TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401

5N 157B Lookout Place

OCT 11 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) - TVA RESPONSES TO NRC COMMENTS RESULTING FROM AUGUST 1-3, 1990 MEETING

References:
1. Letter from TVA to NRC dated July 31, 1990, "Watts Bar Nuclear Plant (WBN) - Revision 2 to Corrective Action Program (CAP) Plan for Cable Issues"
2. Letter from TVA to NRC dated June 15, 1990, "Watts Bar Nuclear Plant (WBN) Unit 1 - Supplemental Information on WBN Cable Issues"
3. Letter from TVA to NRC dated May 22, 1989, "Watts Bar Nuclear Plant (WBN) - Nuclear Performance Plan, Volume 4"

Enclosed is TVA's submittal providing the methodologies to address and resolve the cable issues, as described in the Corrective Action Program (CAP) Plan.

Enclosure 1 provides TVA's responses to the NRC comments expressed during the August 1-3, 1990 meeting held at WBN. Enclosure 2 provides the associated Cable Issues CAP Plan changes to reflect the methodologies employed to address the issues. This letter supersedes TVA's letter submitted July 31, 1990 (Reference 1), and incorporates the additional NRC recommendations.

Enclosure 3 provides the cable bend radius figures which were inadvertently omitted from TVA's June 15, 1990 submittal (Reference 2). Enclosure 4 provides the list of commitments resulting from this submittal.

These activities also modify TVA's methodology for resolution of the midroute flexible conduit issue, the jamming issue, and vertical conduit support issue, as described in Section 2.1 of Chapter III of the Nuclear Performance Plan (NPP) Volume 4 (see Reference 3).

NRC review and subsequent endorsement of the revised CAP is requested. Please direct any questions concerning this submittal to R. J. Stevens, WBN Site Licensing, at (615) 365-1550.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

M. O. Medford

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

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

TVA RESPONSES TO NRC COMMENTS
FROM AUGUST 1-3, 1990 SITE MEETING

The following is a summarization of the NRC comments and the associated TVA responses to resolve the cable issues described in the corrective action program (CAP) plan for Watts Bar Nuclear Plant (WBN).

1. CABLE JAMMING

NRC Comment

Provide additional information regarding the methodology TVA will employ to identify and bound the potential undetected damage due to cable jamming at WBN.

TVA Response

Jamming is a consideration when three single conductor cables of the same diameter are being pulled into a conduit. The ratio of the conduit inner diameter to the cable outer diameter (D/d) is defined in IEEE-690-1984, paragraph A9.2.4.4 as the jam ratio. As described, jamming is most likely to occur when the jam ratio is between 2.8 and 3.1 because the cables at that point are most vulnerable to alignment in a flat configuration.

The Technical Evaluation Report TER-C5506-649, issued by NRC on January 30, 1987, identified the potential for undetected cable damage at WBN since TVA installation documents did not address the jam ratio.

Method of Resolution:

TVA performed a calculation[1] to identify those safety-related conduit/cable configurations with the greatest potential for undetected jamming to have occurred during installation. The criteria applied to the Class 1E conduits include:

- The conduit contains three (3) cables of the same size.
- Each conduit contains only single conductor cables larger than #10 AWG.
- The ratio of inside diameter of conduit (D) divided by the average outside diameter of one of the cables (d) is between 2.8 and 3.1.

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As described in the TER, two factors are required for jamming to occur:

- The three cables must physically be able to fit in a flat row inside the conduit, i.e., the sum of the cable diameters approximately matches the conduit inner diameter.

- A sufficient radial pressure must be present to force the three cables from a triangular configuration to a flat configuration. This will only occur at a bend in the conduit.

In addition, cables in conduits with runs between pull points of 10 feet or less are not likely to experience pulling tensions large enough to give rise to excessive sidewall bearing pressure (SWBP) and initiate cable jamming. Therefore, only conduits with runs greater than 10 feet were considered in the evaluation.

The conduits identified which meet the criteria described above will be walked down, isometrics will be completed, and SWBP values calculated. The population will then be ranked according to their resultant SWBPs.

A number of the cables identified by the above process will be replaced as a result of other issues. The worst-case cables based on SWBP will be examined during removal to identify any degradation indicative of jamming. Cables in the worst-case conduit configuration of those removed exhibiting no visible jamming damage will be considered the "bounding" configuration.

The lower-ranked configurations of the above identified population will be considered enveloped by this inspection. Any higher ranking configurations will be analyzed, inspected, reworked, or tested to confirm that damage has not occurred to these cables due to jamming.

In addition, TVA revised Construction Specification, G-38, to 1) identify the "critical range" ratio based on the conduit to cable diameter, and 2) prohibit pulls where the calculated ratio is within this range to ensure that no jamming will occur.

2. CABLE SUPPORT IN VERTICAL CONDUIT

NRC Comment

How will TVA restrain power cables to provide adequate support in vertical conduit?

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TVA Response

TVA has performed drawing reviews and calculations to find those families of conduits containing safety-related cables wherein the potential exists that adequate support was not provided to meet the requirements of Article 300-19, National Electric Code (1987). For power cables (V4/V5), where the length of the vertical drop exceeds the support spacing stipulated in the NEC and a discrete support is not present, TVA will initiate the necessary design changes and field modifications to ensure that the subject cables are in compliance with NEC 300-19 allowances.

3. **CABLE PROXIMITY TO HOT PIPES**

NRC Comment

How will TVA ensure that pipes less than 2 inches in diameter do not impact the surrounding conduits for future installations?

TVA Response

TVA will revise Construction Specification G-40 for future installations to ensure that pipes less than 2 inches in diameter do not touch conduits.

In addition, TVA will document the basis to ensure the adequacy of safety-related cables with respect to their proximity to hot pipes through evaluations, calculations, walkdowns, and modifications. In particular, the analysis will demonstrate that cable sizing includes sufficient conservatism to account for the cables' allowed proximity to pipes with temperatures of 104°F and hotter.

4. **CABLE PULLBY/TESTING**

NRC Comment

Provide additional information regarding the high potential withstand test utilized by TVA for low-risk conduits.

TVA Response

TVA will utilize the recommendations of the latest revision of IEEE-400 for hi-pot testing and will require the use of negative polarity DC.

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5. CABLE BEND RADIUS

NRC Comment

Provide additional support for the selection of the lower bound for multiconductor, low-voltage cables and the long-term effects of the overbending and retraining of medium voltage cables.

TVA Response

Prior to fuel load, additional tests will be performed to ensure the stresses associated with bending do not cause conductor deformation when a multiconductor cable is bent to the lower bound established by the single conductor test described in the June 15, 1990 submittal. The additional test shall consist of bending applicably sized multiconductor cable(s) to the previously established lower bound; retraining to the acceptable limit specified by Rockbestos Technical Bulletin No. 28; removing the cable jacket, filler material, etc.; and inspecting the conductor for deformation. This information will be evaluated for impact to the bend radius program described in the June 15, 1990 submittal.

To ensure that the mechanisms pertinent to cable performance under small bend radius conditions have been fully identified and properly evaluated, TVA will perform additional tests and/or analyses. These efforts will include considerations, as appropriate, for age-related consequences of such bends for both normal and accident service. Although such actions have not been fully established at this time, TVA will provide details regarding this effort to NRC, as discussed previously in the June 15, 1990 submittal.

In addition, as part of the long-term program to validate bend radius conclusions, TVA will engage in corona and load cycle tests of medium voltage cable bent to the lower bound (established by the test discussed in the TVA June 15, 1990 submittal to NRC) and retrained to a radius of 8 times the maximum cable outside diameter.

Furthermore, TVA will solicit several cable manufacturers' review of the technical adequacy of TVA's approach to the establishment of the bend radius lower bound limits previously identified. This information will be evaluated for potential impact to TVA's analysis.

NOTE: As discussed with NRC during this meeting, independent verification of the tests performed at CLSB will not be required.

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6. SIDEWALL BEARING PRESSURE

NRC Comment

Provide additional information regarding the sample population used to address sidewall bearing pressure at WBN.

TVA Response:

TVA initiated resolution of the SWBP issue by developing design calculations to determine the magnitude of SWBPs exerted on Class 1E cables in existing conduit installations at WBN. Screening calculations were performed to reduce the number of conduits to those containing Class 1E cables which had the greatest potential of having exceeded their allowable SWBP.

Based on field inspection, a sample of 81 conduits exhibiting severe-case SWBPs were determined. The sample consisted of approximately 20 conduits each from voltage levels V2, V3, V4, and V5 which exhibited the most severe conduit configurations based on engineering evaluation. Sidewall bearing pressure values were then calculated and compared to the allowable values established by testing, as described in TVA's June 15, 1990 submittal.

Based on the established limits, one conduit (1B1054G) from the 81 sample evaluations, described above, contained cables which exceeded these limits when calculated in one direction. The cables in this conduit will be replaced.

To provide further confidence, TVA will randomly select an additional 40 conduits located in harsh environments which have not been previously analyzed. These conduits will be walked down to develop isometric sketches reflecting the as-installed configurations. SWBPs and pulling tensions will then be calculated considering this information. The calculated values will be compared to the established limits described in the General Construction Specification, G-38. Those cables determined to have potentially exceeded the allowable SWBP limits will be analyzed and/or replaced, as necessary.

TVA will provide a response to the issues in the WBN TER relative to the applicability of TVA's cable SWBP testing program to actual plant installation conditions.

Additionally, TVA will further enhance Construction Specification G-38 to require additional engineering participation when the expected sidewall bearing pressures for new cable installations approach the maximum allowable limits.

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7. MIDROUTE FLEXIBLE CONDUIT

NRC Comment

Provide additional information regarding TVA's approach to resolve the concern involving pulling cable through midroute flexible conduit.

TVA Response

The midroute flexible conduit issue will be resolved in conjunction with the cable damage program. During the evaluation of the conduits inspected for cable pullby damage at WBN, a section of conduit containing one midroute flexible conduit in a run containing a damaged cable was removed. The midroute flex conduit was sent to the University of Connecticut (U.C.) for analysis. Upon visual inspection, U.C. concluded that, although a significant amount of pullby damage occurred to the cables located at the flexible conduit, no damage resulted from pulling cables through the midroute flexible conduit.

To validate the above conclusions, TVA will evaluate the configuration of the conduits involved in the high-potential withstand tests conducted to address the pullby issues to determine if sufficient quantities of midroute flexible conduits having significant offsets exist to adequately resolve this issue. The results of ongoing inspection of cables removed for other issues may also be utilized to resolve this issue.

If the above approach does not yield a sufficient sample, TVA will, by walkdown, identify additional conduits containing midroute flex. Cables in these conduits will be inspected at access points for evidence of damage which may have resulted from pulling through flex.

The results of TVA's analysis will be documented in a calculation.

8. AMPACITY

NRC Comment

What is TVA's basis for the cable tray covers' derating factor utilized in the ampacity calculations?

TVA Response

Background:

During reviews performed in the mid-1980's by the Bellefonte

Electrical Evaluation team and INPO, it was determined that TVA's ampacity standards (DS E12.1.1 through DS E12.1.4, References 2-5) lacked an adequate basis and failed to give proper consideration for the influence of a variety of configurations (covers, fire wrap, coatings, conduit grouping factors, etc.). As a result, the aforementioned standards were superseded by DS E12.6.3, (Reference 6), which included the necessary deratings. Calculation EEB-CSTF-0001, "Methodology Used as a Basis for Cable Ampacities Shown in TVA Electrical Design Standard DS E12.6.3," documented the basis upon which this standard was established.

This calculation states that a review was performed of the available guidance for derating cables in ladder type trays due to the presence of solid covers. The National Electric Code (NEC, NFPA-70) called for a 5 percent derating for covers 6 feet or greater in length. TVA was unable to identify a basis for these values. Additional literature[7,8] surveyed indicated that derating factors of 25 percent were appropriate. However, neither document provided guidance for choosing a maximum length of cover for which derating is not required. As a result, in mid-1986, TVA initiated an informal survey of architect/engineering firms and utilities to determine if a consensus existed regarding this length. Following this review, TVA established its 10-foot rule. Information gathered during this survey was not formally documented.

Though TVA's nuclear plants were all designed utilizing standards which were based upon ICEA P-46-426, review programs have been instituted at each plant to assess cable sizing per the uniform heat generation methods of DS-E12.6.3 and ICEA P-54-440 (this latter standard was not issued until much of the design was complete). Where deficiencies have been identified (compared to P-54-440), tray covers have been shortened, in lieu of cable replacement, to comply with the 10-foot rule provided that they were not required for other reasons. Consideration was given to utilizing raised covers, however, available literature indicated that this configuration afforded only 2 to 3 percent better ampacities than conventional solid covers.

During an NRC visit during June of 1990, ampacity derating factors and the 10-foot rule were discussed. TVA was asked to provide further information regarding this "rule." As a result, another survey was initiated to determine if TVA's practices still reflected industry consensus. The results of this informal survey were provided to the NRC during the August 1-3, 1990 meeting.

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Based upon this survey, two conclusions may be drawn:

1. TVA's tray cover derating factor is consistent with the most conservative of industry practices.

2. TVA's practice of derating covers beginning at 10 feet is a median position in the industry. Some architect engineers (AEs) and utilities use a 6-foot rule for covers, solid or raised/solid (though no basis could be cited for the latter). Other AEs and utilities surveyed do not derate for covers of any length or apply only marginal derating (5 percent). One surveyed AE also used a 10-foot rule:

While no clear single consensus can be said to exist, TVA's practices appear to be inline with industry methodologies.

However, to provide an additional level of conservatism, TVA will consider the following alternatives to address the potential derating effects on cables routed in tray segments where solid metal covers of length greater than 6 feet are installed.

1. Perform laboratory testing to support TVA's derating philosophy for solid tray covers (25 percent for covers greater than or equal to 10 feet).

2. For those trays with solid covers in excess of 6 feet, which result in additional cables determined to be potentially undersized, modify the covers to be less than or equal to 6 feet long, unless otherwise required by design criteria. In such cases, those cables determined to be potentially undersized will be further reviewed to determine corrective action.

3. Apply the 25 percent derating factor for tray covers greater than 6 feet in length. Any cables that fail to meet the sizing criteria due to this additional consideration will be analyzed and/or reworked to establish the basis for acceptance. The dispositioning of these cables will be documented in a TVA calculation.

9. CABLE INSTALLATION

NRC Comment

Provide enhancement of the installation specification in the areas of megger testing and cable lubricant selection.

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TVA Response

TVA's post-installation test requirements for electrical cable are consistent with those specified by IEEE 690-1984, requiring a combination of high-potential, megger, or functional testing dependent upon the specific cable construction and its intended service. However, to provide additional assurances regarding the integrity of the cable, TVA will revise its installation specification to require megger testing as a minimum for all future installations in Class 1E raceways.

In addition, TVA's installation specification will be enhanced to provide greater assurance that the appropriate cable lubricants are selected for a given pull in accordance with the manufacturers' recommendations.

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REFERENCES:

1. Calculation WBPEVAR8905050, "Cable Jamming."

2. DS E12.1.1, "Conductor Current Carrying Capacity, Polyethylene Insulated, 0-8000V."

3. DS E12.1.2, "Conductor Current Carrying Capacity, Cross-linked Polyethylene Insulated, 0-15,000V."

4. DS E12.1.3, "Current Carrying Capacity, Silicone Rubber Insulated, 0-600V."

5. DS E12.1.4, "Conductor Current Carrying Capacity, Ethylene Propylene Rubber Insulated, 0-15,000V."

6. DS E12.6.3 R1, "Ampacity Tables for Auxiliary and Control Power Cables, (0-15,000 Volts)," November 7, 1986.

7. "Ampacity of Cable in Covered Tray," IEEE PAS-103, pp 345-362, 1984 by Gary Engmann.

8. "Interam Fire Protection Materials, Protective Envelope System," 3M Report, dated 1986.

ENCLOSURE 2

REVISED CAP PAGES