCE Spring Convention, April 1978, provided by the staff during the meeting to determine whether the limitations expressed in the paper are relevant to TVA's planned application.

RESPONSE:

The analytical model that has been used in the research to develop inelastic response spectra (and studied in the Mahin and Bertero paper, Reference 2, as well as in References 3 through 5) is a single degree of freedom (SDOF) elastic-perfectly-plastic oscillator subjected to time histories representative of relatively broad band response spectra. Three conditions are involved that affect the application of the inelastic response spectra in structural analyses:

1. Structural response can reasonably be modeled by a single degree of freedom, linear-perfectly-plastic oscillator.

2. The structure has the desired ductile deformation capability.

3. The reduction factors for deriving the inelastic spectra are dependent on the spectral shape (i.e., frequency content of the excitation) and the natural frequency of the structure.

In the Watts Bar cable tray evaluation, inelastic design principles are applied to the transverse tray response. The transverse tray response satisfies the above conditions as follows:

1. The Watts Bar cable tray transverse response can be reasonably represented by SDOF models because:

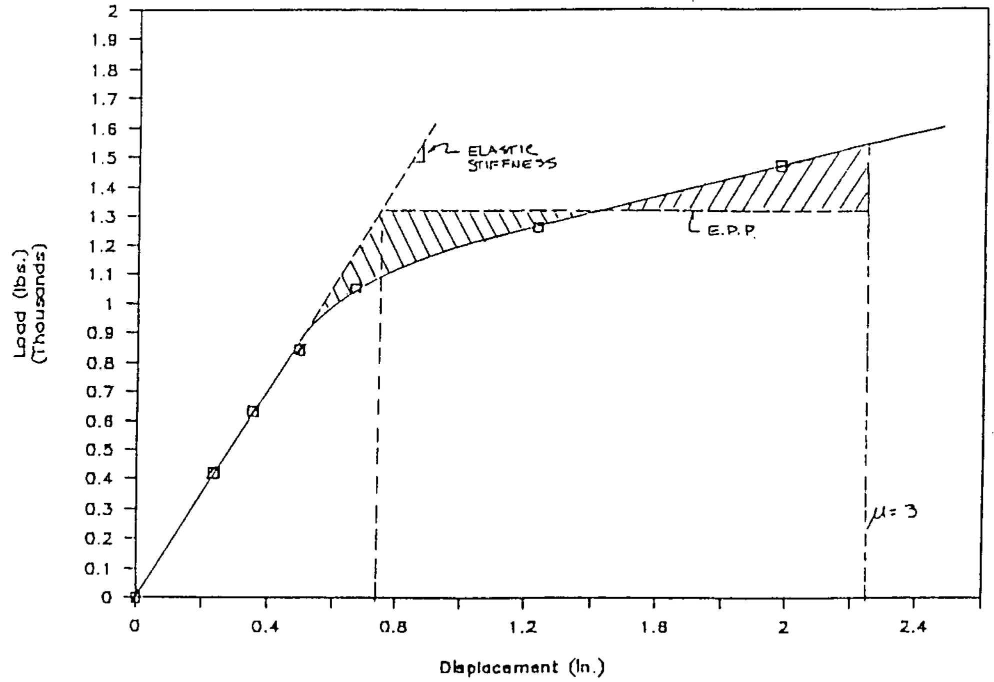
a) The cable tray supports restrain the cable trays in all three directions of response at both ends of each cable tray span. This effectively breaks the cable tray system into several single span problems.

b) Further, as ladder trays behave much like shear beams in the transverse direction (Reference 6), the single span problems can reasonably be modeled as SDOF systems. (The spans of a shear beam on rigid supports are completely decoupled.)

c) At the higher loading levels in the TVA test of the Watts Bar 3-span cable tray configurations, the effects of transverse tray response on adjacent spans is not significant. This can be observed by comparison of load-deflection data among the different tested configurations.

In addition, the Watts Bar cable tray systems can be adequately represented as having elastic-perfectly plastic response in the transverse direction. The TVA test data clearly shows that the Watts Bar cable trays behave as non-linear, inelastic systems. This is further substantiated by the cyclic tests. The EPP approximation of the tested configurations was developed, consistent with the guidance provided in Reference 1, by maintaining energy balance in the response as indicated in the following diagram.

Load-Displacement Curve



The shaded areas are balanced up to $\mu_a = 3.0$. Thus, at maximum transverse response at $\mu_a = 3.0$, the EPP approximation results in an exact energy balance.

On the bases presented above, the Watts Bar cable trays can be reasonably modeled by single degree of freedom, linear-perfectly-plastic oscillators.

2. The TVA tests have adequately demonstrated that the Watts Bar cable trays can withstand ductilities well in excess of $\mu_a = 3$, remain stable, and carry concurrently a sustained vertical load. In addition, the TVA tests show that the Watts Bar cable trays can achieve high ductilities under repeated cyclic loading.

The TVA tests show that condition 2 is satisfied.

3. The Watts Bar in-structure floor response spectra that represent the input excitation are of relatively narrow band in comparison to the ground motion spectra typically used in the research conducted on the SDOF models. However, the evaluation methodology conservatively compensates for this difference by broadening the in-structure floor response spectra peaks, multiplied by 1.2, across all frequencies.

Thus, all three conditions are met and the methodology is appropriate for the evaluation of the Watts Bar cable trays.

QUESTION #4:

Justify the bases for using a ductility of 3 for inelastic seismic analysis in light of the recommendations provided in NUREG/CR-1161.

RESPONSE:

The static and cyclic tests conducted on the Watts Bar trays demonstrate a ductile deformation capability significantly exceeding that corresponding to an allowable ductility of 3 in the transverse direction. The deflections corresponding to the allowable ductility of 3 are in the order of 2-3/4 inches. Such displacements are compatible with the functional capability of the cables in the tray.

A maximum allowable ductility of 3 (evaluation of as-built structures) is selected based on guidance in Table 3 of NUREG/CR-1161, Section III.D regarding a reasonable limit compatible with the functional requirements of cable trays, which can deform inelastically to a moderate extent without unacceptable loss of function.

QUESTION #5:

Address how TVA's proposed use of the inelastic response spectra for cable trays conforms with the recommendations in NUREG/CR-1161 which apply to inelastic building response.

RESPONSE:

The inelastic design aspects addressed in NUREG/CR-1161 are based on the methodology referred to in responses to questions 1 and 2 above. The applicability of such a methodology to Watts Bar cable tray evaluation has been addressed in detail in the response to question 3 above.

Two sections of NUREG/CR-1161 relate to inelastic analysis of systems or components supported to building structure.

1. NUREG/CR-1161 recognizes the use of inelastic design methods for facilities, structures, equipment, instruments or components in Table 3 of Section III.D.

2. Section IV.D provides guidelines for the generation and use of the in-structure response spectra for cases in which limited amount of inelastic response of the structure has been allowed. (Underline added for emphasis.)

Since reduction in the in-structure elastic spectra to account for non-linear behavior of the building structure is not used, the provisions of Section IV.D are not applicable to the Watts Bar cable tray qualification.

In conclusion, the use of inelastic response spectra for cable tray evaluation at Watts Bar is in compliance with the NUREG/CR-1161 provisions.

REFERENCES

1. Newmark, N. M. and Hall, W. J., "Earthquake Spectra and Design", Earthquake Engineering Research Institute, Monograph Series, 1987

2. Mahin, S. A. and Bertero, V. V., "An Evaluation of Inelastic Seismic Design Spectra", Proceedings, ASCE Spring Convention and Exhibition, Pittsburgh, Pennsylvania, April 24-28, 1978.

3. "An Evaluation of Response Spectrum Approach to Seismic Design of Buildings", Applied Technology Council, San Francisco, California, September, 1974.

4. Veletsos, A. S. and Newmark, N. M., "Effect of Inelastic Behavior on the Response of Simple Systems of Earthquake Motions", Proceedings, Second World Conference on Earthquake Engineering, 1960, pp. 895-912.

5. Riddell, R. and Newmark, N. M., "Statistical Analysis of the Response of Non-Linear Systems Subjected to Earthquakes", Department of Civil Engineering Report, ICU 79-2016, Urbana, Illinois, August, 1979.

6. Johnson, W., Shunmugavel, P., and Chien, J., "Strength and Stiffness Characteristics of Steel Ladder-type Cable Trays", Structural Engineering in Nuclear Facilities, Volume 2, ASCE.

ENCLOSURE 3

CONDUIT DAMPING

Date:
Item No: CAS047A

NRC FSAR MEETING
Seismic and Civil Issues Program

Program Element: Conduit

NRC Reviewer(s): Joe Braverman

TVA Responsible Person: Tom Cureton

Issues Discussed/Information Presented:

Page Number: 3.7-39 Paragraph/Line Number: 3.7.3.15 Category: B/C

Table 3.7-2 is referenced for damping values. These values have been revised from old FSAR.

Open Issue(s)/Request(s):

Numerous questions to be clarified by TVA. Basis for using average damping values needs justification. Tests by Wyle and ANCO correspond to lower values.

TVA Planned Action/Position:

The attached provides supplemental justification for conduit damping values.

Prepared By: T Cureton Jr

Reviewed By: [signature] 4-15-91

Approved By: Ruben O Hernandez 4-15-91

2470M

CONDUIT DAMPING ISSUE

NRC FSAR REVIEW MEETING WITH TVA NOVEMBER 5-9,1990

Item No: CAS047

INTRODUCTION

The intent of this submittal is to provide supplemental justification for conduit damping values of 4% and 7% for OBE and SSE respectively at Watts Bar Nuclear Plant (WBN). Two justifications for the 4% and 7% are presented in this response. First, the conduit systems and supports at WBN are indeed bolted steel structures for which Reg. Guide 1.61 recommends damping values of 4% and 7%. The second justification compares the controlling parameters of other licensed nuclear plant facilities that use 4% and 7% conduit damping values with these parameters for WBN.

JUSTIFICATION

Damping for Bolted Steel Structures

For bolted steel structures, Reg. Guide 1.61 recommends the use of 4% and 7% for OBE and SSE respectively. The conduit and supports used at WBN are considered bolted steel structures for the following reasons:

1. All conduit segments are joined together by threaded fitting connections. There are no welded conduit-to-conduit connections.

2. All of the conduit is attached to the support structure via one or two bolt clamps. There are no welded conduit-to-support connections.

3. At least 80% of the conduit supports are attached to the building structure with concrete anchor bolts.

Comparison of other Licensed Nuclear Plant Facilities with WBN

Several licensed plants use conduit damping values equivalent to those proposed for WBN. Design parameters for five of those plants (Byron, Braidwood, Clinton, Grand Gulf, and Vogtle) were obtained and compared with those at WBN and summarized in the attached table.

The five cited plants have input ground acceleration levels comparable to WBN. The conduits for those plants, like WBN, are of all-steel construction. Additionally, they are of comparable size ranges, fill level, span length, and clamp type. Further comparison of support types was also made; a summary is also provided in the attached table.

As shown in the attached table, WBN conduit systems are comparable to those five plants currently licensed to 4%/7% damping levels. The proposed damping for WBN is therefore justified and supported by these precedents.

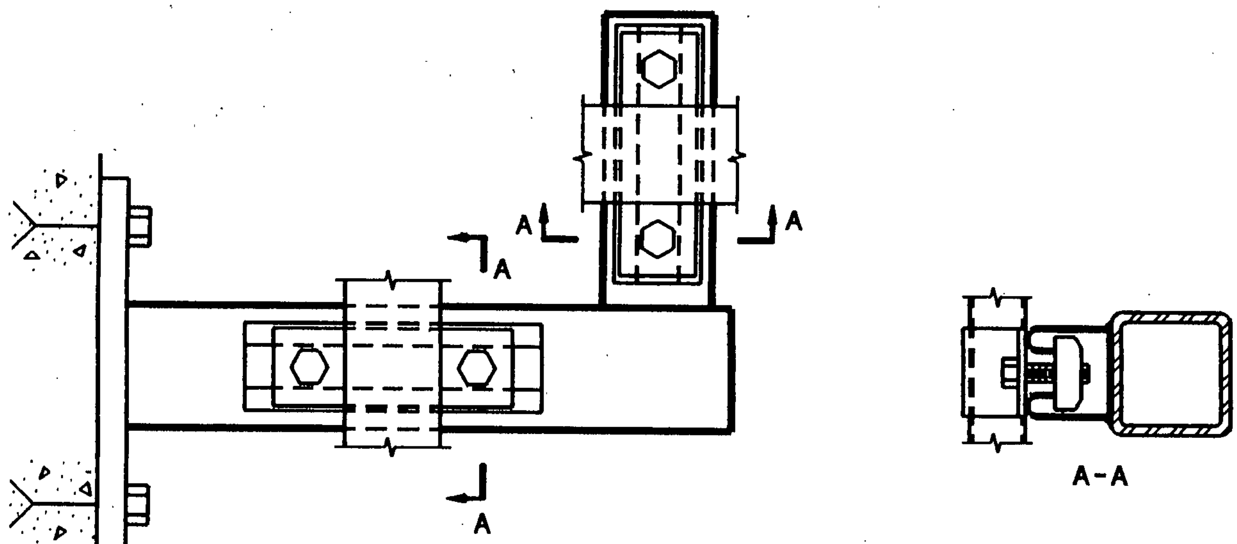
p. 3 of 6

COMPARISON OF CONDUIT DAMPING VALUES FOR SELECTED NUCLEAR PLANT FACILITIES

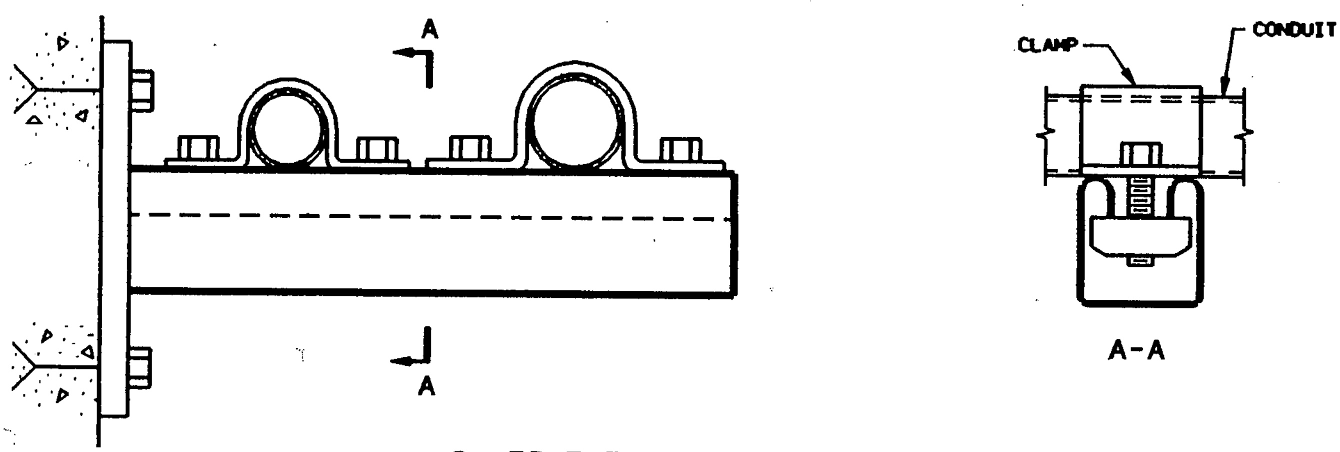
	BYRON	BRAIDWOOD	CLINTON	GRAND GULF	VOGTLE	WATTS BAR
DAMPING	4%/7%	4%/7%	7%	7%/7%	4%/7%	4%/7%
INPUT GROUND ACCELERATION	0.2 g	0.2 g	0.25 g	0.15 g	0.2 g	0.215 g
SPECTRAL TYPE	RG 1.60	RG 1.60	RG 1.60	Modified Newmark	RG 1.60	Mod. Newmark Site Specific
CONDUIT MATERIAL	steel	steel	steel	steel	steel	steel
CONDUIT FILL	40%	40%	40%	40%	40%	40%
CONDUIT SIZES	3/4" - 6"	3/4" - 6"	3/4" - 6"	1" - 4"	3/4" - 4"	3/4" - 5"
CONDUIT SPANS	10' - 15'	10' - 15'	10' - 15'	8' - 10'	8'	5' - 15'
CLAMP TYPE	2 bolt	2 bolt	2 bolt	1 & 2 bolt	2 bolt	1 & 2 bolt
SUPPORT TYPES (*)	(1) (2) (7)	(1) (2) (7)	(1) (2) (7)	(1) (2),(6) (7)	(1),(3) (5) (7)	(1),(4) (5) (7)

Notes:
- (1) Cantilever
- (2) Unistrut
- (3) Some steel frames
- (4) Some braced cantilevers
- (5) Combination tube steel/Unistrut
- (6) Cantilever frame, tube steel
- (7) Members welded to baseplate
- (*) Attached are typical conduit support details for selected plants

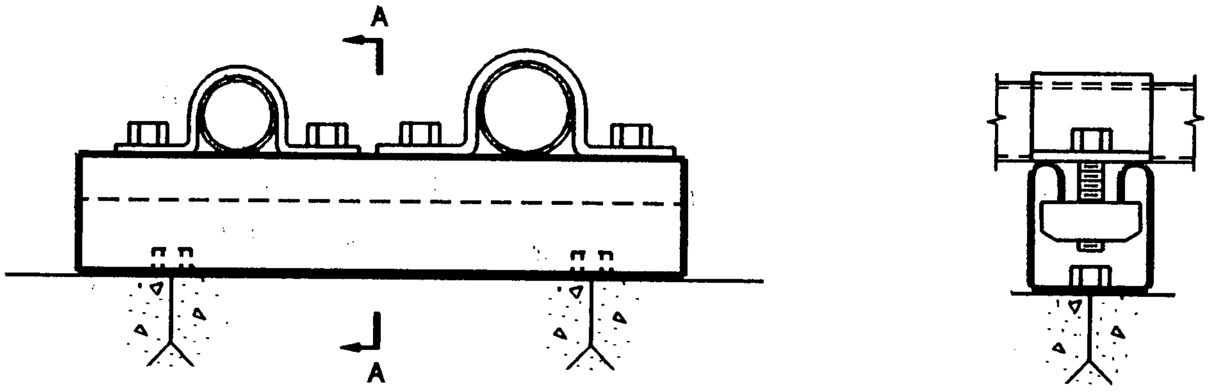
WATTS BAR - TYPICAL CONDUIT SUPPORT TYPES



CANTILEVERED TUBE STEEL

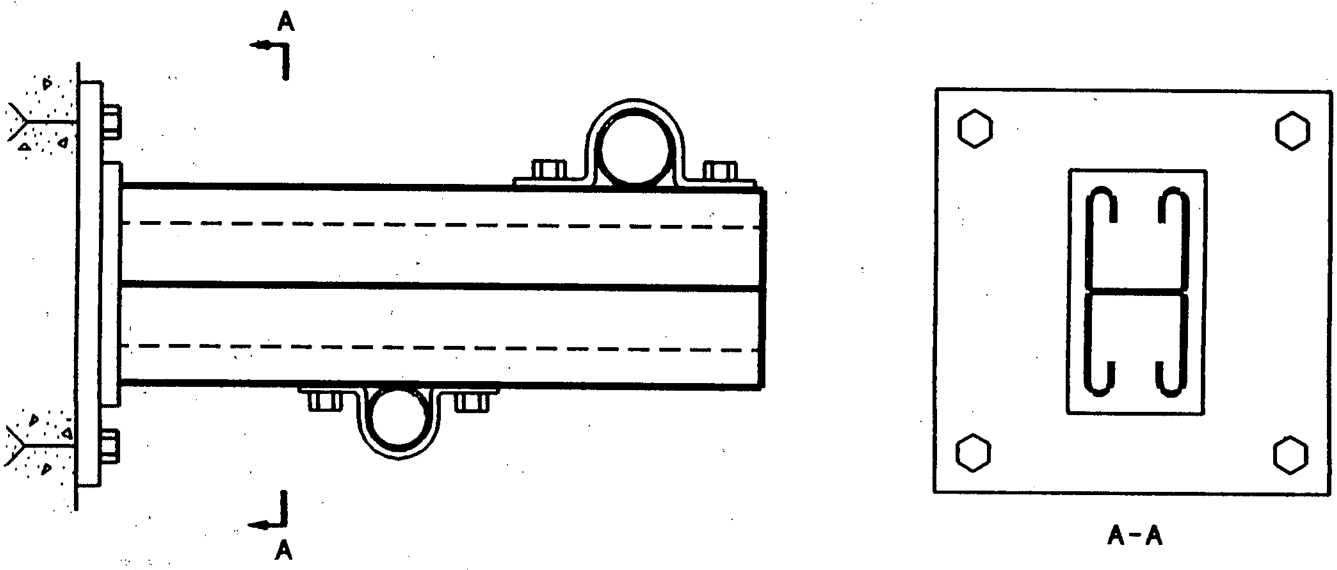


CANTILEVERED UNISTRUT

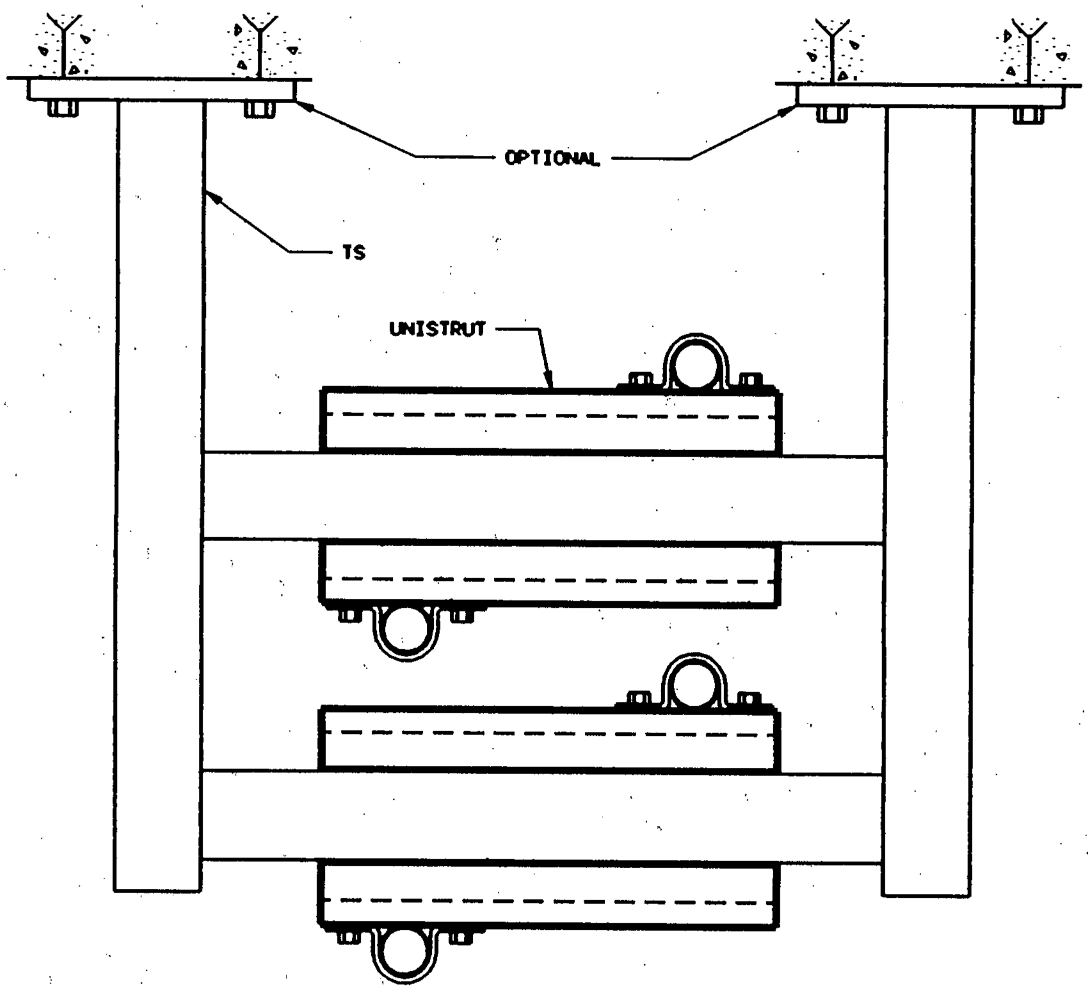


FLUSH MOUNTED UNISTRUT

GRAND GULF - TYPICAL CONDUIT SUPPORT TYPES

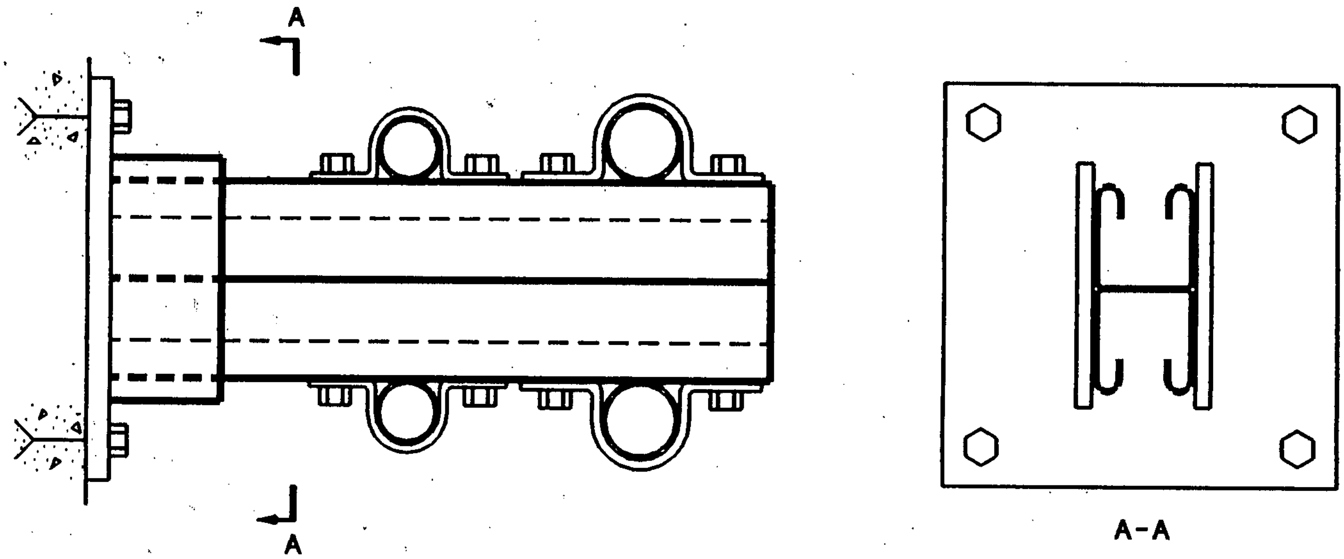


CANTILEVERED UNISTRUT

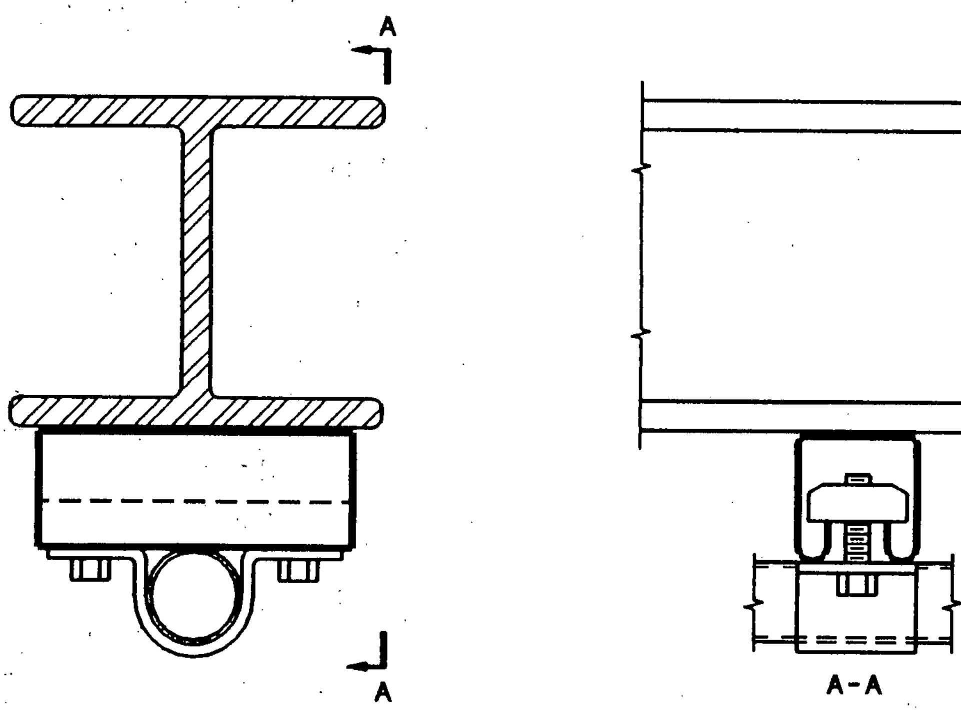


CANTILEVERED FRAME TUBE STEEL

BYRON, BRAIDWOOD, AND CLINTON - TYPICAL CONDUIT SUPPORT TYPES



CANTILEVERED UNISTRUT



FLUSH MOUNTED UNISTRUT

ENCLOSURE 4

EQUIPMENT QUALIFICATION IEEE 344-1975 AND IEEE 344-1971

NRC FSAR MEETING
Seismic and Civil Issues Program

Program Element: ESQ

NRC Reviewer(s): Joe Braverman/Gary Hammer

TVA Responsible Person: Joe Chen

Issues Discussed/Information Presented:

Page No: 3.9-31 Paragraph No: 3rd paragraph Category: B/C

Added-Only ASME III pumps and valves purchased after 9/1/74 meet the special requirements in Regulatory Guide 1.48. The remaining components in the referenced tables meet qualification requirements in IEEE 344-1971 and consistent with ASME Code applicable at the time of procurement.

Open Issue(s)/Request(s):

Need further evaluation. Need to review/confirm that SQRT requirements were met. Need to define how the guidelines of Standard Review Plan 3.10 for plants docketed before October 27, 1972 were met.

TVA Planned Action/Position:

All necessary qualification documents will be available upon ESQ corrective action program (CAP) completion.

This supercedes any previous information which may have been submitted for the identified FSAR sections.

Continue on Page 2 of 24

Prepared By: [signature]

Reviewed By: Wayne L. Smathers

Approved By: [signature] 4/15/91

2655M

The Watts Bar Category I electrical and mechanical equipment seismic qualification program is consistent with the guidance provided by the NRC Standard Review Plan (NUREG-0800), Revision 2, July 1981, Section 3.10, acceptance criteria for plants with CP applications docketed before October 27, 1972. The equipment has been seismically qualified either in direct compliance with IEEE STD 344-1975/Regulatory Guide 1.100 (equipment procured after September 1, 1974), or in accordance with a program which provided as a minimum, qualification to the requirements of IEEE 344-71 and in addition addressed the following guidelines of SRP 3.10:

1. For qualification by single frequency testing, the input acceleration was equal to or greater than the acceleration level expected at the equipment mounting location.

2. For qualification by single frequency testing, tests were performed at critical frequencies through the range of 1 to 33 Hz. Test frequencies included (but were not limited to) all equipment resonances determined from the resonant search tests.

3. In all cases, testing was conducted in one vertical and two orthogonal horizontal axes. The majority of seismic tests were conducted with simultaneous vertical and horizontal excitations (biaxial inputs) as delineated in IEEE Std. 344-1975.

TVA's program for seismic qualification of Watts Bar equipment relative to the procedures of 344-1975 was first discussed with NRC in September 1976, References 1 and 2. TVA's discussion of its efforts to ensure compliance with current criteria included:

1. Commitment to early implementation of new criteria, and discussion of steps taken toward this end, e.g., updated seismic qualification requirements for equipment purchased after September 1, 1974.
2. Discussion of engineering rationale, citing specific examples, leading to the generic conclusion that for equipment purchased prior to September 1974, TVA's implementation of the IEEE 344-1971 test procedures was sufficiently conservative to more than adequately envelop the effects of multi-mode/multi-axis seismic excitation.

Since this first meeting, there has been a continuing dialogue with NRC regarding the adequacy of TVA's seismic qualification program. This dialogue is reflected in the WBN FSAR 112 series of questions and answers, culminating in question 112.33, its answer, and related correspondence in References 3, 4 and 5. The result of all this discussion was that NRC would conduct a SQRT review of certain NSSS and non-NSSS equipment at Watts Bar. NRC indicated in question 112.33 that the Watts Bar NSSS equipment had already been reviewed on a generic basis but applicability to Watts Bar needed to be determined.

The site audit was conducted in April, 1982, with the objective, as stated in the SER (Reference 6 and 7), to resolve the concern as to the extent to which the WBN equipment seismic qualification program satisfied IEEE 344-1975, Regulatory Guide 1.100, and the guidelines of SRP 3.10. The results of the site audit were documented in NRC's letter to TVA dated September 23, 1982.

The WBN SQRT audit correspondence and supporting documentation for responses to questions extend over the timeframe from September 1982 to May 1990, References 8 through 19.

The Safety Evaluation Report (NUREG-0847) with its supplements 1, 3 and 4 document the results of NRC's review of the Watts Bar equipment seismic qualification program through March 1985. In SSER-3 Section 3.10 the status of generic and specific concerns is described as of January 1985. At that time eight open issues remained. SSER-3 Section 3.10.3 summarized the SQRT audit status by concluding that "an appropriate seismic and dynamic qualification program has been defined and substantially implemented, with the exception of the above open issues. The open issues for both generic and equipment-specific items must be resolved before fuel loading."

TVA has provided responses to all of the eight open issues referred to in SSER 3, References 15 through 19. NRC has accepted TVA's responses and closed seven of the eight open issues as documented by Inspection Report 50-390/90-05, Reference 20. The remaining open issue concerns single frequency single axis qualification tests for Westinghouse supplied electrical equipment. That issue is being resolved as part of the WBN ESQ Program which has been reviewed by the NRC from a programmatic standpoint, as documented by NRC's letter dated September 11, 1989.

In order to more accurately reflect WBN's equipment seismic qualification program, Section 3.7.3.16, 3.9.2.2, and 3.10 of the FSAR will be clarified as follows:

Section 3.7.3.16 - Material added to the section (Attachment 1)

Section 3.9.2.2 - Added sentence to cross reference Section 3.7.3.16. (Attachment 2)

Section 3.10 - Replace first paragraph with paragraph which existed prior to Amendment 64 and add cross reference to Section 3.7.3.16. (Attachment 3)

References:

1. NRC letter to TVA, dated November 16, 1976 - S. A. Varga to Godwin Williams

2. TVA letter to NRC, dated February 7, 1977 - J. E. Gilleland to S. A. Varga

3. NRC letter to TVA, dated March 20, 1981 - R. L. Tedesco to H. G. Parris

4. TVA letter to NRC, dated April 8, 1981 - L. M. Mills to H. R. Denton

5. NRC letter to TVA, dated October 23, 1981 - R. L. Tedesco to H. G. Parris

6. WBN Safety Evaluation Report (NUREG-0847), dated June 1982, Section 3.10

7. WBN Safety Evaluation Report (NUREG-0847), Supplement 1, dated September 1982, Section 3.10

8. TVA letter to NRC, dated December 1, 1982 - L. M. Mills to E. Adensam

9. TVA letter to NRC, dated June 3, 1983 - L. M. Mills to E. Adensam

10. TVA letter to NRC, dated June 10, 1983 - L. M. Mills to E. Adensam

11. NRC letter to TVA, dated April 25, 1984 - T. M. Novak to H. G. Parris

12. TVA letter to NRC, dated May 17, 1984 - L. M. Mills to E. Adensam

13. TVA letter to NRC, dated May 25, 1984

14. TVA letter to NRC, dated June 19, 1984

15. TVA letter to NRC, dated February 22, 1985

16. TVA letter to NRC, dated March 21, 1985

17. TVA letter to NRC, dated March 23, 1985

18. TVA letter to NRC, dated April 30, 1985 - J. A. Domer to E. Adensam

19. TVA letter to NRC, dated January 30, 1986 - R. Gridley to B. J. Youngblood

20. NRC letter to TVA, dated May 10, 1990 - B. D. Liaw to O. D. Kingsley

Bar spectra by a considerable margin and therefore, the loads for the four loop generic analysis envelope the loads for Watts Bar. Consequently, seismic qualification of the Watts Bar reactor internals is demonstrated since the four loop reactor internals have been qualified on a generic basis.

3.7.3.15 Analysis Procedure for Damping

The specific percentage of critical damping value used for Category I structures, systems, and components are provided in Tables 3.7-2 and 3.7-24. | 64

3.7.3.16 Seismic Analysis and Qualification of Category I Equipment Other Than NSSS

All seismic Category I floor or wall-mounted mechanical and electrical equipment was analyzed or tested and designed to withstand seismic loadings in the horizontal and vertical directions. The floor response spectra obtained from the analysis of structures were used in the analyses. Each procurement specification for equipment contained the particular floor response spectra curve for the floor on which the equipment is located. Depending on the relative rigidity and/or the complexity of the equipment being analyzed, the vendor could use one of the following four methods to qualify the equipment: | 64

1. Dynamic analysis method,
2. Simplified dynamic analysis method,
3. Equivalent static load method,
4. Testing method.

INSERT ATTACHED

The basis used for selection of the appropriate accelerations used in the above paragraph is described in further detail in Section 3.7.3.16.2. Table 3.7-25 identifies how each seismic Category I item was initially qualified. | 64

Equipment is considered to be rigid for seismic design if the first natural frequency is equal to or more than 33 cycles per second.

3.7.3.16.1 Dynamic Analysis Method For Equipment and Components | 64

Equipment that is rigid and rigidly attached to its support structure was analyzed for a g-loading equal to the acceleration of the supporting structure at the appropriate elevation.

For nonrigid, structurally simple equipment, the dynamic model consisted of one mass and one spring. Keeping the values of the mass and the spring constant, the natural period of the equipment

INSERT TO SECTION 3.7.3.16

The Watts Bar Category I electrical and mechanical equipment seismic qualification program is consistent with the guidance provided by the NRC Standard Review Plan (NUREG-0800), Revision 2, July 1981, Section 3.10, acceptance criteria for plants with CP applications docketed before October 27,1972. The equipment has been seismically qualified either in direct compliance with IEEE Std. 344-1975/Regulatory Guide 1.100 (equipment procured after September 1, 1974), or in accordance with a program which provided as a minimum, qualification to the requirements of IEEE 344-1971 and in addition addressed the following guidelines of SRP 3.10:

1. For qualification by single frequency testing, the input acceleration was equal to or greater than the acceleration level expected at the equipment mounting location.

2. For qualification by single frequency testing, tests were performed at critical frequencies through the range of 1 to 33 Hz. Test frequencies included (but were not limited to) all equipment resonances determined from the resonant search tests.

3. In all cases, testing was conducted in one vertical and two orthogonal horizontal axes. The majority of seismic tests were conducted with simultaneous vertical and horizontal excitations (biaxial inputs) as delineated in IEEE Std. 344-1975.

3.9.2.2 Seismic Qualification Testing of Safety-Related Mechanical Equipment

Design of Category I mechanical equipment to withstand seismic, accident, and operational vibratory loadings is provided either by analysis or dynamic testing.

Generally tests are run with either of the following two objectives:

1. To obtain information on parts or systems necessary to perform the required analysis, or

2. To prove the design (stress or operability) adequacy of a given equipment or structure without performing any analysis of this particular equipment or structure. | 64

The need for the first type of tests is dictated by lack of information on some of the inputs vital to the performance of an analysis. These tests can be either static (to obtain spring constants) or dynamic (to obtain impedance characteristics). No general descriptions can be given for this type of tests because of their strong dependence on the specific needs of the analyst. | 64

The need for the second type of test is mainly dictated by the complexity of the structure/equipment under design. This vibration testing is usually performed in a laboratory or shop on a prototype basis, using various sources of energy.

For general seismic qualification requirements for mechanical and electrical equipment, see Section 3.7.3.16.

ATTACHMENT 3

REPLACE WITH ATTACHED

3.10 SEISMIC DESIGN OF CATEGORY I INSTRUMENTATION AND ELECTRICAL EQUIPMENT

Seismic Category I Instrumentation and Electrical equipment for the Watts Bar Nuclear Plant was either furnished by Westinghouse or purchased by TVA. TVA's seismic qualification program for instrumentation and electrical equipment at Watts Bar is based on the guidelines of IEEE 344-1971 and IEEE 344-1975. The guidelines of IEEE 344-1975 were used for procurements initiated after September 1, 1974. 64

Instrumentation and electrical equipment was purchased in assemblies except for local panel instrumentation as described in 3.10.1. TVA provided the vendor with a required response spectrum as a part of the equipment specification in order that the vendor could qualify his equipment. The derivation of the response spectrum is described in Section 3.7.

3.10.1 Seismic Qualification Criteria

TVA Supplied

Class 1E Power Equipment

Table 3.10-1 lists the procurement packages for Class 1E power equipment. TVA's seismic qualification criteria is based on IEEE 344-1971 or IEEE 344-1975 as discussed above. 64

The capability of ESF circuits and the Class 1E system to withstand seismic disturbances is established by seismic analysis and/or testing of each system component. The qualification criteria used in the design of Seismic Category I electrical equipment are given below. 64

1. Safety related equipment designated as Seismic Category I, when subjected to the vertical and horizontal acceleration of the safe shutdown earthquake (SSE), shall perform as follows: 64

   a. Equipment shall retain its structural integrity during and after the seismic event. 64

   b. Equipment shall be capable of performing its design function during and after the seismic event. 64

   c. Maximum displacement of the equipment during the earthquake shall not cause loss of function of any externally connected parts, such as conduit, cable, or bus connections. 64

Equipment anchorage/support design is discussed in Section 3.9.3.4.2. Other considerations for the seismic qualification of Category I electrical equipment are described in Section 3.7.3. 64

REPLACEMENT FOR 1ST PARAGRAPH OF SECTION 3.10

Seismic Category I instrumentation and electrical equipment for the Watts Bar Nuclear Plant was either furnished by Westinghouse or purchased by TVA. TVA's seismic qualification program for instrumentation and electrical equipment at Watts Bar is based on the requirements of IEEE 344-1971 and the NRC Standard Review Plan, Section 3.10 (specifically, acceptance criteria for plants with CP application docketed before October 27,1972) as discussed in Section 3.7.3.16.

ENCLOSURE 5

STRUCTURAL AND GEOSCIENCES ISSUES

Item No:
Date:

NRC FSAR MEETING
Seismic and Civil Issues Program

Program Element: Civil Structural

NRC Reviewer(s):

TVA Responsible Person: R. D. Rowell (A2, A4, A5, A8, A9, A10); R. A. James (A1), D. J. Etzler (A3), F. Y. Sun (A6, A7, A8, A9, A10)

Open Issue(s)/Request(s):

Questions resulting from NRC review of Watts Bar FSAR Amendments 54 through 64, section 3.8. The specific questions asked are provided on the attached sheets.

TVA Planned Action/Position:

Responses are provided on the attached sheets.

Prepared By: Rex Rowell, Robert A James, Frank Y Sun, [signature]

Reviewed By: [signature]

Approved By: [signature] 4/15/91

2812M

STRUCTURAL AND GEOSCIENCES BRANCH
REVIEW OF WATTS BAR FSAR AMENDMENTS 54-64
SECTION 3.8 "CATEGORY I STRUCTURES"

NRC Questions and TVA Responses

Q1. P. 3.8-3, Section 3.8.1.2 "Applicable Codes, Appendix 3.8E: "CODES LOAD DEFINITIONS AND LOAD COMBINATIONS FOR THE MODIFICATION AND EVALUATION OF EXISTING STRUCTURES AND FOR THE DESIGN OF NEW FEATURES ADDED TO EXISTING STRUCTURES AND THE DESIGN OF STRUCTURES INITIATED AFTER JULY 1979"

This is a new appendix to amendment 64. Ductility factors are based on AISC-N690 which the staff has not reviewed.

A1. The FSAR addresses the design of several major structures. Individual tables giving load combinations and allowable stresses are referenced for each structure. In order to address new designs, modification to existing structures, and evaluation of existing structures, TVA captured the most recent load definitions, load combinations, and allowable stresses in one location. Appendix 3.8E is intended to be the single focal point and is consistent with provisions of NUREG-0800, section 3.8.4.

For the design and evaluation of structures subjected to thermal loads, TVA uses an energy balance method if structural response is within the elastic region. When the elastic response is exceeded, an inelastic evaluation is performed. The acceptance criteria for thermal evaluations takes advantage of the ductile nature of steel. Acceptance is established by evaluation of ductility ratios for localized response in the region of formation of a plastic hinge mechanism and for overall response in the region remote from the formation of a plastic hinge mechanism. For regions associated with the formation of a plastic hinge mechanism the maximum acceptable ductility ratios is 3.0 for inelastic analysis. For regions remote from the formation of a plastic hinge mechanism, the acceptable ductility ratios are taken from the ANSI/AISC N-690 Specification, section Q1.5.8.

Q2. P.3.8-3 Section 3.8.1.2, "Applicable Codes Standard and Specifications".

The following items are not consistent with or are not in the SRP.

a. Tangential Shear
b. ACI Chimney Code (ACI 307-09)
c. ACI 214-27

A2. These items were added by amendment 64 to clarify TVA's position on tangential shear, to provide reference to ACI code 307 which was used during design and ACI 214 which is referenced in TVA General Construction Specification G-2 and was added to the FSAR to be consistent between documents.

The following specific response is provided for each item:

Item (a) Tangential shear, as applied at WBN, is consistent with the SRP, and tangential shear was considered as recommended by the NRC in previous NRC Question 131.45. Item 1) of the NRC Question 131.45 states: "Since shield building is not considered as a containment structure an appropriate code would be ACI-318 supplemented by the provisions of Section 3.8.4 of the SRP. Indicate your intent to comply with this position."

In the response to item 1) TVA stated: "TVA has reviewed the design of the shield building and found the tangential shear to be less than that allowed in the ACI 318-71 code for shear walls, which therefore meets the provisions of Section 3.8.4 of the SRP. See revised Section 3.8.1.4. TVA has evaluated the design of the shield building for compliance with the criteria in the SRP Section 3.8.4."

Item b) ACI chimney code (ACI 307) was referenced and utilized for WBN original design due to a lack of code direction on design of reinforcing around openings. TVA chose to reference the only code (ACI 307) available at the time the design of WBN was performed.

Item (c) ACI 214 was used as reference input to TVA G-2. It discusses various methods for evaluating strength, one of which is employed in TVA G-2. Also, ACI 214 is referenced in the TVA Concrete Quality Evaluation Report CEB 86-19-C section 2.2 to show that concrete acceptance criteria in TVA G-2 is compatible with industry standards. Thus, its placement in the FSAR is for reference purposes only.

Q3. P.3.8-5, NCIG-02, Revision 0, cited by the applicant is not the revision accepted by the staff. NCIG-02, Revision 2, is the revision accepted by the staff in a letter dated April 9, 1987, to the Nuclear Construction Issues Group. Our letter of April 9, 1987 also stipulated limitations on the applications of NCIG-02, Revision 2 which have not been addressed by the applicant. This should be considered an open item to be resolved by the applicant.

A3. NCIG-02, Revision 0, was the basis for the Department of Energy (DOE)/Weld Evaluation Project (WEP), EG&G Idaho, Incorporated, statistical assessment of the TVA performed safety related welding at the TVA WBNP.

This sampling plan was developed and implemented in 1985/1986 prior to NC1G-02, Revision 2 being available. NRC concluded in NUREG-1232, Volume 4, "TVA's phase II reinspection effort was an effective sampling effort and thus the reinspection results can be used to assess the welding quality at Watts Bar Unit 1."

The FSAR revision was intended to document the use of the NCIG-02, Revision 0 as the basis for the DOE/WEP assessment of the safety related welding at WBNP.

Any further sampling reinspections of structural welds after issue of NCIG-02, Revision 2 are performed in accordance with NCIG-02, Revision 2 requirements. It is noted from memorandum of April 9, 1987, T. P. Speis to W.H. Weber: "Any nonconformances found during the use of NCIG-02 must be properly evaluated and documented. A given representative physical property (i.e., hardness) shall be not used to justify another physical property (i.e., tensile strength). If representative physical properties are used for a group of items, in lieu of the use of specified or actual properties, the basis for doing so shall be justified and documented as part of the engineering evaluation." The FSAR will be revised to reflect the above discussion/clarification.

Q4. Table 3.8.4-2, Section 1b. At elevation 741 feet, equipment loads of 175 psf was reduced to 100 psf, explanation must be given by the applicant.

A4. This change was made to correct a discrepancy between the design criteria WB-DC-20-21 and the FSAR. The change is to clarify that TVA uses a live load of 100 psf plus equipment loads, during design, instead of the 175 psf equipment load as was shown in the FSAR. Thus, TVA has used a true live load coupled with equipment loads during design rather than the 175 psf equipment load only, as implied in the FSAR.

Q5. Table 3.8.4-6, "Manways in RHR Sump Value Room" This table is changed without explanation. Reasons should be provided.

A5. The table was revised to delete loading conditions which were no longer required and to make the FSAR consistent with the design criteria. These load combinations reflect up-to-date load conditions. Allowable stresses were maintained identical to the original commitments.

Q6. Table 3.8.3-3. "Personnel Access Doors in Crane Wall" is eliminated in the proposed FSAR change. Reasons should be stated.

A6. Table 3.8.3-3 has not been eliminated. There was no change made to this table.

Q7. Table 3.8.4-5 is dropped from previous FSAR without explanation.

A7. Table 3.8.4-5 has not been dropped. There was no change to this table.

Q8. Table 3.8.4-6 thru Table 3.8.4-22. "Allowable Stresses of Various Structural Components" and Tables 3.8.5-1 thru 3.8.5-2 "Crane Allowable Stresses". They require justification.

A8. Table 3.8.4-6 See Q5.

* Table 3.8.4-7 - Sheets 1 through 5

Load combinations were rearranged and clarified for applicability to specific doors. Allowable stresses remain the same as Pre-Amendment 64 material.

Table 3.8.4-8	Updated load case VII reservoir levels from 737.5 to 740.3 and 740.3 to 728. Corrected typographical error on (1.h5 to 1.15) on factor of safety of sliding
Table 3.8.4-9	No change
Table 3.8.4-10	Added statement of maximum steel stress (fs = 0.9 Fy) for SSE allowable load case for clarification purposes/compatibility with FSAR commitments.
Table 3.8.4-11	Changed flood elevations to reflect criteria, and worst site data information.
Table 3.8.4-12	No change
Table 3.8.4-13	Minor editorial changes. Added new part on Concrete Bulkheads, including a new note on concrete bulkheads. Rearranged all the loading conditions and broke out portion on concrete bulkheads as a separate section in the table. The old version had a combination dealing with wind load which was deleted by Amendment 64. The allowable stresses did not change, between the old and new versions.
Table 3.8.4-14 & 15	No changes
Table 3.8.4-16, -17, & -18	Typographical/editorial error corrections.
Table 3.8.4--19 & -20	No changes

Table 3.8.4-21	Allowable for compression case was eliminated, deleted loading combinations 7 & 8, and tension and shear allowables for load cases 4, 5, & 6 were reduced. Load cases Yj, Yr, & Ym were deleted because they were equal to zero.
	1) Loadings No. 7 & 8 were eliminated because they were not controlling loadings by comparison with loading Nos. 2 & 4.
	2) Allowable stresses for tension and compression were combined into bending allowable. The allowable stresses have not been changed; however, they were rearranged to make the FSAR consistent with AISC Manual of Steel Construction, 7th edition, and the actual design conditions.
	3) Allowable stresses for shear and bending were lowered to comply with design criteria for spent fuel pool gates; WB-DC-40-43, R2: NUREG 0800-Standard Review Plan Section 3.8.4; and AISC Manual of Steel Construction, 7th Edition.
Table 3.8.4-22	New table was added by amendment 57 for ADGB to reflect design position for this structure.
Table 3.8.5- -1 & -2	These tables have never existed in the FSAR.

Q9. P. 3.8.4-22 "Control Room Shields Doors". "These accelerations" are not specified.

A9. The accelerations are as referenced in design criteria WB-DC-20-25.

Q10. P. 3.8.4-26. "Railroad Access Hatch Cover" & "Railroad access Doors". "These accelerations are not specified."

A10. The accelerations are as referenced in design criteria WB-DC-40-60.

ENCLOSURE 6

NUMBER OF OBE EVENTS

NRC FSAR MEETING
Seismic and Civil Issues Program

Program Element: Equipment Seismic Qualification

NRC Reviewer(s): Joe Braverman/Gary Hammer

TVA Responsible Person: Joe Chen/Carlo Brillante

Issues Discussed/Information Presented:

Page Number: 3.7-18 Paragraph/Line Number: 3.7.3.2.1 Category: B/C

New FSAR states that the number of peak stress cycles for OBE and SSE are 20 and 10 respectively versus a total of 600 and 300 specified in old FSAR.

Open Issue(s)/Request(s):

Need to determine if used for equipment. If so, then TVA to provide justification.

TVA Planned Action/Position:

The original FSAR identified 600 and 300 cycles as the total estimated cycles, respectively for the OBE and SSE. This includes all levels of responses and stresses during the 15 seconds of strong excitation.

For the seismic qualification testing of Category I equipment, the number of equivalent peak stress cycles per seismic event is in accordance with IEEE-344-1975. The number of OBEs (2) and SSEs (1) has not been changed.

For ASME Class 1 piping the fatique analysis will consider 5 OBE events and a total of 50 equivalent peak stress cycles. This is in agreement with the SRP.

Section 3.7.3.2.1 of the FSAR will be revised to clarify the above relative to piping analysis and equipment qualification. (Attached: FSAR mark-up)

Prepared By: C.P. Brillante

Reviewed By: Joe Chen

Approved By: [signature] 4/30/91

2855M

In the analysis of piping subsystems there are two distinct approaches to seismic analysis; a detailed analysis described in general through Section 3.7.3 and discussed in Section 3.7.3.8.2; and a simplified analysis. The simplified piping system analysis is discussed in Section 3.7.3.8.3. 64

The general seismic analysis of Category I equipment and components is discussed in Section 3.7.3.16. Additional details applicable for simplified analysis are discussed in Sections 3.7.3.5 and 3.7.3.10. 64

The seismic analysis of HVAC subsystems is discussed in Section 3.7.3.17.

The seismic analysis of conduit and cable tray subsystems is discussed in Section 3.10.3.

The detailed seismic analyses of Category I subsystems is based upon dynamic analyses using the lumped mass normal mode method with idealized mathematical models. The inertial properties of the models are characterized by mass, eccentricity, and mass moment of inertia of each mass point. Mass points are located at carefully selected points in order to accurately model the subsystem as described in Section 3.7.3.3.1. The stiffness properties are characterized by the moment of inertia, area, torsion constant, Young's modulus, and shear modulus.

The response of Category I subsystems are computed by the response spectrum modal analysis method or the time history analysis method. All significant modes of vibration are considered in determining the total response. Subsystem response is calculated in three orthogonal directions.

Seismic responses of the Category I subsystems, equipment, and components are determined and combined in accordance with Sections 3.7.3.6 and 3.7.3.7. The damping ratios used in the dynamic analyses of the structures, subsystems, and equipment/components are shown in Table 3.7-2. 64

3.7.3.2 Determination of Number of Earthquake Cycles

3.7.3.2.1 Category I Systems and Components Other Than NSSS

During the design life of the plant (40 years), two earthquakes of OBE magnitude and one SSE are postulated to occur. This was based upon a study of seismic history in the Southern Appalachian Province over a 100-year period. Based on this study, each occurrence is conservatively assumed to have a time duration of 15 seconds of strong excitation. ~~The number of equivalent peak stress cycles considered for the OBE and the SSE are 20 cycles and 10 cycles, respectively~~. * 64

SEE ATTACHED PAGE FOR ADDITIONAL PARAGRAPHS ADDRESSING EQUIPMENT AND ASME CLASS 1 PIPING. *

Paragraphs to be added to FSAR Section 3.7.3.2.1:

For Class A Category I components, an evaluation of predominant frequencies revealed that the most significant response of components is conservatively considered using an average frequency of 20 Hz. Therefore, the number of cycles considered for the OBE and SSE are 600 and 300, respectively. (This paragraph reinstated from Amendment 51 of the FSAR.)

The seismic qualification testing of Category I equipment considers the number of events and durations described above in accordance with IEEE-344-1975.

<u>ASME Section III Class 1 Piping Analysis</u> - Since the piping in this scope has been reanalyzed in accordance with SRP requirements, the piping analysis has assumed the occurrence of 5 OBEs and 1 SSE. The number of peak stress cycles may be obtained from the synthetic time history used for the analysis (with a minimum duration of 10 seconds), or a minimum of 10 peak stress cycles per event assumed.