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TVA

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

MAR 13 1991

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

Gentlemen:

In the Matter of the Application of) Docket No. 50-438
Tennessee Valley Authority) 50-439

BELLEFONTE NUCLEAR PLANT (BLN) - TRANSMITTAL OF TVA POSITION REGARDING STRUCTURAL ANALYSIS METHODS AND CRITERIA FOR PIPING, TUBING, AND SUPPORTS (TAC #79277)

In accordance with TVA's letter to the NRC staff dated December 4, 1990, enclosed for staff review is the TVA position regarding its proposed approach for performing the reanalyses to provide verification of the adequacy of safety-related and Category I(L) piping, tubing, and supports at BLN.

In Section 4.1 of the enclosure, TVA requests NRC staff acceptance of the use of proposed criteria/methods that represent acceptable alternatives to guidance in applicable Standard Review Plan sections or involve approaches not yet formally addressed in NRC staff guidance. These criteria/methods are identified below:

(1) Response Spectra Analysis Methodology described in Section 4.1.1 and Table 2 of the enclosure.

(2) Damping Values for Uniform Response Spectra described in Section 4.1.2 and Table 2 of the enclosure.

(3) Peak Spectral Shifting as described in Section 4.1.3 and Table 2 of the enclosure.

(4) Use of OBE Load Cases as described in Section 4.1.4 and Table 2 of the enclosure.

In Sections 4.2.1 through 4.2.3 of the enclosure, TVA describes certain analytical methodologies intended to be used in the reevaluation of BLN piping, tubing, and supports. TVA seeks staff acceptance of specific portions of these analytical methodologies which are identified below:

MAR 13 1991

U.S. Nuclear Regulatory Commission

(1) Code Case N-468 methodology to perform study analyses to justify a site-specific equivalent load factor as discussed in Section 4.2.1 and Table 1 of the enclosure.

(2) NCIG-4 methodology, specified in EPRI Report NP-6628, dated April 1990, to demonstrate the structural adequacy of small bore piping, tubing, and supports as described in Section 4.2.2 and Table 1 of the enclosure.

(3) Methodology for reevaluation of Categories I(L)A and I(L)B piping described in Section 4.2.3 and Table 2.

A written staff position on the enclosure is requested by June 21, 1991. As discussed with NRC staff and management, timely resolution of key issues such as noted in the enclosure is important to TVA's consideration of the nuclear option at BLN. Should TVA proceed with construction of BLN after staff resolution of this and other positions, the agreements reached will be used to govern design, construction, and operation of BLN and will be incorporated into the BLN Final Safety Analysis Report, as appropriate.

Bruce S. Schofield will contact the BLN project manager to schedule working level meetings to assist in the staff's review of these positions. As discussed in our January 17, 1991 meeting with the staff, the first working level meeting will be scheduled approximately 10 days after staff receipt of this document.

If you have any questions please contact Mr. Schofield at (205) 574-8058.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

Mark J. Burzynski for

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

Enclosure
cc (Enclosure): See page 3

MAR 13 1991

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ENCLOSURE

BELLEFONTE POSITION PAPER

STRUCTURAL ANALYSIS METHODS AND CRITERIA

FOR PIPING, TUBING, AND SUPPORTS

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this position paper is to:

- Provide the criteria and methods that TVA intends to utilize in the reevaluation of safety-related and Category I(L) piping, tubing, and supports to assess or reaffirm the adequacy of the current, "as-built" plant configuration.

- Request NRC acceptance of specific regulatory criteria and analytical methodologies to be used by TVA in the reevaluation of safety-related and Category I(L)[1] piping, tubing, and supports at BLN. These analytical methods and criteria are described in Sections 4.1 and 4.2.1 through 4.2.3 and summarized in Tables 1 and 2.

2.0 SUMMARY

This position paper describes certain criteria and methods that TVA intends to use in the reevaluation of safety-related and Category I(L) piping, tubing, and supports at BLN. TVA intends to use a combination of reanalysis and reinspection to verify the adequacy of BLN safety-related and Category I(L) piping, tubing, and supports.

TVA requests NRC acceptance of the use of certain proposed criteria/methods, as described in Section 4.1, that represent acceptable alternatives to guidance in applicable Standard Review Plan (SRP) sections or involve approaches not yet formally addressed in NRC Staff guidance. For each alternative to SRP guidelines or approach not yet formally addressed in NRC Staff guidance, this position paper provides the technical justification for the TVA position.

TVA describes in Sections 4.2.1 through 4.2.3 certain analytical methodologies intended to be used in the reevaluation of BLN piping, tubing, and supports. TVA seeks Staff acceptance of specific portions of these analytical methodologies. (The scope and analytical methods of this reevaluation effort are summarized in Table 1.)

TVA describes in Sections 4.2.4 through 4.2.9 additional aspects of the reevaluation effort. These involve programmatic measures and controls to assist in the implementation of the reevaluation of piping and supports. Staff acceptance of these measures is not requested.

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[1] Category I(L) piping is defined as piping which is not safety-related but whose failure could reduce the functioning of safety-related plant features to an unacceptable level. Category I(L) piping is further sub-divided into Category I(L)A which is piping for which pressure boundary integrity must be maintained during a seismic event and Category I(L)B which is piping for which only structural integrity (position retention) must be maintained.

TVA describes in Section 4.2.10 current intentions with respect to the application of leak-before-break methodologies. TVA considers that the proposed application of leak-before-break methodology is consistent with Staff guidance.

3.0 BACKGROUND

The BLN Preliminary Safety Analysis Report (PSAR), submitted in support of the application for a construction permit in 1973, indicated the following with regard to the design and classification of piping and supports:

- Loading categories and allowable stress intensities for safety-related piping classified as ASME Class 1 shall meet the requirements of the ASME Boiler and Pressure Vessel Code, Section III, 1971 Edition.

- For ASME Class 2 and 3 piping, normal, upset, emergency, and faulted loading categories and allowable stress levels shall be in accordance with ASME Section III, Summer 1972 addenda.

- Non-safety-related piping that is required to be seismically designed shall be designed to the same loading requirements as defined for ASME Class 2 and 3 components.

The BLN PSAR was approved by a Safety Evaluation Report dated May 24, 1974, without exceptions with regard to piping or support design criteria. Detailed criteria and design methods were subsequently developed by TVA and implemented at BLN. These criteria upgraded the applicable ASME Code Section III edition to the 1974 edition, including the Summer 1974 addenda.

Several analysis methods have been used as the basis for the design of existing safety-related and Category I(L) piping and tubing and their supports at BLN. These analysis methods were in use up to the time of deferral in 1988.

- Rigorous analysis has been used for ASME Class 1, 2, and 3 piping except as indicated in the following paragraph. Rigorous analysis, as defined by TVA and used in this paper, means explicit dynamic analysis using the time history method or response spectrum method.

- A simplified analysis using the same analytical techniques as for the rigorous analysis but with less complete documentation (i.e., without analysis isometrics) or alternate criteria utilizing span tables has been used for ASME Class 2 and 3 and Category I(L)A piping less than 6 inches in diameter with a pressure less than 275 psig and a temperature less than 200 degrees F. Category I(L)A piping stresses are required to meet ASME Class 3 acceptance criteria.

- Category I(L)B piping and tubing has been analyzed and supported for dead load in accordance with ANSI B31.1.

4.0 TECHNICAL POSITIONS AND JUSTIFICATION

In its reevaluation effort for piping, tubing, and supports at BLN, TVA generally intends to apply technical criteria and analytical methodologies consistent with guidance in the applicable portions of the SRP. The particular provisions and editions of the SRP which TVA intends to apply in this reevaluation, subject to exceptions noted below or identified at a later time, are set out in References 1 through 9. These SRP sections generally describe means acceptable to the Staff to conform to those aspects of General Design Criteria 1, 2, 4, 14, and 15 applicable to piping, tubing, and supports.

4.1 Selected Criteria and Methods Proposed for BLN Reevaluation - Staff Acceptance Requested

4.1.1 Response Spectra Analysis Methodology

TVA proposes that modal and directional responses, including closely spaced frequencies, be combined by the square root of the sum of the squares (SRSS). This is a change from SRP Section 3.9.2 which applies an absolute sum combination of directional responses for closely spaced modal frequencies. TVA proposes to combine algebraically high frequency (i.e., greater than 33 Hz) modes prior to combination with other modes by SRSS.

TVA also proposes that stresses due to differential seismic anchor motion (SAM) from building motion be considered only if the piping system has anchors in independently responding structures. In this respect, the containment shell and containment internal structures will be considered to respond independently. In this case, SAMs for each direction will be summed by SRSS. For anchors in the same building, differential SAM from seismic building motion is typically less than 1/8 inch and therefore need not be considered.

Justification for the criteria discussed above is provided by References 10 through 12. Appendix N of the ASME Code Section III is consistent with the combination of modal and directional responses by SRSS, including closely spaced modes.

4.1.2 Damping Values for Uniform Response Spectra

TVA proposes that variable damping described in Code Case N-411 be allowed for enveloped uniform response spectra analyses. Technical justification for this variable damping is provided by Reference 10. TVA proposes to apply Code Case N-411 consistent with the provisions of the Code Case and Regulatory Guide 1.84 (13). TVA notes that the NRC has recently accepted the utilization of Code Case N-411 damping with enveloped uniform response spectra at Watts Bar Nuclear Plant (14). The utilization of N-411 damping with enveloped uniform response spectra was also approved for Washington Nuclear Project No. 1 in 1985 (15).

4.1.3 Peak Spectral Shifting

Regulatory Guide 1.122 (Reference 16) recommends that floor spectra be broadened to account for uncertainties in modeling and analytical techniques. As discussed in NUREG 1061(10), piping systems will be excited at only one peak frequency. The broadening of the input spectra can artificially increase the total energy to the system if there are modes with frequencies close to the peak frequency. Peak spectral shifting is an alternative that envelopes responses instead of enveloping the seismic input. This approach is included in NUREG 1061 and the revised Appendix N of the ASME Code and ASME Code Case N-397. Accordingly, TVA proposes that spectral peak shifting be allowed as an option to peak broadening.

4.1.4 OBE Load Cases

The Operating Basis Earthquake (OBE) is defined as that earthquake which produces the maximum vibratory ground motion for which those features of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public are designed to remain functional. In Reference 17 the Atomic Safety and Licensing Board for Diablo Canyon held that the Safe Shutdown Earthquake (SSE) is the seismic design basis for safety-related or Category I structures and equipment and the OBE is the benchmark for the balance of the plant. OBE load cases were included in the original TVA design criteria. Further, the existing piping and support designs are based on OBE loads as well as SSE. TVA proposes that OBE load cases be considered only in regard to secondary stress effects in accordance with Code Case N-451 for ASME Class 1 piping and Code Case N-462 for ASME Class 2 and 3 piping. Specifically, the load combination for which fatigue allowables must be met will include both the seismic inertia effect and the secondary effect from seismic anchor motions.

4.2 Analytical Methodologies and Approaches - Selected Staff Acceptance Requested

4.2.1 ASME Piping Reanalysis

TVA intends to reanalyze ASME Class 1 piping and large bore (greater than 2 inch diameter) ASME Class 2 and 3 piping. ASME Class 1 piping and ASME Class 2 and 3 piping greater than 6 inches in diameter will be reanalyzed by rigorous analysis. ASME Class 2 and 3 piping which is greater than 2 inches in diameter and less than or equal to 6 inches in diameter and contains moderate energy fluid (less than 200 degrees F and 275 psig) may be reanalyzed using either rigorous analysis or alternate criteria.

This reevaluation effort will utilize recalculated response spectra (see TVA position paper on Seismic Design of Category I Structures), the results of the walkdowns requested by IEB 79-14 (where necessary for piping analyzed by rigorous methods), the information on as-built variances reported by a number of change request documents which are being compiled into a data base, and the criteria and methods discussed below and summarized in Table 1.

Acceptable alternate analysis techniques include the utilization of span tables or an equivalent static analysis approach as provided in Reference 8. The utilization of span tables will be limited to piping with a design temperature less than or equal to 200 degrees F and where environmental temperature due to normal and upset conditions will not increase pipe temperature above 200 degrees F.

With respect to the equivalent static analysis approach, analyses will be performed to justify a site-specific equivalent static load factor. As called for by Section 3.7.2 of the SRP (8), these analyses will be presented to the Staff for acceptance. (These analyses are expected to be completed by June of 1991.) These analyses will follow the approach outlined in Code Case N-468 (22) with the added provision that the stiffnesses utilized in the analyses will be adjusted so that the fundamental natural frequencies for the models match the peak of the floor response spectra. This approach will eliminate the need to control piping system frequency for piping analyzed by equivalent static analysis. TVA specifically requests Staff acceptance of the utilization of the N-468 methodology for analyses to justify a site-specific equivalent static load factor.

One objective of the reevaluation effort will be to minimize the number of snubbers. Where the analysis results do not justify snubber removal, the analysis will be repeated to assess whether snubber replacement by a passive device such as a strut, energy absorber or seismic stop is justified.

Energy absorbers are designed to absorb energy by plastic deformation. ASME Code Case N-420 covers acceptable design methods for linear absorbing supports. NRC Regulatory Guide 1.84 accepts Code Case N-420 subject to each applicant's providing specified information prior to implementing the Code Case. Energy absorbers and pseudo-linear analysis methodology for their evaluation have been developed by Bechtel (18). The use of energy absorbers and the pseudo-linear analysis methodology developed by Bechtel were accepted by the NRC for snubber replacement on the Point Beach Unit 1 main steam bypass line (19). Applications of energy absorbers, including the information requested by Regulatory Guide 1.84 for use of Code Case N-420, will be justified on a case-specific basis.

Seismic stops with built in clearances or gaps have been developed by R. L. Cloud and Associates (RLCA) (20). Methodology developed by RLCA based on standard dynamic analysis methodology and equivalent linearization/iterative procedures would be used for evaluating the response of systems which utilize seismic stops. The use of seismic stops and the methodology for evaluating the response of systems containing seismic stops were accepted by the NRC for a pilot program at Byron Unit 2 to replace 13 snubbers with 8 seismic stops (21). Applications of the utilization of seismic stop methodology will be justified on a case-specific basis.

Supports for ASME Class 1 piping for which new loads calculated in the reevaluation exceed loads for which the supports have been previously justified will be reanalyzed to determine the acceptability of the support for the new loads.

For ASME Class 2 and 3 piping, bounding analyses of supports will be used for reconciliation with newly calculated loads. Supports with newly calculated loads higher by more than 10 percent than previously justified by calculation will be grouped into categories with similar geometries and supports. The supports are generally deflection limited and a load increase of 10 percent is not expected to substantially reduce the margin between calculated and allowable stress. The acceptable design loads for each category will be determined by analysis of the most limiting supports to demonstrate acceptability for the increased loads. This analysis will include a check against any deflection limits used in the analysis described above. This check on support rigidity will not be required for supports in piping systems analyzed using the equivalent static analysis approach due to the method used to determine the site specific equivalent static load factor in which the fundamental natural frequencies for the models for an equivalent static analysis approach match the peak of the floor response spectra.

Calculations showing acceptability of these reanalyzed bounding support configurations will provide the basis for justification of all supports for ASME Class 2 and 3 piping where newly calculated loads exceed by more than 10 percent the previously justified loads.

TVA specifically requests Staff acceptance of the bounding analyses of supports, as described above.

4.2.2 ASME Class 2 and 3 Small Bore Piping Verification

ASME Class 2 and 3 small bore (diameter 2 inches and smaller) piping will be verified as follows:

- Computerized piping flexibility analysis methods will be used to demonstrate adequate flexibility for piping to accommodate thermal expansion and seismic anchor movements. Alternate span table criteria may be utilized to demonstrate adequate flexibility for tubing.

- If accepted by the NRC, structural adequacy for small bore piping under seismic loading will be demonstrated by utilization of the NCIG-14 methodology. TVA understands that NUMARC plans to formally submit to the NRC the procedure for seismic qualification by this methodology bore piping (23). This procedure utilizes a seismic design method based on a generic analysis. The use of the NCIG-14 enveloping procedure is considered adequate to verify the structural adequacy under seismic loading of small bore piping and instrument tubing. In response to an inquiry to the ASME, the ASME Boiler and Pressure Vessel Committee issued a letter to Duke Power Company dated January 16, 1990, which indicates that a seismic evaluation procedure which envelopes anticipated seismic loads will meet Code requirements for piping (2 inches diameter and smaller) designed under the rules of Section III NC/ND-3600.

  TVA specifically requests Staff acceptance of utilization of the NCIG methodology for reevaluation of installed small bore piping concurrent with Staff review of the NUMARC/EPRI proposal.

- Screening walk-throughs of as-installed piping and tubing will be performed to identify and address issues related to the ability of piping flexibility to accommodate anchor movements and any potentially significant adverse spatial interactions.

- Supports will be analyzed to demonstrate the acceptability of vertical and horizontal loads, as recommended by EPRI Report NP-6628 (23). Horizontal loads will use peak acceleration from the 5 percent damped floor response spectra corresponding to the support elevations. The vertical loads will use deadweight plus 100 percent of the horizontal seismic loads and are considered to act in the downward direction. Allowable support stresses will be as specified in Subsection NF of Section III of the ASME Code.

- Analysis packages for ASME Class 2 and 3 small bore piping will meet requirements for ASME Code N-5 piping analysis packages.

4.2.3 Reevaluation for Category I(L) Piping

Category I(L)A and Category I(L)B piping and Category I instrument tubing will be checked for compliance with Final Safety Analysis Report (FSAR) commitments using a field screening process covering this piping which correlates design attributes and configurations with reliable seismic performance.

This field screening process will include review for dead load support spans and design detailing. Piping systems which are subject to high temperatures (greater than 200 degrees F) will be evaluated for thermal growth and impact on supports using computer analysis or simplified calculation methods. Systems which may be subjected to the effects of either inter-building, inter-system, or equipment anchor motions will be screened using earthquake experience and test data. The field screening process will identify design features which have resulted in past piping failures such as induced anchor motions and damage to fragile system components.

Outliers identified from plant walk-throughs and the screening process will be assessed by bounding analyses or individual evaluations using either rigorous computer analysis or simplified calculation methods.

TVA specifically requests Staff acceptance of the methodology for reevaluation of Categories I(L)A and I(L)B piping and Category I instrument tubing as described above.

4.2.4 Actions Requested by IEB 79-02 and IEB 79-14

Programs to address issues raised by IE Bulletins 79-02 and 79-14 were developed before deferral of BLN but were not completed. These programs will be completed and documented prior to licensing. As part of this effort, the program to resolve concerns addressed by IEB 79-14 will include all rigorously analyzed ASME Class 1, 2, and 3 piping.

4.2.5 Compilation of Operating Modes and Plant Transients

The operating modes and plant transients which must be addressed in the piping stress analysis will be compiled for each system which is safety-related or may adversely affect a safety-related system, i.e., Category I or I(L). This compilation will provide or reference the temperature and pressure of the piping for each operating mode, insulation weight, thermal and seismic anchor movements, and applicable seismic response spectra. This compilation will also identify instances where environmental temperature may affect piping stress and should be taken into account. Information on thermal-hydraulic transients which must be considered will be provided. The compilation of such an easily usable set of input data on operating loads and plant transients will facilitate verification that input information is correct and control of input data and updating of information.

4.2.6 Piping Configuration Data

Piping geometry and configuration data will be compiled for all piping to be rigorously analyzed. This data will be in a form which will facilitate checking of the data and its internal consistency. This data will then be used in analysis packages as these are required. The compilation of data will consolidate information required by piping analysts.

4.2.7 Assurance that Analyses Cover ASME Piping

For each system containing ASME piping, TVA intends to identify specific piping sections covered by individual analysis packages to assure complete analytical coverage of such systems.

4.2.8 Analysis Handbooks and Procedures

Analysis handbooks for piping stress analyses will be reviewed and revised as required to include current analytical criteria and methodologies and to resolve open issues. Separate handbooks will be developed to handle rigorous analyses and evaluations of piping using alternate criteria.

4.2.9 Data for Support Load Evaluation

Information on the loads for which adequacy of individual supports have been demonstrated by calculations or tests will be compiled. This compilation of data will facilitate checking of newly calculated support loads to identify those supports for which load margins have decreased as a result of the reanalysis effort.

4.2.10 Leak-Before-Break Analyses

TVA intends to perform leak-before-break analyses for applications where there are significant maintenance/accessibility/in-service inspection incentives for removal of existing pipe whip restraints or where the supports provided to restrain piping under postulated rupture loads cause high thermal stresses. Leak-before-break analyses will comply with the guidance provided in draft SRP Section 3.6.3, published in the Federal Register on August 28, 1987 (3).

Current candidates for application of leak-before-break methodology include:

- o Reactor coolant system
- o Pressurizer surge line
- o Core flood lines
- o Decay heat system
- o Portions of the main steam system where reliable leak detection and measurement can be assured.

This list may be expanded as other candidates are identified. With the exception of portions of the main steam line, leak-before-break justifications have been accepted by the NRC for specific applications for the systems listed above. For example, Reference 24 concludes that an acceptable technical basis has been provided to justify leak-before-break in the main loop primary piping of B&W Owners Group facilities. However, exemptions to General Design Criterion 4 to apply leak-before-break to eliminate protection against the dynamic loads resulting from postulated breaks of primary main loop piping must be justified on a facility specific basis. Applications for which leak-before-break has been justified and accepted by the NRC include both carbon steel and stainless steel systems.

For all high energy lines where leak-before-break criteria cannot be demonstrated to be met, the postulated pipe break location criteria in NRC Branch Technical Position MEB 3-1 (as referenced by Section 3.6.2, Revision 2, (5) of the SRP) will be used to determine the position of postulated intermediate high energy line breaks. Note that Generic Letter 87-11 (25) revised SRP Section 3.6.2 by removing all reference to arbitrary intermediate breaks in Branch Technical Position MEB 3-1.

With the exception of the elimination of arbitrary intermediate breaks (which does not require Staff acceptance), case-specific applications of leak-before-break will be submitted at a later time for Staff acceptance.

5.0 ADDITIONAL ISSUES TO BE ADDRESSED DURING REEVALUATION

TVA intends to address various open issues as part of the reevaluation effort for BLN. TVA notes below the sources of such issues which will be included in the reevaluation effort.

5.1 Resolution of Open Items

BLN open items (CAQs, Employee Concerns, etc.) applicable to piping and piping supports will be reviewed, and resolutions will be developed for open items affecting the analyses or structural adequacy of safety-related and Category I(L) piping.

5.2 Review of Applicable Issues at Other TVA Plants

Technical issues or concerns applicable to piping, tubing, or supports identified at other TVA plants (i.e., Browns Ferry, Sequoyah, and Watts Bar) and their resolutions will be reviewed for applicability to BLN. A specific disposition for each applicable design or analysis issue will be developed for BLN.

6.0 REFERENCES

1. SRP Section 3.9.2, "Dynamic Testing and Analysis of Systems, Components, and Equipment," Revision 2, July 1981.

2. SRP Section 3.9.3, "ASME Code Class 1, 2, and 3 Components, Component Supports, and Core Support Structures," Revision 1, July 1981.

3. Draft SRP Section 3.6.3, "Leak-Before-Break Evaluation Procedures," as published in the Federal Register, Vol. 52, No. 167, dated August 28, 1987.

4. SRP Section 3.6.1, "Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," Revision 2, October 1990.

5. SRP Section 3.6.2, "Determination of Rupture Locations and Dynamic Effects Associated With the Postulated Rupture of Piping," Revision 1, July 1981.

6. SRP Section 3.9.1, "Special Topics for Mechanical Components," Revision 2, July 1981.

7. SRP Section 3.7.1, "Seismic Design Parameters," Revision 2, August 1989.

8. SRP Section 3.7.2, "Seismic System Analysis," Revision 2, August 1989.

9. SRP Section 3.7.3, "Seismic Subsystem Analysis," Revision 2, August 1989.

10. NUREG 1061, Volume 2, "Report of the US Nuclear Regulatory Commission Piping Review Committee - Evaluation of Seismic Designs - A Review of Seismic Design Requirements for Nuclear Power Plant Piping," April 1985.

11. NUREG 1061, Volume 4, "Report of the U.S. Nuclear Regulatory Commission Piping Review Committee - Evaluation of Other Dynamic Loads and Load Combinations," December 1984.

12. NUREG/CR 3811, "Alternate Procedures for the Seismic Analysis of Multiply Supported Piping Systems," August 1984.

13. Regulatory Guide 1.84, "Design and Fabrication Code Case Acceptability, ASME Section III, Division 1," Revision 24, June 1986.

14. NRC Letter, Docket No. 50-390, dated June 29, 1989, "Watts Bar Nuclear Plant (WBN) - Revision to Corrective Action Program (CAP) Plan for Hanger and Analysis Update Program (HAAUP).

15. NRC Letter, Docket 50-460, dated August 22, 1986, "Approval of ASME Code Case N-411 - Washington Nuclear Project No. 1."

16. Regulatory Guide 1.122, "Development of Floor Design Response Spectra for Seismic Design of Floor-Supported Equipment or Components," Revision 1, dated February 1978.

17. Atomic Safety and Licensing Appeal Board Decision in the Matter of Pacific Gas and Electric Company (Diablo Canyon Nuclear Power Plants, Units 1 and 2), Docket Nos. 50-275 OL and 50-323 OL (Seismic Proceeding), dated June 16, 1981 (ALAB-644).

18. "Energy Absorbers in a Full Scale Dynamic Test," by A. S. Yan, H. M. Lee, and A. Singh, ASME PVP-182, 1989, ASME Pressure Vessels and Piping Conference, Honolulu, Hawaii, July 23-27, 1989.

19. NRC Letter Docket Nos. 50-266 and 50-301, dated April 10, 1987, forwarding "Safety Evaluation Report - Point Beach Nuclear Plant - Energy Absorbers as Replacements for Snubbers on the Unit 1 Main Steam Bypass Line."

20. "Seismic Stops for Nuclear Power Plants," by R. L. Cloud, J. S. M. Leung, P. H. Anderson, Mechanical Engineering, October 1989.

21. NRC Letter, Docket Nos 50-454, 50-455, 50-456 and 50-457, dated May 21, 1990, "Implementation of Seismic Stops at Byron Station, Unit No. 2 (TAC No. 74116)."

22. ASME Code Case N-468, "Alternate Method of Earthquake Description for Class 2 and 3 Piping at Low Seismicity Sites, Section III, Division 1," approved by ASME, March 8, 1989.

23. "Procedures for Seismic Evaluation and Design of Small Bore Piping (NCIG-14)," EPRI Report NP-6628, dated April 1990.

24. NRC Letter to B&W Owners Group Leak-Before-Break Task Force dated December 12, 1985.

25. Generic Letter 87-11, "Relaxation in Arbitrary Intermediate Pipe Rupture Requirements," dated June 19, 1987.

Table 1

SUMMARY OF BELLEFONTE PIPING REANALYSIS SCOPE AND METHODS

Classification	Size	Additional Restrictions/ Limits	Reanalysis/ Reevaluation Scope	Proposed Seismic Reanalysis/Reevaluation Methods	Proposed Criteria	Remarks
Category I - ASME Class 1 Piping	All	----	100%	Rigorous	ASME Code Class 1	Dynamic analysis could include time history in specific cases
Category I - ASME Class 2 and 3 Piping	> 6" ϕ	or P ≥ 275 psi or T ≥ 200 °F	100%	Rigorous	ASME Code Class 2 and 3	Dynamic analysis could include time history in specific cases
	≤ 6" ϕ and > 2" ϕ	and P < 275 psig and T < 200°F	100%	Rigorous or Alternate (Equivalent Static or Span Table)		
Category I - ASME Class 2 and 3 Piping and Instrument Tubing	≤ 2" ϕ	--	100%	NCIG-14 (Rigorous and Alternate also acceptable)	NCIG-14	
Category I(L) Piping I(L)A and I(L)B and Category I Instrument Tubing	All	--	Bounding cases	Dead weight and thermal flexibility by Alternate Analyses (Equivalent Static or Span Table). Walkdown criteria, based on bounding analyses.	Walkdown Criteria	Walkdown criteria will include horizontal support requirements for seismic.

General Note: All Category I and Category I(L)A piping and tubing with design/operating temperature greater than 200°F will be analyzed for flexibility using computerized analysis methods.

TABLE 2

BELLEFONTE PIPING ANALYSIS CRITERIA AND METHODS

CRITERIA/ METHOD	NRC GUIDANCE	REFERENCES	TVA POSITION FOR BELLEFONTE	TECHNICAL REFERENCES
1. Response Spectra Analysis Methodology	1. Uniform response spectrum (enveloped) or independent support motion analyses are allowed. 2. Directional responses are to be combined by the square root of the sum of the squares (SRSS) method. Modal responses are to be combined by SRSS with special consideration for closely spaced modes per Reg. Guide 1.92. (1). 3. For independent support motion, group responses are combined by absolute sum. 4. Seismic anchor motion (SAM) responses are to be combined in "The Most Unfavorable" way (Pseudostatic effeots).	• SRP 3.9.2 • Reg. Guide 1.92	1. Uniform spectrum (enveloped) or independent support motion analyses will be allowed in combination with the criteria below. 2. Modal and directional responses including responses of closely spaced modal frequencies will be combined by the SRSS method. High frequency modes will be combined algebraically prior to being combined with other modes by SRSS. (2) 3. Where applicable (independent spectra input), group responses for each direction will be combined by the absolute sum method. 4. Stresses due to differential seismic anchor motion (SAM) from building motion will be considered only if the piping system being analyzed has supports attached to independently responding structures, e.g., the reactor and turbine buildings. Group responses for each direction will be combined by the SRSS method.	• NUREG 1061 (Vol. 4, Sec 2) • NUREG/CR 3811 • Revised Appendix N of ASME Code • NRC Memo dated 10/3/89
2. Damping Values	1. Regulatory Guide 1.61 damping is allowed. 2. Variable damping specified in ASME Code Case N-411 may be used but is limited to the uniform (enveloped) spectra analysis method.	• SRP 3.9.2 • Reg. Guide 1.84 (Rev 24)	1. Damping values will be taken from either of: • Regulatory Guide 1.61 or • Variable Damping Specified in ASME Code Case N-411(3) 2. Variable Damping (N-411) will be allowed for uniform spectrum but not for independent spectra analyses.	• NUREG 1061 (Vol.2, Sec. 2)

TABLE 2 (Cont'd)

BELLEFONTE PIPING ANALYSIS CRITERIA AND METHODS

CRITERIA/ METHOD	NRC GUIDANCE	REFERENCES	TVA POSITION FOR BELLEFONTE	TECHNICAL REFERENCES
3. Peak Spectral Shifting	1. Peaks of Floor spectra must be broadened to account for uncertainties.	• Reg. Guide 1.122	1. Spectral peak shifting will be allowed as an option per revised Appendix N of ASME Code.	• Revised Appendix N of ASME Code • ASME Code Case N-397
4. OBE Load Cases	1. OBE is defined as an earthquake that could reasonably be expected to occur over plant life. 2. OBE shall be at least one-half of SSE.	• 10 CFR 100, Appendix A	1. OBE definition and load cases were addressed in the original design. In reevaluation, consideration of OBE will be limited to OBE contribution to secondary stress and fatigue. Specifically, the load combination for which fatigue allowables must be met will include both the OBE seismic inertia effect and the secondary effect from seismic anchor motions.	• ALAB - 644 (Diablo Canyon) June 16, 1981. • NUREG 1061 (Vol. 2, Sec. 3) • Code Case N-451 • Code Case N-462

Notes:

1. Combination of High Frequency Modes is not addressed.
2. High Frequency modes are modes in excess of about 33 HZ for Reg. Guide 1.60 Spectra (BLN Spectra).
3. This does not apply to time history analyses.