

TENNESSEE VALLEY AUTHORITY

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SEP 12 1990

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) - DAMPING VALUES FOR HEATING, VENTILATING, AND AIR CONDITIONING (HVAC) DUCTS, CONDUIT, AND CABLE TRAY SYSTEMS

Reference: TVA letter to NRC dated April 30, 1990, Damping Values for Heating, Ventilating, and Air Conditioning (HVAC), Conduit, and Cable Tray Systems at WBN

Enclosed are the damping values for cable tray, conduit, and HVAC systems at WBN. These values were presented during the August 2, 1990 meeting with NRC's staff regarding civil and seismic issues at WBN. Justification for the damping values had previously been provided to NRC during engineering team inspection 390, 391/89-21 conducted at WBN November 13 through 17, 1989.

TVA's previous submittal, referenced above, is superseded by the enclosed.

TVA requests NRC's acceptance of these values for use at WBN as part of the corresponding corrective action program plans. These values are also included in Amendment 64 of the WBN Final Safety Analysis Report.

If there are any questions, please telephone P. L. Pace at (615) 365-1827.

Very truly yours,

TENNESSEE VALLEY AUTHORITY



E. G. Wallace, Manager  
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Enclosures  
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## ENCLOSURE 1

DAMPING VALUES FOR QUALIFICATION OF  
ELECTRICAL CONDUIT AND CONDUIT SUPPORTS FOR DYNAMIC LOADSI. BACKGROUND

Damping is used to account for varying degrees of energy dissipation under dynamic loadings in structures and systems consisting of different materials and types of construction. The conduit systems at WBN consist generally of rigid steel and aluminum conduit with welded steel supports and bolted support attachments. The conduit is filled with various amounts and types of electrical cables. These characteristics common to the conduit system are sources for energy dissipation and contribute to higher damping values.

II. DAMPING VALUES

Based on damping test data, the values of damping for WBN conduit and conduit supports are as follows for both rigid steel and aluminum conduit systems. The damping value for application to operating basis earthquake (OBE) is 4 percent and 7 percent for safe shutdown earthquake (SSE) and design basis accident (DBA) events.

III. TECHNICAL BASIS

Testing by TVA (Reference 1) and ANCO (Reference 2) has demonstrated higher damping values for conduit systems. These test programs considered numerous variables including conduit size, cable fill ratio, span length, clamp type, etc., that are common to conduit systems. The results of these tests show that 4 and 7 percent damping is sufficiently conservative for conduit systems used at WBN. Additionally, the 4 and 7 percent damping values are consistent with the Standard Review Plan (SRP) damping for conduit and conduit support systems.

IV. SUMMARY/CONCLUSIONS

In summary, supportive test data is available demonstrating that damping values are 4 percent for OBE and 7 percent for SSE/DBA events for rigid steel and aluminum conduit systems used at WBN. These damping values are consistent with Final Safety Analysis Report (FSAR) Amendment 64.

V. REFERENCES

1. TVA, "Summary Test Report on Damping in Electrical Conduit," Report Number CEB-BN-1028, June 23, 1987.
2. ANCO Engineers, Inc, "Cable Tray and Conduit Raceway Seismic Test Program," Prepared for Bechtel Power Corporation, Report Number 1053-21.1-4, Release December 15, 1978.
3. Watts Bar Nuclear Plant Seismic Analysis Corrective Action Program Plan, Revision 1 (L44 890629 807).

## ENCLOSURE 2

DAMPING VALUES FOR QUALIFICATION  
OF CABLE TRAY AND CABLE TRAY SUPPORTS FOR DYNAMIC LOADSI. BACKGROUND

Damping is used to account for varying degrees of energy dissipation under dynamic loadings in structures and systems consisting of different materials and types of construction. Although the WBN FSAR includes damping values used for general welded or bolted steel structures, it does not specifically address damping values for cable tray systems. These systems consist of welded tube steel supports with bolted tray assemblies, which include bolted support attachments, fittings, and splices. The majority of the cable tray runs consist of multiple levels of trays on common supports. The trays are fabricated of relatively light gauge formed sheet metal and are loaded with varying amounts and types of coated and uncoated cables. The system damping as well as the system frequency will be controlled by the cables and trays as observed in tests.

II. DAMPING VALUES

A 4 percent damping value for OBE and a 7 percent damping value for SSE and DBA loading conditions are to be used in evaluating WBN cable tray systems.

III. TECHNICAL BASIS

Regulatory Guide (RG) 1.61 does not specifically address damping values for bolted or welded cable tray systems although the general damping values for bolted and welded steel structures are provided.

Alternatively, RG 1.61 also allows use of test data to support higher damping values. Consistent with this provision, a higher damping value was obtained in Reference 1, Section 7.2. Several characteristics inherent to cable tray systems contribute to the observed phenomenon of higher damping.

- A. The mass of cable (coated or uncoated) vibrating within the tray tends to dampen tray vibration. Uncoated cables demonstrate higher degrees of damping than coated cables. Tests indicate that the damping is mainly because of the interaction of cables with each other and with the tray.
- B. Cable tray bending and support flexibility combine to provide energy dissipation capabilities, which allows for higher system damping.

The above mechanisms for energy absorption (cable movement, cable tray physical characteristics, support types, and attachment details at WBN) are similar to those that were tested in the ANCO Test Program. The WBN cable tray system is similar to the system that was tested. Analysis of the data obtained in the ANCO test program clearly demonstrates that the main energy absorbing mechanics are those noted above. Therefore, the damping values to be expected from the WBN systems are similar to those obtained in the ANCO Test Program.

## ENCLOSURE 2

DAMPING VALUES FOR QUALIFICATION  
OF CABLE TRAY AND CABLE TRAY SUPPORTS FOR DYNAMIC LOADS

As shown in Reference 1, the minimum observed damping for the coated cables is 7.5 percent. The damping obtained in the uncoated systems is much greater, 20 percent or more. The test values are valid for a minimum input acceleration of 0.1g. Since the spectral acceleration for WBN structures is 0.1g or greater for both OBE and SSE, the damping values of 4 and 7 percent are applicable. Additionally, the 4 and 7 percent damping values are consistent with SRP damping for cable tray and cable tray support systems.

IV. SUMMARY/CONCLUSIONS

In conclusion, 4 and 7 percent damping values are acceptable for use in evaluating WBN cable tray systems for OBE, SSE, and DBA loading conditions. These damping values are consistent with FSAR Amendment 64.

V. REFERENCES

1. Cable Tray and Conduit Raceway Seismic Test Program, ANCO Engineers, Inc., Report 1053-21.1-4.
2. Watts Bar Nuclear Plant Seismic Analysis Corrective Action Program Plan, Revision 1 (L44 890629 807).

## ENCLOSURE 3

DAMPING VALUES FOR QUALIFICATION OF  
HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)  
DUCT AND DUCT SUPPORTS FOR DYNAMIC LOADSI. BACKGROUND

Damping is used to account for varying degrees of energy dissipation under dynamic loadings in structures and systems consisting of different materials and types of construction. Although the WBN FSAR includes damping values used for general welded or bolted steel structures, it does not specifically address damping values for HVAC duct systems. These systems have large, thin-walled members, often with many bolted type joints, and with many riveted connections to their supports. The supports are generally bolted to the building concrete with expansion anchors. These bolted types of connections contribute significant sources of energy dissipation that help limit the duct system responses. Due to the complex behavior of HVAC systems, available test data is used to correlate results of simplified linear analysis models with the actual behavior.

II. DAMPING VALUES

Seismic qualification of WBN HVAC duct systems was performed using 7 percent damping for both OBE and SSE. This was based on data obtained from full scale seismic tests on nonwelded ducts performed by Wyle Laboratories for TVA. However, recent review of the damping test data indicates that the following damping values are more consistent with the available test data for nonwelded ducts: 4 percent for OBE and 7 percent for SSE for Sheet Metal and Air Conditioning Contractors National Association (SMACNA) companion-angle duct constructions, and 7 percent for OBE and SSE for SMACNA pocket-lock duct constructions. Damping values of 2 percent for OBE and 5 percent for SSE are to be used for welded duct constructions. The basis for these damping values is discussed below.

III. TECHNICAL BASIS

RG 1.61 does not specifically address damping values for bolted or welded HVAC duct systems although the general damping values for bolted and welded steel structures are provided. Alternatively, RG 1.61 also allows use of test data to support damping values higher than the ones tabulated therein. Consistent with this provision, TVA conducted damping tests on full scale HVAC duct specimens and evaluated the results (Reference 1). Based on this evaluation, it was concluded that for plants designed to mean value plus one standard deviation spectra, mean values of the damping indicated by the tests should be used for design. (WBN response spectra, which are based on Modified Newmark Spectra, meet the mean plus one standard deviation requirement.) Mean damping values of 6 percent for OBE and 7 percent for SSE for companion-angle ducts, and 10 percent for both OBE and SSE for pocket-lock ducts are indicated by the test data (Reference 1). Therefore, the damping values of 4 percent for OBE and 7 percent for SSE for companion-angle ducts, and 7 percent for OBE and SSE for pocket-lock ducts are conservatively enveloped by the test data.

## ENCLOSURE 3

DAMPING VALUES FOR QUALIFICATION OF  
HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)  
DUCT AND DUCT SUPPORTS FOR DYNAMIC LOADS

For welded types of duct, the damping values of 2 percent for OBE and 5 percent for SSE are within the FSAR ranges of damping for welded structures. Even though the ducts are welded, the supports are usually bolted to the main building structure which results in additional energy dissipation. Since additional energy dissipation is the basis for the FSAR allowance to increase SSE damping from 2 percent to 5 percent on welded steel structures at or near yield, the 5 percent SSE value for welded constructions is justified. These damping values for welded duct systems also correspond to those recommended in Reference 2 for air cleanup systems which typically are also welded constructions. Additionally, the damping values are consistent with SRP damping for HVAC duct systems.

IV. SUMMARY/CONCLUSIONS

It is TVA's position that the damping values given in Section II should be used to evaluate HVAC duct systems because they have a sound technical basis as discussed in Section III. These damping values are consistent with FSAR Amendment 64.

V. REFERENCES

1. Sequoyah Nuclear Plant, Units 1 and 2, HVAC Damping Values, Gilbert Commonwealth, Inc., Report 2783.
2. Nuclear Air Cleaning Handbook - Design, Construction, and Testing of High-Efficiency Air Cleaning Systems for Nuclear Application by C. A. Burchsted, J. E. Kahn, and A. B. Fuller, Contract Number W-7045-eng-26, Oak Ridge National Laboratory.
3. Watts Bar Nuclear Plant Seismic Analysis Corrective Action Program Plan, Revision 1 (L44 890629 807).