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JAN 25 1988

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 - FINAL 10 CFR 21 REPORT ON SILICONE RUBBER-INSULATED CABLES

References:
1. TVA letter to NRC dated September 10, 1987, "Sequoyah Nuclear Plant Units 1 and 2 - Docket Nos. 50-327 and 50-328 - Facility Operating Licenses DPR 72 and 77 - Preliminary 10 CFR 21 Report on Silicone Rubber-Insulated Cables"
2. TVA letter to NRC dated November 20, 1987, "Sequoyah Nuclear Plant (SQN) Units 1 and 2 - Cable Test Program Procedures, Data, and Results"
3. TVA letter to NRC dated November 24, 1987, "Sequoyah Nuclear Plant (SQN) Units 1 and 2 - Wyle Laboratories Test Report for Silicone Rubber-Insulated Cables"
4. TVA letter to NRC dated December 28, 1987, "Sequoyah Nuclear Plant (SQN)-Silicone Rubber Insulated Cable Issue Resolution"

In a letter dated September 10, 1987 (reference 1), TVA provided NRC with a preliminary report based on information that led TVA to a determination that a potential problem existed that was reportable pursuant to the requirements of 10 CFR 21. The problem concerned the potential inability of silicone rubber-insulated cables to perform their intended function as a result of decreased insulation wall thicknesses due to relatively low impact forces. TVA took a conservative approach and submitted a 10 CFR 21 report before completion of further tests because of uncertainties regarding the cause of the anomalies and potential generic implications. The purpose of this letter is to provide a final report describing the additional tests and evaluations and TVA's conclusions. This report is contained in enclosure 1. The final report is supplemented by the

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University of Connecticut, Singleton Materials Engineering Laboratory, and Central Laboratories Services reports, which are enclosed with this letter, and also by the information previously supplied to NRC in reference 2 and 3 above.

TVA concludes, as explained in the attached report, that manufacturing, shipping, handling, receipt/storage, and installation practices did not, and would not reasonably be expected to reduce cable insulation thickness to a point where it would fail to perform its intended function under design basis accident conditions. This conclusion, as presented in reference 4, is based on the results of the extensive TVA test program, which show that all the tested silicone cables were adequate to perform their function. TVA when it submitted its preliminary 10 CFR 21 report was not aware that cables would function with only 4 mils of insulation. Nor was it aware that the tested silicone cables had not been damaged to the point where they could not perform satisfactorily. Based on these considerations, TVA no longer believes that the concerns about silicone rubber-insulated cable constitute a reportable problem under the requirements of 10 CFR 21. Therefore, this is TVA's final report on this subject.

If you have any questions or comments, please telephone M. R. Harding at (615) 870-6422.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

R. Gridley

R. Gridley, Director
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Enclosures
cc: See page 3

U.S. Nuclear Regulatory Commission

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Enclosures
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ENCLOSURE 1

FINAL 10 CFR 21 REPORT ON SILICONE RUBBER-INSULATED CABLES

In a letter dated September 10, 1987 (reference 1), TVA provided NRC with a preliminary report based on information that led TVA to a determination that a potential problem existed that was reportable pursuant to the requirements of 10 CFR 21. The problem concerned the potential inability of silicone rubber-insulated cables to perform their intended function as a result of decreased insulation wall thicknesses due to relatively low impact forces.

The initial electrical test results from high-voltage DC testing on installed silicone rubber-insulated cable were identified in Special Test Instruction (STI)-17, which was provided to NRC by way of reference 2. The four conductor anomalies resulting from these tests were subsequently subjected to an extensive laboratory evaluation program performed at the University of Connecticut's Electrical Insulation Research Center (EIRC). The EIRC test report was informally provided to NRC on August 12, 1987, in Bethesda, Maryland, and is included as attachment 1.

The results of this evaluation failed to identify a definitive cause for the anomalies on the conductors. However, two conductors were found to have "voids" in the insulation, at the conductor surface, in the vicinity of the areas exhibiting the breakdown or high-leakage current. Measurements of the insulation thickness remaining at these "voids" yielded results as low as 8 mils. It was postulated that similar "voids" may have caused the test anomalies on these two conductors.

In order to determine the cause of these reduced insulation areas, TVA began a test program at its Singleton Materials Engineering Laboratory (SMEL). These tests determined that it was possible to create "voids," such as those found in the EIRC testing, in a repeatable manner using relatively low impact energy levels. The results of these tests, which were previously provided informally to the NRC, are included as attachments 2 and 3.

Cables from all three manufacturers of Sequoyah Nuclear Plant's (SQN's) silicone rubber cables, American Insulated Wire (AIW), Anaconda, and the Rockbestos Company, evidenced somewhat similar susceptibility to damage from impact forces. TVA's testing of installed cables had, up to that date, been limited to only one manufacturer, AIW. Accordingly, TVA expanded its in-situ test program to the remaining two manufacturer's cables while also expanding its testing of AIW cable. TVA's test program used high-voltage DC testing on worst-case samples on the basis that the longest cable runs would have the highest probability for evidencing unacceptable damage that may have occurred during manufacturing, shipping, handling, receipt/storage, or installation. This additional testing of 75 conductors identified breakdowns in three AIW conductors and one conductor manufactured by the Rockbestos Company. In addition, two Rockbestos conductors exhibited what were, at that time, considered unacceptable polarization indices. There were no failures of conductors manufactured by Anaconda. An expanded presentation of these test results was provided in TVA's public meetings with NRC on September 10, 1987, in Knoxville, Tennessee, and on November 24, 1987, in Bethesda, Maryland.

While the majority of cables passed the high-voltage test, thus demonstrating that they have the ability to perform their function, the few anomalies resulted in TVA's issuance of a Condition Adverse to Quality Report (CAQR) SQP 871411. In addition, because of uncertainties regarding the cause of the anomalies and potential generic implications, TVA took a conservative approach and made a preliminary 10 CFR 21 report before further tests were completed (reference 1). The preliminary 10 CFR 21 report stated that the level of impact force that resulted in significant decreases in insulation wall thickness might be within that which could possibly occur during manufacturing, handling, shipping, receipt/storage, or installation. TVA was concerned that these early results could indicate the inability of the cable to perform its intended function under design basis accident (DBA) conditions.

To resolve the CAQR, TVA began a complete and unprecedented environmental qualification program at Wyle Laboratories. The purpose of this program was to determine whether silicone rubber-insulated cables with reduced insulation thicknesses were capable of performing their intended function during SQN's normal and DBA conditions. Silicone rubber cable from each of the three SQN manufacturers had its insulation wall thickness intentionally reduced. Subsequent postaccident measurements determined this thickness had been reduced to as low as 4 mils for AIW and Anaconda conductors, and 6 mils for Rockbestos. These were lower than any thickness measured on any of SQN's installed conductors that exhibited anomalies. The measurements on the installed conductors that exhibited anomalies are provided in the EIRC test report (attachment 1) for the initial AIW conductors and in TVA's Central Laboratories Services test report (attachment 4) for the four additional AIW and Rockbestos conductors that had breakdowns in the subsequent testing.

TVA's environmental qualification test program on these reduced insulation cables was highly successful. It demonstrated, with margin, that silicone rubber-insulated cables with insulation wall thicknesses lower than any discovered on installed cables at SQN are capable of performing their intended function during normal and DBA conditions. In addition, all the cables with anomalies had, during the high-voltage testing, exhibited satisfactory performance up to 7,000 volts DC, which far exceeds the service voltage for these cables. In addition it exceeded the dielectric strength previously agreed to by TVA and NRC as necessary to prove cable adequacy for service. This level was established, in accordance with industry standard IEEE 383-1974, at 240 volts DC per mil of cable insulation, and was based on the minimum environmentally qualified thickness. The successful test results of 4 mils for AIW and Anaconda and 6 mils for Rocbestos show that adequacy for service is demonstrated by a dielectric strength of 960 volts DC and 1440 volts DC, respectively. Thus, the Wyle test established that the initial anomalies on installed cables occurred at levels well in excess of that which would be indicative of the cables' ability to function as required. The complete results of the Wyle test program were provided to NRC by way of reference 3 and were discussed in the public meeting in Bethesda, Maryland, on November 24, 1987.

In addition, information from ASTM D 3755 on direct current dielectric strength testing of electrical insulating materials shows that the combined attributes of the TVA test program resulted in a conservative approach to

demonstrating cable integrity. These attributes include the voltage level, rate of voltage application, surrounding medium, temperature, and acceptance criteria. Information from a recent IEEE Insulated Conductors Committee meeting indicated that the use of polarization indices is inappropriate for the type of cable tested at SQN, and that the values noted in our test are not a proof of failure. This information, in conjunction with the Wyle test results, the insulation remaining on the cables with anomalies and the high voltage at which the anomalies occurred, suggests that the anomalies were due to the conservatism of the test program itself, and not to any inadequacies in the cable which would adversely affect the performance of its function. TVA's test program, therefore, demonstrated the ability for continued operation of the silicone rubber cables currently installed in SQN.

TVA has now demonstrated that none of the anomalies show that the cable would not have performed its intended function. Accordingly, the basis for originally instituting a test program no longer applies. Since there does not appear to be any evidence that cables actually were damaged to the point where they could not perform satisfactorily, we could reasonably conclude on this basis alone that the silicone cables are adequate. In addition, however, tests have already been conducted on a worst-case sample, based on the longest cable runs, which provides even further assurance that the cables were not damaged to the point where they could not perform satisfactorily.

TVA in its preliminary 10 CFR 21 report stated that the level of impact force which results in significant decreases in insulation wall thickness "may be within that which could possibly occur" during manufacturing, handling, shipping, receipt/storage, or installation. TVA when it submitted its preliminary 10 CFR 21 report was not aware that cables would function with only 4 mils of insulation. Nor was it aware that the tested silicone cables had not been damaged to the point where they could not perform satisfactorily. This current evidence does not lead to the conclusion that manufacturing, shipping, handling, receipt/storage or installation practices could reasonably be expected to reduce the cable insulation thickness to a point where it would fail to perform its intended function under design basis accident conditions. Based on these considerations, TVA no longer believes that the concerns about silicone rubber-insulated cable constitute a reportable problem under the requirements of 10 CFR 21. Therefore, this is TVA's final report on this subject.

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ATTACHMENT 1

TESTS ON SILICONE RUBBER-INSULATED CONTROL CABLES

Electrical Insulation Research Center
Institute of Materials Science
University of Connecticut

July 20, 1987