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SUBJECT: Forwards rev to seismic qualification of equipment position paper. Following resolution of position, agreements will be incorporated into FSAR.

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**AUG 28 1991**

U.S. Nuclear Regulatory Commission  
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Gentlemen:

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

BELLEFONTE NUCLEAR PLANT (BLN) - TRANSMITTAL OF REVISION TO TVA POSITION  
REGARDING SEISMIC QUALIFICATION OF EQUIPMENT (TAC #79279)

In accordance with the August 7, 1991 telephone conference between TVA and the NRC, the enclosed is the revision to the Seismic Qualification of Equipment position paper. Following resolution of this position, 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.

A written staff position on the enclosure is requested by September 20, 1991.

If you have any questions, please contact Paul Wilson at (205) 574-8544.

Very truly yours,

W. J. Museler

Enclosure  
cc: See page 2

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## ENCLOSURE

### BELLEFONTE POSITION PAPER REGARDING SEISMIC QUALIFICATION OF EQUIPMENT

#### PURPOSE

This document describes TVA's criteria for seismic qualification of mechanical and electrical equipment at the Bellefonte Nuclear Plant (BLN), and TVA's program for further verifying and documenting the seismic adequacy of equipment. TVA requests NRC staff concurrence that the BLN seismic equipment qualification (SEQ) criteria (with the changes described below) and the SEQ verification program described herein are sufficient to demonstrate the seismic adequacy of Category I and Category I(L) equipment.

#### SUMMARY

It is TVA's position that the current BLN criteria for seismic qualification of equipment, with the changes described in this document, are proper for licensing of the plant. Electrical equipment was qualified in accordance with IEEE 344-1975, except for B&W supplied instrumentation and control (I&C) equipment which was qualified to IEEE 344-1971 criteria and the supplemental requirements provided in Reference 9. Where practicable (i.e., where qualification test reports exist), the documentation for the B&W supplied I&C equipment will be upgraded to IEEE 344-1975 criteria. Mechanical equipment was designed to ASME Code criteria, where applicable, or other criteria generally consistent with IEEE 344-1975.

The SEQ verification program described later in this document, as well as the Seismic Margins Assessment described in Bellefonte position paper regarding Seismic Design Ground Motion (8), will provide additional assurance of the seismic adequacy of mechanical and electrical equipment at BLN.

#### BACKGROUND

Appendix A to 10 CFR Part 100 requires in part that structures, systems, and components important to safety be designed to withstand the effects of the safe shutdown earthquake (SSE) and remain functional. These items are designated as Seismic Category I in accordance with Regulatory Guide 1.29 (1). In addition, those portions of structures, systems, and components that are not required to remain functional during an SSE, but whose failure could cause unacceptable damage to any Category I item, should be designed so that the SSE would not cause such damage to occur. These items are designated as Seismic Category I(L) at BLN. (See Regulatory Guide 1.29, Section C.2, and BLN Final Safety Analysis Report (FSAR), Section 3.7.2.8.)

Sections 3.9 and 3.10 of the BLN Preliminary Safety Analysis Report (PSAR) specified criteria for seismic qualification of mechanical and electrical equipment. The criteria for Category I mechanical equipment such as pumps, valves, heat exchangers, tanks, major NSSS components, and reactor internals generally specified the use of analytical methods. The criteria specified in the PSAR for Category I electrical equipment were in accordance with IEEE 344-1971 (2). The NRC staff approved the PSAR seismic qualification

criteria supplemented by the requirements contained in Enclosure 5 to an NRC letter to TVA dated September 14, 1973 in its May 24, 1974 Safety Evaluation Report (3) for a construction permit. The seismic qualification criteria and program subsequently included in the FSAR, and described below, meet or exceed these previously approved criteria.

Current BLN criteria for seismic qualification of Category I mechanical equipment are provided in Section 3.9 of the FSAR. Category I mechanical equipment is qualified by analysis, static and/or dynamic testing, or a combination of analysis and testing. ASME Code components are required to meet the design requirements of Section III of the Code (4). Specific criteria for seismic qualification of reactor coolant system (RCS) mechanical components (reactor internals, reactor coolant piping, control rod drive mechanisms, etc.) are provided in Section 3.9.3 of the FSAR. Specific criteria for ASME Code Class 2 and 3 pumps and Class 1, 2, and 3 valves, and their respective drives, operators, and vital auxiliary equipment are provided in Section 3.9.3.2 of the FSAR. The active pumps and valves also meet Regulatory Guide 1.48 (5), which delineates for ASME Code components acceptable design limits and appropriate loading combinations associated with plant conditions and seismic events. Other active mechanical equipment is qualified in accordance with methods similar to those for pumps and valves. Testing procedures similar to those for electrical equipment in IEEE 344-1975 (6) are used for components that are mechanically or structurally complex, and for which the responses cannot be adequately predicted by analytical methods.

Criteria for seismic qualification of Category I electrical equipment are provided in Section 3.10 of the FSAR. Category I electrical equipment, except for B&W supplied I&C equipment, is qualified to IEEE 344-1975 criteria. B&W supplied I&C equipment is qualified to IEEE 344-1971 criteria and the supplemental requirements in Reference 9. The supplemental requirements require, in part, multi-frequency, biaxial testing equivalent to the requirements of IEEE 344-1975. Additional information regarding the types and numbers of the B&W supplied I&C equipment, and the testing methods used, are given in Attachment 1.

Criteria for seismic qualification of Category I(L) equipment and structures are provided in Section 3.2.1 of the FSAR. The criteria require that Category I(L) equipment and structures maintain structural integrity during the SSE so that a failure would not reduce the functioning of any Category I item to an unacceptable level or result in incapacitating injury to occupants of the control room.

#### **TECHNICAL POSITION AND APPROACH**

1. The current FSAR criteria described above for seismic qualification of Seismic Category I and Category I(L) mechanical and electrical equipment are considered adequate. Mechanical and electrical equipment (except for B&W supplied instrumentation and control (I&C) equipment) was qualified to IEEE 344-1975 criteria. B&W supplied I&C equipment was qualified to criteria that met the intent of the recommended practices of IEEE 344-1975. In addition, approximately 30 percent of the individual B&W supplied I&C equipment items were subsequently qualified to IEEE 344-1975 criteria in connection with the Washington Public Power Supply Systems WNP-1 Plant (a similar B&W NSSS plant). The BLN documentation for B&W supplied I&C equipment will be supplemented with WNP-1 qualification reports where such reports exist.

2. An SEQ verification program will be performed. The verification program will include the following elements.
  - a. An SEQ list will be generated. This list will include all equipment for which seismic evaluation is required, i.e., the Seismic Category I and Category I(L) equipment.
  - b. For each Category I item on the SEQ list, seismic qualification data will be compiled and an SEQ qualification package will be assembled. Data to be compiled for the SEQ packages will include:
    - o Equipment design specification
    - o Equipment procurement specification
    - o Vendor drawings
    - o Seismic qualification report (or equivalent)
    - o Field walkdown data (if appropriate)
    - o TVA review and evaluation sheets
    - o Seismic design input
    - o FSAR commitments

SEQ packages will be reviewed to ensure that the seismic qualification reports for individual equipment items meet applicable requirements of the FSAR, as supplemented by the requirements of Reference 9, for B&W supplied I&C equipment. The effects of the new floor response spectra (see Bellefonte Position Paper Regarding Seismic Design of Category I Structures (7)) on the seismic qualification reports will be reviewed. The reviews of the SEQ packages will be performed in accordance with a written procedure to ensure consistency and uniformity of the reviews. Potential nonconformances identified as a result of these reviews will be dispositioned on a case-by-case basis using available industry data and evaluated by engineers experienced in the seismic qualification of equipment.

- c. Category I(L) equipment will be evaluated for structural adequacy where potential adverse interactions with Category I equipment could occur. Where appropriate, this evaluation will be performed as part of the planned seismic interaction review. Where necessary (e.g., in the case of potential flooding from tanks), analytical checks of Category I(L) equipment will be made. The results of these evaluations will be documented.
- d. To provide further assurance of the acceptability of equipment anchorages, an evaluation of anchorages for major classes of equipment will be performed. The evaluation will consider the as-built anchorage details and the new floor response spectra. A plant walk-through inspection will be conducted to select the limiting equipment anchorages from each equipment class for the subsequent evaluation.
- e. Finally, outstanding unresolved issues (e.g., Condition Adverse to Quality Reports) relating to seismic equipment qualification will be identified, addressed, and resolved as part of activities (a) through (d) above.

## TECHNICAL JUSTIFICATION

The technical justification for TVA's position on seismic qualification of equipment is summarized below.

1. Electrical equipment (except for B&W supplied I&C equipment) has been qualified to IEEE 344-1975 criteria, which meets current NRC requirements. Mechanical equipment has been qualified by analysis to ASME Code criteria where applicable. Other mechanically or structurally complex components have been qualified to criteria comparable to IEEE 344-1975 criteria.
2. B&W supplied I&C equipment has been qualified to IEEE 344-1971 criteria and the supplemental requirements of Reference 9. These criteria meet the intent of the recommended practices of IEEE 344-1975 criteria and are considered acceptable for this equipment. In addition, the documentation for this equipment will be supplemented with WNP-1 qualification reports where such reports exist.
3. The SEQ verification program described above will ensure that BLN's safety-related equipment is not damaged, nor its operating capability impaired to an unacceptable level during a design basis seismic event. The program also insures that adequate seismic qualification documentation is compiled and maintained for Category I and Category I(L) equipment, and that seismic qualification reports for individual equipment items meet applicable requirements. The program will also ensure that the new floor response spectra being generated for BLN will be reviewed for effects on previous seismic qualification reports. This will ensure that the basis for qualification of equipment (including anchorages) remains valid in view of any new floor response spectra.
4. As part of its seismic verification of BLN, TVA will perform a Seismic Margins Assessment (SMA) as described in Bellefonte Position Paper Regarding Seismic Design Ground Motion (8). The SMA will utilize final NRC guidelines and will provide further assurance of the seismic adequacy of mechanical and electrical equipment.

## REFERENCES

1. Regulatory Guide 1.29, Seismic Design Classification, Rev. 3, U.S. Nuclear Regulatory Commission, September 1978
2. IEEE Standard 344-1971, IEEE Guide for Seismic Qualification of Class I Electric Equipment for Nuclear Power Generating Stations, Institute of Electrical and Electronics Engineers, Inc., September 16, 1971
3. Safety Evaluation of the Bellefonte Nuclear Plant Units 1 and 2, U.S. Atomic Energy Commission, May 24, 1974
4. ASME Boiler and Pressure Vessel Code, Section III, 1971 Edition with Addenda through Summer 1972
5. Regulatory Guide 1.48, Design Limits and Loading Combinations for Seismic Category I Fluid System Components, U.S. Nuclear Regulatory Commission, May 1973. (Now incorporated into Section 3.9.3 of the Standard Review Plan)
6. IEEE Standard 344-1975, IEEE Recommended Practices for Seismic Qualification of Class IE Equipment for Nuclear Generating Stations, Institute of Electrical and Electronics Engineers, Inc., January 31, 1975
7. Bellefonte Position Paper Regarding Seismic Design of Category I Structures, Enclosure to TVA Letter from E. G. Wallace to NRC, dated February 14, 1991
8. Bellefonte Position Paper Regarding Seismic Design Ground Motion, Enclosure to TVA Letter from E. G. Wallace to NRC, dated February 14, 1991.
9. Enclosure 5 to Atomic Energy Commission (AEC) Letter From A. Schwencer to TVA (J. E. Watson), dated September 14, 1973

ATTACHMENT 1

SEISMIC QUALIFICATION OF B&W SUPPLIED INSTRUMENTATION AND CONTROL (I&C) EQUIPMENT AT BELLEFONTE NUCLEAR PLANT (BLN)

The I&C equipment supplied by B&W to BLN includes various modules, components, cabinets, and consoles supplied by Bailey Controls Company (BCCo) and other vendors. The approximate numbers of these various equipment items are shown below.

<u>Type</u>	<u>Total Number for Both Units</u>
BCCo modules (820, 882, 885, and 890 product line modules)	~2800
manufactured components (such as meters)	~400
Components manufactured by BCCo subvendors (e.g., Lambda, Vitro)	~3000
BCCo manufactured parts used with the modules and components	~140
BCCo cabinets and consoles	~140

Approximately 67 unique equipment items were used as type test units to qualify all equipment to IEEE 344-1971 criteria and the supplemental requirements in Reference 9. Overall, the qualification program used for the B&W I&C equipment items meets the intent of the recommended practices of IEEE 344-1975. The following table lists the supplemental requirements of Reference 9 and identifies the methods by which these supplemental requirements were met.

REFERENCE 9 SUPPLEMENTAL REQUIREMENTS	BLN IMPLEMENTATION
<b>I. SEISMIC TEST FOR EQUIPMENT OPERABILITY</b>	
<p>1. A test program is required to confirm the functional operability of all Seismic Category I electrical and mechanical equipment and instrumentation during and after an earthquake of magnitude up to and including the SSE.</p>	<p>The B&amp;W program for BCCo manufactured I&amp;C modules, components, and parts, defined in B&amp;W Document 11-1305000001, "Seismic Design Specification," specifies a program to confirm the functional operability of all B&amp;W supplied 1E I&amp;C equipment during and after an earthquake of magnitude up to and including the SSE. In general, operability was confirmed by subjecting the equipment to multi-frequency, biaxial excitation while the equipment was in the operational condition. B&amp;W I&amp;C equipment was subjected to the equivalent of two BLN SSEs.</p>
<p>2. The characteristics of the required input motion should be specified by one of the following:</p> <ul style="list-style-type: none"> <li>(a) response spectrum</li> <li>(b) power spectral density function</li> <li>(c) time history</li> </ul> <p>Such characteristics, as derived from the structures or systems seismic analysis, should be representative of the input motion at the equipment mounting locations.</p>	<p>The characteristics of the required input motion are specified by the required response spectra (RRS) in B&amp;W Document 54-6581, "Seismic Qualification Test Procedure for Class 1E Modules." The RRSs are derived from the structure and system seismic analyses and define the motion at the equipment mounting locations. The derivation of the response spectrum is also described in Section 3.7 of the FSAR.</p>
<p>3. Equipment should be tested in the operational condition. Operability should be verified during and after the testing.</p>	<p>Equipment was tested in the operational condition and operability was verified during and after the testing as shown in the individual test reports for each device. The individual test reports for the B&amp;W supplied 1E I&amp;C equipment are summarized in Section 3.10A of the FSAR.</p>
<p>4. The actual input motion should be characterized in the same manner as the required input motion, and the conservatism in amplitude and frequency content should be demonstrated.</p>	<p>The actual input motion was characterized in the same manner as the required input motion, and the conservatism in amplitude and frequency content is demonstrated in the individual test reports.</p>

<p>5. Seismic excitation generally have a broad frequency content. Random vibration input motion should be used. However, single frequency input, such as sine beats, may be applicable provided one of the following conditions are met:</p> <ul style="list-style-type: none"> <li>(a) The characteristics of the required input motion indicate that the motion is dominated by one frequency (i.e., by structural filtering effects).</li> <li>(b) The anticipated response of the equipment is adequately represented by one mode.</li> <li>(c) The input has sufficient intensity and duration to excite all modes to the required magnitude, such that the testing response spectra will envelope the corresponding response spectra of the individual modes.</li> </ul>	<p>Random input motion with a multi-frequency content was used as described in B&amp;W Document 54-6581, "Seismic Qualification Test Procedure for Class 1E Modules."</p>
<p>6. The input motion should be applied to one vertical and one principal (or two orthogonal) horizontal axis simultaneously unless it can be demonstrated that the equipment response using the vertical direction is not sensitive to the vibratory motion along the horizontal direction and vice versa. In the case of single frequency input, the time phasing of the inputs in the vertical and horizontal directions must be such that a purely rectilinear resultant input is avoided.</p>	<p>The modules were tested with a biaxial dependent input motion that was applied to simulate excitation in one vertical and one horizontal axis simultaneously with the input motions repeated in four different orientations. The input motion used is described in B&amp;W Document 54-6581, "Seismic Qualification Test Procedure for Class 1E Modules."</p>
<p>7. The fixture design should meet the following requirements:</p> <ul style="list-style-type: none"> <li>(a) Simulate the actual service mounting.</li> <li>(b) Cause no dynamic coupling to the test item.</li> </ul>	<p>The fixture design simulated the actual service mounting and caused no dynamic coupling to the test item as described in the individual test reports.</p>

REFERENCE 9 SUPPLEMENTAL REQUIREMENTS	BLN IMPLEMENTATION
<b>II. SEISMIC DESIGN ADEQUACY OF SUPPORTS</b>	
<p>1. Analyses or tests should be performed for all supports of electrical and mechanical equipment and instrumentation to ensure their structural capability to withstand seismic excitation.</p>	<p>The B&amp;W test program, defined in the individual test plans and test procedures for the cabinets and consoles, specifies the tests and analyses that were performed for all B&amp;W supplied cabinets and panels which act as supports of electrical and mechanical equipment and instrumentation. The results of this test program demonstrate the supports' structural capability to withstand seismic excitation, as described in the individual test reports.</p>
<p>2. The analytical results must include the following:</p> <p>(a) The required input motions to the mounted equipment should be obtained and characterized in the manner as stated in Section I.2.</p> <p>(b) The combined stresses of the support structures should be within the limits of ASME Section III, Subsection NF - "Component Support Structures" (draft version) or other comparable stress limits.</p>	<p>The individual qualification test reports for the supports demonstrate that the required input motions to the mounted equipment were obtained and characterized in the manner stated in Section I.2, and that the combined stresses of the support structures are within the limits of ASME Section III, Subsection NF - "Component Support Structures."</p>
<p>3. Supports should be tested with equipment installed. If the equipment is inoperative during the support test, the response at the equipment mounting locations should be monitored and characterized in the manner as stated in Section I.2. In such a case, equipment should be tested separately and the actual input to the equipment should be more conservative in amplitude and frequency content than the monitored response.</p>	<p>The cabinets and panels were tested with simulated equipment loads installed. Since the equipment was not operative during the cabinet and panel tests, the response at the equipment mounting locations was monitored and characterized in the manner as stated in Section I.2. The equipment was tested separately and the actual input to the equipment was more conservative in amplitude and frequency content than the monitored response. The actual input to the equipment is documented in the individual test report.</p>
<p>4. The requirements of Sections I.2, I.4, I.5, I.6, and I.7 are applicable when tests are conducted on the equipment supports.</p>	<p>The requirements of Sections I.2, I.4, I.5, I.6, and I.7 were applied to the tests conducted on the equipment cabinets and panels.</p> <p>The cabinets and panels were tested with a biaxial independent input motion that was applied to one vertical and one principal horizontal axis simultaneously as described in the individual test reports</p>