TVA

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

JUN 19 1991

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

Gentlemen:

In the Matter of	)	Docket Nos. 50-327
Tennessee Valley Authority	)	50-328

SEQUOYAH NUCLEAR PLANT (SQN) - UNITS 1 AND 2 - CABLE TEST PROGRAM ISSUES FROM THE NRC FEBRUARY/MARCH 1991 VISIT (TAC NO. 77129/77130)

During the weeks of February 25 and March 11, 1991, NRC visited the SQN site to review the calculations that support the cable test program and to perform walkdown inspections of selected conduits. The results of this review were discussed in the March 15, 1991, exit meeting at the SQN site. Three open items were identified during this meeting by NRC. The first item concerns the use of effective vertical drop conduit length in calculations, the second item concerns the resolution of an unverified assumption in the calculations, and the last item concerns the derating for cables in trays with covers between 6 and 10 feet long. TVA agreed to provide information for the resolution of these items.

On May 21, 1991, a telephone discussion was held between TVA and NRC as a follow-up on SQN's cable monitoring program (CMP). NRC requested additional information on this program in relationship to cable training radius concerns found during the walkdown inspections of the February/March 1991 visit. TVA clarified that the CMP is intended to test large motor lead cables periodically and perform visual inspection of environmentally qualified cables during maintenance and modifications. This program monitors the cables most susceptible to premature degradation resulting from training radius violations coupled with the presence of high ohmic heating or environmental stressors.

By monitoring these cables, early detection of degradation is ensured and assessment for this condition would be considered for all potentially affected cables. Before the addition of procedural training radius requirements in December 1985, TVA's installation of cables at all voltage levels is considered similar; and therefore no unique concern should exist for any specific type of cable based on installation practices.

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The CMP for SQN is not intended to identify training radius violations but to monitor the most susceptible cables to ensure identification of insulation degradation. This program is consistent with the recommendations in Office of Inspection and Enforcement Information Notice 86-49, "Age/Environment Induced Electrical Cable Failures." These explanations provided NRC with the clarifications requested and no CMP concerns remain open.

Enclosure 1 provides a summary of the February/March 1991 NRC visit and exit meeting. Enclosure 2 provides the information for resolution of the three items identified during the visit. Enclosure 3 provides a summary of the commitments made in this letter.

Please direct questions concerning this issue to Keith C. Weller at (615) 843-7527.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

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ENCLOSURE 1

SUMMARY OF NRC'S FEBRUARY/MARCH 1991 VISIT

A meeting was held March 15, 1991, to discuss the results of the conduit calculation review effort conducted by NRC during the weeks of February 25 and March 11. The purpose of the review was to assess the SQN pullby, jamming, and vertical drop cable calculations. The review included field walkdowns of selected conduits. Information concerning ampacity ratings for cable in trays with covers between 6 and 10 feet in length was also discussed relative to an allegation received by NRC.

No open items that were associated with the pullby calculation were identified. No problems were noted with the calculations, and there was no evidence of parachute cord discovered during the walkdowns. However, during the walkdown of Conduit 1PM2136II, a cable was found to have excessive tension, and another was found to have been twisted in an "S" bend inside Junction Box JB2223. NRC acknowledged that this conduit was to be "high-pot" tested and would consider the results of that test in evaluating potential cable damage. A lack of cable slack in several conduits was also noted. TVA responded that this type of concern was bounded by the cable monitoring program outlined in TVA's January 23, 1989, submittal to NRC.

Similarly, no open items were identified during the review of the jamming calculation and the associated walkdowns.

Two minor issues that were associated with the review of the vertical drop calculation remain open. This first item concerns the use of effective vertical drop conduit length in calculations. During the conduit calculation effort, the 1987 selection criteria stated, "TVA will evaluate all conduits inside containment that contain 10 CFR 50.49 silicone rubber insulated cables that contain a 90 degree condulet at the top and that have a vertical drop immediately below the condulet, which exceeds the requirements of National Electric Code (NEC), Article 300-19." The current criteria in General Construction Specification G-38 recognize that horizontal runs in the overall conduit configuration will provide some support to the cables. NRC is concerned that the "effective" vertical drop was not considered. TVA was requested to provide information describing why the previous criteria were satisfactory.

The second item concerns the resolution of an unverified assumption (UVA) in the calculations. Each of the conduit calculations contains a UVA concerning the use of the Sequoyah Cable Routing System (SCRS) data base as input to the calculation. This was procedurally required as the SCRS information cannot be considered "quality assured" input. NRC expressed concerns with the term "unverified." TVA provided information that indicates that the information can be considered validated for the purposes of the calculations. TVA stated that they will continue to develop additional justification for the removal of the UVAs.

The cable tray cover/ampacity allegation discussions were focused on SQN's deviation from the NEC, which states that a 5 percent derating should be made for cables with tray covers over 6 feet in length. TVA currently applies a 25 percent derating for cables with covers 10 feet and over in length. The allegation stated that there was no technical justification for not complying with the code for tray covers between 6 and 10 feet in length. TVA stated that although there was no technical concern with deviating from the code, a 5 percent cable derating would be applied for cable tray covers between 6 and 10 feet in length for consistency with this code. The 25 percent cable derating will be maintained for cable tray covers 10 feet and over in length.

NRC stated that there is currently no test data associated with cable tray covers less than 12 feet in length, which would support or refute the NEC. The staff stated that this would be pursued on a generic basis.

ENCLOSURE 2

RESOLUTION OF NRC OPEN ITEMS
FROM CABLE TEST PROGRAM (CTP) CONDUIT CALCULATION REVIEW

NRC inspection team visits during the weeks of February 25 and March 11, 1991, identified two items dealing with the unverified assumptions (UVA) contained in three of the CTP calculations and the use of the "effective vertical drop" conduit lengths in the vertical drop calculation. Also discussed at that time was the cable tray cover/ampacity allegation concerning Sequoyah's deviation from the National Electrical Code (NEC) requirements to derate cables in trays with covers over 6 feet in length. This submittal provides TVA's response to those issues.

TVA has revised three calculations (SQN-CSS-033 [pullbys], SQN-CSS-034 [vertical drop], and EEB-CSTF-0008 [jamming]) to remove the UVA associated with the Sequoyah Cable Routing System (SCRS) data base. Also, except for the addition of two field sketches, SQN-CSS-034 has been revised to incorporate NRC audit comments. These two sketches will be obtained (with two-party verification) and are expected to be added to SQN-CSS-034 by the end of the Unit 2 Cycle 5 refueling outage.

Attachment 1 provides TVA's justification for removing the UVA concerning the use of the SCRS data base as a starting point for the three CTP conduit calculations. This justification is based on an analysis of the effects of the discrepancies discovered by the long-term cable management program. The analysis concluded that none of the cable route deviations caused an adverse condition with respect to the predetermined attributes of ampacity, equipment qualification, separation (voltage and safety divisions), 10 CFR 50 Appendix R, and raceway fill. The evaluation of these deviations against the issues of pullby, jamming, and vertical drop "worst-case" conduit selections reveals that there is no negative impact on these conclusions. Because of these findings, the use of the SCRS data base for this application is acceptable.

Attachment 2 outlines the program that TVA is implementing to comply with the NEC derating requirements for tray covers greater than 6 feet in length. In order to ensure that the required cables under covers greater than 6 feet are adequately sized, TVA is applying the 5 percent derating universally to all Class 1E power cables (Node Voltage-12, 13, 14, and 15) that have not already been derated by 25 percent for covers longer than 10 feet, unless they have been verified to contain no covers or covers of 6 feet or less in length. No action will be required for any cables that were previously derated for covers or whose route contained a cover 6 feet or less in length. This conservative approach will ensure that the power cables with or without covers are adequately sized to perform their intended safety functions. The documentation for this additional derating will be included in each cable's respective ampacity parent calculation. These efforts should be completed by September 30, 1991.

Attachment 3 provides TVA's position on the use of "effective vertical" conduit lengths for determining the Sequoyah worst-case vertical conduits for testing and subsequent postrestart evaluations. This position focuses on the mutually agreed upon selection criteria for worst-case vertical cables/conduits. The adequacy of supports for other installed cables in vertical conduits was addressed in two postrestart activities. These efforts involved the walkdown of conduits outside containment containing 10 CFR 50.49 cables, calculating static bearing pressures for effective vertical lengths greater than the NEC limits (Unit 2 only), and providing supports to increase the training radius in a small number of condulets and junction boxes (both units).

As a measure to ensure the adequacy of future vertical conduit/cable installations, General Construction Specification G-38, "Installation, Modification and Maintenance of Insulated Cables Rated up to 15,000 Volts," was revised to require the application of the NEC requirements from April 1988 forward. The adequacy of installed cables for the life of the plant is ensured by TVA's implementation of a "Cable Monitoring Program and Assessments" activity to periodically test, monitor by surveillance, trend problems, and modify the cables/configurations as necessary. This program implements for Sequoyah the recommendations of Office of Inspection and Enforcement Information Notice 86-49, "Age/Environment Induced Electrical Cable Failures."

ATTACHMENT 1

OF ENCLOSURE 2

SEQUOYAH NUCLEAR PLANT

CABLE TEST PROGRAM (CTP) CALCULATIONS
UNVERIFIED ASSUMPTIONS

BACKGROUND

The purpose of the CTP was to determine if there was a programmatic problem with the installation of cables in conduits at Sequoyah. The Sequoyah Cable Routing System (SCRS) data base was used as a starting point for the CTP to identify the safety-related conduits, the number of cables in a conduit, their unique identification, their route, and their construction. Any deviation in these variables could affect the number and severity of the pullbys in the pullby calculation, the critical jam ratio for the conduit/cable configurations in the jamming analysis, and the first two selection criteria for the worst-case vertical conduit determination.

This data base is unverified; and because the data base has not been quality assured (QA), its use as design input in a QA calculation must be documented and tracked (in calculation cross-reference information system) as an "unverified assumption" (UVA). This is an administrative requirement of Nuclear Engineering Procedure 3.1, "Calculations." However, it is TVA's engineering judgement that any random errors that may exist will not have a significant impact on the overall analysis and conclusions of a program of this magnitude.

DISCUSSION

To support this position, the following is an analysis of the findings of Sequoyah's long-term cable management program (LTCMP) on the issues of pullbys, jamming, and vertical drop.

As part of the LTCMP, 59 cables from each unit were randomly selected and signal traced to determine their exact route. The results of this effort revealed that only two of the cables had route deviations that affected conduits. One deviation resulted in four cables being installed in a conduit instead of three, and the other resulted in two cables being installed in a conduit instead of one. These deviations had no adverse affect on the predetermined acceptance criteria attributes of ampacity, environmental qualification (EQ), 10 CFR 50 Appendix R, train/voltage separation, or raceway fill. Thus, the adequacy of the cable routing data base, with respect to those attributes, was verified; and the signal tracing sample was considered statistically valid.

Another evaluation of the LTCMP data revealed 122 conduit documentation deviations out of over 4,000 conduit/tray interactions. These deviations primarily dealt with a cable being "designed" but not installed in a given conduit. This happened when the cable data base and the corresponding conduit data base failed to be updated simultaneously when the designed route was changed. These errors resulted in the "as-designed" record showing an extra cable that was never installed in that conduit.

DISCUSSION (continued)

The only impact of these deviations to the CTP pullby calculation is that the number of cables in two of the 93 "ranked" and "calculated" conduits (Nos. 39 and 57) is reduced. By removing these extra cables from the conduit analysis, their previously acceptable sidewall bearing pressure values will now be even lower.

These 122 findings had no affect on jamming and vertical drop calculations for the CTP. The jamming calculation scope was limited to three single conductors larger than #10 American Wire Gauge and of the same size that fall into the critical jam ratio for a given conduit size. The 122 deviations did not include any conduits that affected these parameters.

The above discussion for pullby and jamming would apply equally to the silicone rubber insulated cables in vertical conduit analysis.

Other programs that have found the SCRS data acceptable with respect to ampacity, EQ, separation, Appendix R, and raceway fill include the independent design inspection of the essential raw cooling water system, Appendix R field walkdowns, the ampacity program, and insitu cable testing for jamming.

CONCLUSION

Therefore, the three calculations that used the SCRS data base as a starting point and documented its use as an unverified assumption have been revised to clear the UVA by virtue of this statistical justification. These calculations are as follows:

EEB-CSTF-0008, Revision 1 (R1) - "Identification of Class 1E Cables Subject To Potential Jamming"

SQN-CSS-033, R1 - "Calculation for Analysis of Cable Pullby Concerns"

SQN-CSS-034, R1 - "Identification/Evaluation of Unit 2 Silicone-Rubber Insulated Class 1E Cable in Vertical Conduit Subject to Testing"

While it is recognized that SCRS deviations exist from a quantitative standpoint, they should have a negligible affect on the overall "worst-case" conduits selection process. With that consideration and the fact that by the completion of Sequoyah's CTP TVA will have tested well over 1,000 conductors, the question as to the adequacy of installed cables at Sequoyah should be clearly resolved.

ATTACHMENT 2

OF ENCLOSURE 2

SEQUOYAH NUCLEAR PLANT

AMPACITY DERATINGS FOR COVERED CABLE TRAYS

BACKGROUND

At the onset of the Sequoyah cable ampacity program, Electrical Design Standard DS-E12.6.3, Revision 1 (R1), "Auxiliary and Control Power Cable Sizing, up to 15,000 Volts," was issued to provide guidance for the sizing of power and control cables by consideration of the derating factors affecting their ampacity. One of these considerations dealt with the impact of cable tray covers on a cable's ampacity. That standard required that "trays with covers longer than 10 feet or trays having multiple covers whose combined length exceeds 10 feet and which are spaced less than 10 feet apart shall have ampacities derated by the multiplying factor 0.750" (25 percent derating).

In order to comply with that requirement, the 1E power cable trays were walked down to identify those with covers subject to these provisions so that they could be factored into the ampacity analysis. The results of this analysis caused some cables to be replaced, some tray covers to be removed, and some covers to be shortened to 10 feet or less. Sequoyah is in compliance with R1 of the subject standard.

DISCUSSION

Power cables in trays that were not subject to the cover derating requirements of R1 of the standard were not derated, and the location of covers less than 10 feet long was not documented. However, as a result of questions raised by NRC about the apparent discrepancy between TVA's standard and the requirements of the National Electrical Code (NEC) for derating cables by 5 percent for tray covers longer than 6 feet, TVA is reevaluating the power cables not previously derated. This reevaluation will take the form of a global 5 percent derating for all 1E power cables that had not been previously derated by 25 percent unless they were verified to not have a cover longer than 6 feet on their tray route. In this manner, all 1E tray covers between 6 and 10 feet would be included without regard for identifying specific lengths and locations. The documentation for these analyses will be contained in the respective parent electrical ampacity calculations. This action is expected to be completed by September 30, 1991.

CONCLUSIONS

While TVA has no technical concern with the present ampacity program, by following the requirements of the NEC for 5 percent derating of 1E power cables installed in trays that may have covers from 6 to 10 feet in length and by applying a 25 percent derating for those under tray covers over 10 feet, TVA believes that this conservatism will further ensure that the power cables under those covers will continue to perform their intended safety function.

ATTACHMENT 3

OF ENCLOSURE 2

SEQUOYAH NUCLEAR PLANT

CABLES SUPPORTED BY 90-DEGREE CONDULETS

BACKGROUND

The predominant concern from supporting cables by 90-degree condulets (or tee condulets) is the potential for cutting the insulation by the corner of the condulet or conductor creep to this edge. The static bearing pressure on the cables supported by such a condulet increases as the length of vertical conduit immediately below the condulet increases.

During the 1987 Sequoyah cable testing program (CTP), one of the criteria (which was mutually accepted by TVA, NRC staff, and NRC's consultants) used to select the "worst-case" vertical conduit configuration specified that "cables will have a vertical drop immediately below the 90-degree condulet that exceeds the requirements of the National Electrical Code (NEC) Article 300-19." This requirement was followed to select the Sequoyah worst-case conduit for testing and was documented in the unissued Calculation SQN-CSS-009. Subsequent to the discovery that the documentation of the selection process had never been completed, the portion of SQN-CSS-009 that dealt with cables supported by condulets was reevaluated in 1990 to verify the worst-case conduit. This effort concluded that the conduit that was selected for testing in 1987 was the only one that met all the selection criteria.

Since the original selection criteria and the NEC made no mention of what is now termed "effective vertical length" or "vertical rise," the original commitment and the methodology employed to select the conduit for testing did not consider the nonvertical portions of conduits and the cumulative effects of the cable weights in the vertical conduits run between those segments and still below the condulet. The segments that had field or factory bends at the top of the vertical runs were also not considered. The requirements to consider the total effective vertical length were introduced into General Construction Specification G-38 in April 1988. The requirement to consider vertical rise was provided in the 1990 NEC.

DISCUSSION

The intent of the original program was to identify the worst-case conduit with respect to vertical support. While it is generally agreed that the nonvertical segments afford some measure of support, no consensus exists to quantify that support. In light of that, it was mutually agreed that the worst-case conduit would be one where the drop in question was immediately below the condulet to be tested and the bearing pressure seen reflected the full weight in the vertical segment.

DISCUSSION (continued)

Subsequent evaluations for support adequacy (as opposed to worst case) have employed the effective vertical length methodology. Such analysis allows each foot of horizontal length to offset one foot of vertical drop. Implicit in such an analysis is the assumption that the coefficient of friction between cables and conduit is a very conservative 0.47. Once pulling lubricants have dried, the coefficient of friction increases dramatically as the cables bond to one another and to the conduit wall. Such a level of conservatism is appropriate for analysis of support adequacy, but would inject a level of uncertainty in assessing the worst-case conduit. Therefore, the use of the mutually agreed criteria appears warranted for selecting the worst-case conduit.

In order to confirm that the unissued Calculation SQN-CSS-009 had identified the worst-case conduit, Calculation SQN-CSS-034 was generated. The worst-case criteria were applied, both on a "conduit basis" and a "cable basis." Both reviews confirm the 1987 findings that only one cable/conduit configuration satisfied all criteria.

Another consideration is that the results of the 5-minute, direct-current, high-voltage test on the worst-case conduit and the subsequent evaluation indicated that the cables did not fail at the point of contact with the corner of the condulet (as would be expected with silicone rubber insulated cable chosen for its high material damage susceptibility). The test anomaly for the four conductors in the condulet was attributed to impact-induced damage and not to the configuration of the cable/conduit. Because the worst-case conduit was confirmed by reevaluation and the failure cause had nothing to do with its support methods, less severe installations were considered acceptable. The replacement of the American Insulated Wire Corporation silicone rubber cables inside containment was done under the new requirements for cable supports.

As a postrestart commitment, TVA performed evaluations on 10 CFR 50.49 cables in vertical conduits outside Unit 2 containment and the Unit 1 annulus. Since these evaluations were intended to assess the need for supports (as opposed to identifying the worst case), they utilized the concept of effective vertical length, calculated the static sidewall bearing pressures on cables that exceeded the NEC limits (Unit 2 conduits only), and inspected the cables in condulets and junction boxes at the top of runs that exceeded the allowable limits (both units). The results of these evaluations revealed that there was no observed cable damage and many cables had adequate support via one or more factors, such as the static coefficient of friction of the raceway, the stiffness of the cables, the fire barrier material, or the pressure seals in the enclosures. These support methods resulted in a maintained minimum training radius and an acceptable installation.

DISCUSSION (continued)

Because of training radius requirements, a small number of condulets/boxes required the addition of a Raychem Corporation heavy wall nuclear grade heat shrinkable tubing between the cables and the inner radius of the condulet or junction box. This method was used to substantially increase the radius of the cable bends when compared with the relatively small radius of the condulet or conduit bushing.

As a final measure, TVA implemented a "Cable Monitoring Program and Assessments" activity to ensure that the safety-related cables at Sequoyah will continue to be capable of performing their intended safety function. This program is ongoing and has the stated purpose of performing inspections, periodic testing, and, if required, upgrading during modifications and maintenance on the cables associated with 10 CFR 50.49 equipment.

This cable monitoring and trending program has been in effect since 1989, and no safety-related cables have failed to date as a result of damage by being supported by 90 degree condulets, tees, or bushings inside junction boxes nor has any adverse degradation been noted in these locations.

CONCLUSION

Because of the above discussions, TVA concludes that its CTP requirements were implemented by selecting and testing Sequoyah's worst-case vertical conduit that met the approved selection criteria. This effort was intended to bound previously installed cables in vertical conduits with less severe configurations. In addition, General Construction Specification G-38, "Installation, Modification and Maintenance of Insulated Cables Rated Up to 15,000 Volts," was revised to require consideration of effective vertical length of conduits and the NEC limits in future installations.

Another measure taken by TVA to ensure the adequacy of past installations was the completion of the postrestart commitments to perform evaluations and corrective actions for vertical conduits containing 10 CFR 50.49 cables outside containment. This effort incorporated the G-38 methodology and provided confidence that vertical conduits containing other than silicone rubber insulated cables were adequate.

As a method for continuing assessment of installed cables, TVA implemented a monitoring/testing/trending program to provide assurance that cables installed at Sequoyah will not be subject to common mode failures when subjected to accident or postaccident conditions. It is TVA's position that this program is consistent with accepted industry practices and meets the recommendations of Office of Inspection and Enforcement Information Notice 86-49, "Age/Environment Induced Electrical Cable Failures."

ENCLOSURE 3

LIST OF COMMITMENTS

1. The addition of two field sketches to TVA calculation SQN-CSS-034 will be completed by the end of the Unit 2 Cycle 5 refueling outage. The sketches will be obtained and verified by a two-party verification.

2. The documentation for the additional cable derating will be included in each respective ampacity parent calculation by September 30, 1991.