TVA EMPLOYEE CONCERNS SPECIAL PROGRAM

REPORT NUMBER: 241.1(B)

REPORT TYPE: SEQUOYAH ELEMENT

REVISION NUMBER: 2

TITLE: CABLE TERMINATION AND SPLICES

Inadequate Splicing and Termination Practices and Procedures

REASON FOR REVISION:

1. Revised to incorporate SRP and TAS comments, and to incorporate Secton 10, Corrective Action.

2. Revised to update Corrective Action.

PREPARATION

PREPARED BY:

M Valentine FO MS — 4/6/87

SIGNATURE — DATE

REVIEWS

~~PEER:~~ REVIEW COMMITTEE:

CW Jaden Karl Diedrich for Parkinson — 4/9/87

SIGNATURE — DATE

TAS:

SR Drane — 5/22/87

SIGNATURE — DATE

CONCURRENCES

SIGNATURE	DATE	SIGNATURE*	DATE
		R R Kearns	4/28/87
		CEG-H: George R McNutt	4-28-87
		SRP: James R Russell	5-27-87

APPROVED BY:

W S Raughley Jr	5/27/87	N/A	
ECSP MANAGER	DATE	MANAGER OF NUCLEAR POWER CONCURRENCE (FINAL REPORT ONLY)	DATE

* SRP Secretary's signature denotes SRP concurrences are in files.

1. CHARACTERIZATION OF ISSUES:

Concern:	Issues:
IN-85-392-001 "What would happen with the large number of electrical splices located underground if the system became flooded? 1. Would the splice hold up under long exposure to moisture? 2. If the splice failed would a safety related problem occur? 3. Would a back-up system be activated?"	a. The adequacy of cable splices is questioned should underground cable systems become submerged from flooding in manholes or cable ducts. b. Plant safety is questioned as a result of a splice(s) failure because of flooding. c. Adequacy of the current design for availability of redundant (back-up) systems is questioned in case of cable splice failure(s).

2. HAVE ISSUES BEEN IDENTIFIED IN ANOTHER SYSTEMATIC ANALYSIS? YES X NO

Documentation Identifiers:

o Identified by TVA SQN ECTG

Date 10/21/86

TVA SQN, ECTG Report, "Cable Problems in Manholes," R1

3. DOCUMENT NOS., TAG NOS., LOCATIONS OR OTHER SPECIFIC DESCRIPTIVE IDENTIFICATIONS STATED IN ELEMENT:

None.

4. INTERVIEW FILES REVIEWED:

File IN-85-392 was reviewed and no additional unreviewed information for Sequoyah was identified for the concern in this report.

5. DOCUMENTS REVIEWED RELATED TO THE ELEMENT:

See Appendix A.

6. WHAT REGULATIONS, LICENSING COMMITMENTS, DESIGN REQUIREMENTS OR OTHER APPLY OR CONTROL IN THIS AREA?

See Appendix A.

7. LIST REQUESTS FOR INFORMATION, MEETINGS, TELEPHONE CALLS, AND OTHER DISCUSSIONS RELATED TO ELEMENT.

See Appendix A.

8. EVALUATION PROCESS:

a. Reviewed available transcripts of NRC investigative interviews for additional information on the concerns.

b. Reviewed Construction Specification G-38 and Modifications and Additions Instructions M&AI-4, M&AI-7, and M&AI-12.

c. Reviewed SQN Inspection Instruction No. 10, "Interconnecting Cable Termination and Insulation Inspection."

d. Reviewed adequacy of installation procedures for splices provided by engineering and supplier.

e. Evaluated adequacy for submersibility of splices used.

f. Evaluated effect of a splice failure on safety-related systems.

g. Evaluated availability of redundant systems in case of a splice failure.

h. Assessed validity of the concern and determined whether problems exist at SQN regarding cable splices in manholes/duct banks.

9. DISCUSSION, FINDINGS, AND CONCLUSIONS:

Chronology:

02/14/75-10/15/76:	Raychem performs immersion tests for TVA
09/13/77:	TVA, standard drawing, SD-E12.5.3, cable splicing, medium voltage, issued
10/30/79:	Modifications and Additions Instructions, M&AI-12, issued
11/08/79:	Modifications and Additions Instructions, M&AI-7, issued
03/20/81:	TVA, standard drawing, SD-E12.5.6, cable splicing, 600 V, single conductor, issued
02/27/84:	TVA, standard drawing, SD-E12.5.8, cable splicing, 600 V, multiconductor, issued
06/10/85:	Concern acknowledged by TVA for Watts Bar
10/21/86:	SQN, ECTG Report 304.03, "Cable Problems in Manholes," issued
12/19/86:	SQN, Corrective Action Report, SQ-CAR-86-058, issued

Discussion:

The Employee Concern questions the consequences of potential flooding on electrical cable splices in manholes or handholes. This issue was raised at WBN and is considered generic to all plants including SQN since cable splice requirements are similar for all plants.

9.1 ADEQUACY OF SUBMERGED CABLE SPLICES

Design Criteria SQN-DC-V-12.4 (App. A, 5.u; 04/26/74) specify that cables required to maintain the plant in safe shutdown or flooded condition be suitable for submersible operation. These cables shall be continuous (not spliced), unless qualified waterproof splices have been tested by the manufacturer according to TVA standard specifications, and have demonstrated their ability to meet performance requirements.

Raychem Tests

As part of TVA's program to qualify cable splices that may be subject to design basis flood levels, TVA provided cable samples to Raychem for test purposes. The samples included low voltage (600 V) power and control cables, signal cables, and medium voltage (8 kV) cables.

Raychem prepared several test configurations of splices on low voltage power, control, and signal cables, using the Raychem Heat Shrink Tubing WCSF-N. The spliced cables were subjected to 100-day immersion in a pressurized cylinder and tested to pressure and temperature parameters supplied by TVA. Raychem reported test results (App. A, 5.v and w; 02/14/75 and 06/27/75) showing that the samples performed satisfactorily.

The medium voltage (8 kV) cable was spliced with a Raychem HVS-A-4-22 5/8 kV splice kit. The cable ends were terminated with Raychem high voltage termination HVT-I-A-2 kits. After electrical tests, the sample was subjected to long-term immersion testing in a pressurized cylinder. The cable loop was connected for current cycling tests. Raychem reported test results (App. A, 5.x and y; 06/18/76 and 10/15/76) showing that the sample performed satisfactorily and maintained original test values and integrity after the 100-day water pressure, load cycling test.

Upon completion of the Raychem tests, the TVA EEB, via memo from Chandler to Pierce (App. A, 5.hh; 11/15/76), issued the "Criteria and Procedures for Making Splices of Insulated Cables in Manholes and Handholes," for interim use by Construction and for incorporation in standard drawings and Construction Specification G-38 (requirements were reflected in G-38 Rev. 2 [App. A, 5.f; 08/03/78]). Although it is not documented, the evaluation team assumed that the tests were performed to qualify Raychem heat shrinkable tubing installed prior to the tests and the issue of the cable splicing standards (App. A, 5.l, m and n). No records were, however, identified by the evaluation team to determine whether the tested splices were used in past applications and for how long.

Electrical Standard Drawings and Procedures Governing Splices

Following the Raychem tests, TVA issued three electrical standard drawings to delineate cable splicing procedures and materials:

- For splicing the class 1E and nonclass 1E medium voltage (5 to 15 kV) insulated conductor cables, TVA Electrical Standard Drawing SD-E12.5.3 (App. A, 5.1; 09/13/77) specifies the procedures, the splice kits, and the materials to be used. SD-E12.5.3 supersedes TVA Electrical Standard Drawings 30B1041 (App. A, 5.z; 06/06/51) and 30B1043 (App. A, 5.aa; 06/06/51). It requires the use of Raychem heat shrink tubing over 3M tape splice kits for all class 1E applications and for all splices located in manholes, handholes, and cable trenches.

- TVA Electrical Standard Drawings SD-E12.5.6 (App. A, 5.m; 03/20/81) and SD-E12.5.8 (App. A, 5.n; 02/27/84) outline the procedures and the materials to be used for splicing 600 V (or less) insulated cables. Raychem heat shrinkable sleeving of various sizes is specified for these splices.

TVA/SQN Modifications and Additions Instruction M&AI-7 (App. A, 5.c; 11/08/79) was developed upon completion of construction in 1979, and gives guidelines for splicing with reference to the electrical standard drawings described above, for details. Similarly, M&AI-12 (App. A, 5.d; 10/30/79) outlines inspection instructions for cable terminations and splices. These M&AIs provide instructions for cable installations performed during modifications and additions to the facilities of the SQN plant.

Prior to TVA's cable splice qualification program and the issue of standards for cable splicing as discussed above, TVA indicated (App. A, 7.b; 01/10/87) that the governing document for splicing was the General Construction Specification G-38, Rev. 0, (App. A, 5.f; 07/25/73), which provides a listing of Raychem heat shrinkable tubing to be used for various sizes of 600 volt splices, but not for medium voltage splices. Interviews of TVA personnel conducted by the evaluation team (App. A, 7.c; 01/25/87) indicate that Raychem heat shrinkable tubing was installed in accordance with vendor instructions prior to the issue of the cable splicing standards (App. A, 5.1, m and n). Although these splices have been in service under adverse conditions for some time without a failure, no splice installation records were identified and the implementation by construction of the cable splicing requirements as stated in Construction Specification G-38 could not be verified by the evaluation team.

Inspection Guidelines

To furnish guidelines for inspection of terminations and splices during plant construction activities, TVA's Division of Construction issued the SQN Inspection Instruction (II) No. 10 (App. A, 5.b; 05/26/77). The inspection instruction requires visual inspection of cables, splices, and terminations as well as continuity and insulation testing (this is discussed in detail in Sequoyah Element Report 241.3). The document also specifies that a splice card be filled out and signed upon successful completion of the inspection and be processed in accordance with the Quality Assurance (QA) Program and the requirements of SNP Construction Procedure No. P-8 (App. A, 5.ff; 04/24/72).

Identified Problems in Manholes

The ECTG Report No. 304.03 (App. A, 5.i; 10/21/86) evaluated two concerns identified at WBN and at BLN: that electrical manholes are in a disorganized state. These concerns were expanded at SQN to include water in the manholes. The report indicated that applicable documents were reviewed and interviews conducted with cognizant engineering, craft, and electrical maintenance personnel, and a sample of six manholes was inspected.

The SQN procedure that covers the installation of cables is M&AI-4 (App. A, 5.cc; 10/30/79); however, it does not include a preventive maintenance or housekeeping program for electrical manholes. The inspection team found that the manholes contained various amounts of water and some had debris lying on the floor. The cables in all the manholes were coated with mud. At several locations, the sump pumps or their controls were not in an operating condition. On the basis of the findings from these sample inspections and interviews with cognizant personnel, the report concluded that although the cable arrangement in the manholes inspected was generally good, manholes need to be cleaned and debris removed. There also appears to be a widespread problem with water in the manholes.

NRC-Identified Problems with Heat Shrinkable Tubing Installation

The NRC issued IE Information Notice No. 86-53 (App. A, 5.g; 06/26/86) to alert licensees to a potentially generic safety problem involving improper installation of heat shrinkable tubing over electrical splices and terminations. The notice states that installation discrepancies with Raychem heat shrinkable tubing have been reported at several plants including Watts Bar and Bellefonte.

In response to the NRC notice, SQN issued SMI-0-317-42, "Walkdown Procedure for 10CFR50.49 Splices" (App. A, 5.gg; 01/06/87). Although the SMI does not specifically address cable splices in manholes, the associated Corrective Action Report (CAR) No. SQ-CAR-86-058 (App. A, 5.h; 12/19/86) notes that, "Corrective action must address, in addition to correcting known examples, the actions taken to identify and correct similar occurrences." Although the evaluation team has not identified any documentation of improper installation of splice kits in manholes, several instances of improper installation of heat shrinkable tubing have been found at SQN under the SMI-0-317-42 program (splices in manholes are not covered under 10CFR50.49). Cognizant TVA personnel interviewed (App. A, 7.a; 12/30/86) stated that they are not aware of any cable splice problems in manholes at SQN.

Examination of Splice Cards

The evaluation team reviewed a number of sample splice cards dating from 1977 to 1980 (no earlier records for splices were identified). The cards state that splices have been made in compliance with Inspection Instruction No. 10 (App. A, 5.b; 05/26/77). However, the splice cards do not show what material was used or to what standard (drawings or manufacturers' splice details) the splices conformed. Although splice locations are recorded on the card, no master document was identified for all splice locations throughout the plant (App. A, 7.c; 01/25/87).

9.2 POTENTIAL FLOODING EFFECTS

Design Criteria SQN-DC-V-12.4 (App. A, 5.u; 04/26/74) define the design considerations and requirements for electrical cables installed in underground conduit banks between the power plant and the associated remote buildings, such as the diesel generator building, the essential raw cooling water (ERCW) pumping station, and the intake pumping station. All cables interconnecting class 1E electrical equipment between the power plant and associated remote buildings are installed in two independent conduit banks: one for each class 1E train A or B as defined in Design Criteria SQN-DC-V-12.2 (App. A, 5.ee; 08/23/74) and as committed to in the FSAR Section 8.3.1.4.2 (App. A, 5.dd).

The evaluation team verified that divisionalized cables in conduit banks are adequately separated in compliance with the design criteria (App. A, 7.c; 01/25/87). A postulated failure of a cable splice in one class 1E train due to flooding should not affect the function of the redundant train if cable splices have been installed correctly in accordance with existing procedures.

However, simultaneous flooding of incorrectly installed cable splices in redundant class 1E manholes could result in a common mode failure.

9.3 REDUNDANCY

The design and installation of class 1E cables in independent conduit banks are based on the requirements for preserving the independence of redundant class 1E systems as stated in the FSAR (App. A, 5.dd). Redundant systems are provided so that single failures, including the failure of a cable splice of a redundant system, will not have an adverse affect on the safety of the plant. Upon loss of one class 1E train, the design allows the plant to meet the single failure criteria with the remaining available class 1E train.

Findings:

a. Review of the design and construction documents revealed that current procedures, standards, and inspection instructions provide sufficient information to make qualified cable splices on medium voltage (5 to 15 kV) and low voltage (600 V or less) cables. Documentation review (G-38, Rev. 0 and Raychem tests) and interviews conducted by the evaluation team also suggests that, prior to the issue of the "Criteria and Procedures for Making Splices of Insulated Cables in Manholes and Handholes" (App. A, 5.hh) and the electrical standard drawings SD-E12.5.3 (medium voltage) and SD-E12.5.6 and SD-E12.5.8 (low voltage), submersible cable splices, including Raychem heat shrinkable tubing, were installed. However, no evidence supporting adequacy of installation or installation records of submersible cable splices could be identified. Furthermore, G-38 does not address splices for medium voltage cables prior to Rev. 2.

   Improper installation of heat shrinkable tubing over electrical splices, as stated in the NRC IE Information Notice, has been identified in CAR No. SQ-CAR-86-058. The current program under SMI-0-317-42 is, however, limited to correcting the problem only for splices on equipment covered under 10CFR50.49. No program is currently in place to review the adequacy of splice installation for cables in manholes.

   No splice cards for cable splices prior to 1977 were identified, and the reviewed splice cards do not record materials used. In addition, the evaluation team found that existing records are insufficient to determine the type, number, and location of cable splices in manholes. Neither

could the evaluation team identify use of cable splices as tested by Raychem for TVA, prior to the issue of the current electrical standard drawings for splicing procedures.

b. The evaluation team determined that cables of redundant class 1E trains are routed through independent conduit banks to the remote buildings in conformance with the design criteria. Although the class 1E cables have been in service under operating conditions for some time, existing records are insufficient to verify the adequacy of the cable splices. Due to possible simultaneous flooding of redundant class 1E manholes, a potential common mode failure of redundant class 1E cable splices cannot be ruled out. A limited walkdown of six manholes identified in ECTG Report No. 304.03 confirmed that manholes are currently flooded, resulting in cables coated with mud, and debris lying on the floor.

c. The design of class 1E cable systems is based on requirements for preserving the independence of redundant class 1E systems. However, because of insufficient cable splice records and the potential common mode failure as stated above, the availability of a redundant class 1E train for safe shutdown of the plant cannot be guaranteed.

Conclusions:

a. The issue of the adequacy of cable splices in flooded manholes is valid, although no splice failures were identified. Construction Specification G-38 provided limited information regarding installation of submersible cable splices (medium voltage splices were not addressed prior to Rev. 2) before the effective issue date of the current installation procedures, and no master document listing all splices throughout the plant was found. Also, splice cards for cable splices prior to 1977 could not be found, and the available splice cards from 1977 on do not record materials used. Therefore, the adequacy of the splices cannot be verified.

b. The issue of possible safety-related problems should a splice fail under flooded conditions is valid. Although cables of redundant class 1E trains are routed through independent conduit banks, the adequacy of the cable splices for service under flooded conditions cannot be verified.

c. The issue of back-up system activation in case of a cable splice failure in one class 1E train is valid. Although current redundant class 1E system design is adequate, the availability of a redundant class 1E train for safe shutdown has to be evaluated in view of a potential common mode failure of class 1E cable splices due to simultaneous flooding of redundant class 1E manholes.

10. CORRECTIVE ACTION:

In response to the findings above which require corrective actions as identified by corrective action tracking documents (CATDs) 241.01 SQN 01, 241.01 SQN 02 and 241.01 SQN 03 (to be identified as CATD-1, CATD-2, and CATD-3, respectively), TVA has generated the following corrective action plans (CAPs) as identified by transmittal TCAB-076 dated 02/17/87 (App. A, 5.jj) and transmittal TCAB-083 dated 03/31/87 (App. A, 5.kk).

The CAP for CATD-1 must be completed prior to restart. The problem descriptions of CATD-1 indicate that current cable splicing standard drawings and M&AIs provide adequate instructions for cable splicing; however, prior to these standards, no evidence of adequate procedures for installation of submersible splices existed, and no splice cards prior to 1977 were found, and splice cards do not record materials used.

To respond to this problem, TVA will:

a. Correct sump pump deficiencies (including power supply, controls, and discharge piping) in all class 1E/CSSC manholes and handholes (MH/HHs) having sump pumps, except MH41 (MH41 is for the additional diesel generator): 37 of the 56 class 1E/CSSC MH/HHs have sump pumps (see EC CATD 304.03-SQN-03). Pump dry the 36 submerged class 1E/CSSC MH/HHs to provide access for the sampling program discussed below.

b. Determine the number of class 1E/CSSC cable splices in the 36 MH/HHs noted in 10a above. Also record the number of class 1E/CSSC cable splices that have been submerged in these MH/HHs. Assuming a similar average number of splices in the remaining MH/HHs, establish the total number of estimated class 1E/CSSC splices. Using an appropriate sampling procedure, such as MIL-STD-105D, establish whether a large enough number of splices has been submerged to provide a representative sample. Only those splices in circuits which are frequently energized will be included in the sample. Submerged cable splices in circuits frequently energized

demonstrate the adequacy of the cable splices. If the number of submerged class 1E/CSSC splices is large enough to establish a 95 percent confidence level that the splices are 95 percent reliable, no further action is required before unit 2 restart.

c. If the sample as stated in paragraph 10b is not large enough to establish a 95 percent confidence level that the splices are 95 percent reliable, verify the proper installation of heat shrink sleeving on all class 1E/CSSC cable splices installed in the 36 MH/HHs noted per paragraph 10a, except those that have been submerged. Also, evaluate the available high pot and megger test data for the class 1E/CSSC medium and low voltage power cables routed through the remaining MH/HHs. Write a CAQ for any inadequate class 1E/CSSC cable splices (see EC CATD 304.03-SQN-03).

These actions should provide an adequate level of confidence regarding adequacy of splices in MH/HHs prior to restart.

The second CAP responds to CATD-2, and its completion is not required prior to restart. The problem description of CATD-2 was: "Insufficient records exist to determine the type, number and location of cable splices in manholes." The action plan for eliminating this problem is to document the type of material used to waterproof the splices, and determine the number and location of all class 1E/CSSC splices in the manholes and handholes. Also, M&AI-7, currently under revision, will require unique identification and documentation of location, cable number, materials used, etc., for future installations of class 1E/CSSC splices. This action should rectify the problem outlined in CATD-2.

The CAP for CATD-3 need not be completed prior to restart. This problem description of CATD-3 indicates that SQ-CAR-86-058 identifies inadequacies in application of Raychem products. No program has been identified addressing adequacy of installation of Raychem products on electrical splices in manholes.

To respond to this problem, TVA will:

- Prepare a special maintenance instruction (SMI) to inspect all class 1E/CSSC cable splices in manholes and handholes to determine if they are adequate for their application.

- Write a CAQ for inadequacies and a work request (WR) to replace all inadequate class 1E/CSSC splices identified.

These actions should ensure that the installed splices are adequate for operation of the plant.

APPENDIX A

5. DOCUMENTS REVIEWED RELATED TO THE ELEMENT:

a. TVA memo R. W. Cantrell to C. C. Mason, "Evaluation of the Adequacy of Installed Class 1E Cables," (B43 851203 915), (12/02/85)

b. SQN Inspection Instruction No. 10, Sections 7 and 8, "Interconnection Cable Termination and Insulation Inspection," R7, (05/26/77), (SQN 840322 018), R16, (03/30/83)

c. SQN Modifications and Additions Instruction M&AI-7, "Inspection Criteria of Cables or Internal Panel Wiring," Section 3.0, R0, (11/08/79)

d. SQN Modifications and Additions Instructions M&AI-12, "Interconnecting Cable Termination and Insulation Inspection," Section 7.0, R0, (10/30/79)

e. Letter from B. J. Youngblood, NRC, to S. A. White, TVA, (B45 860714 832), with the attached transcript of the investigative interview conducted by the NRC on 02/21/86 at the First Tennessee Bank Building in Knoxville, TN, (06/23/86)

f. General Construction Specification G-38, "Installing Insulated Cables Rated Up to 15,000 Volts," R0, (07/25/73) R1, (10/22/75) R2, (08/03/78) and R8, (03/17/86)

g NRC Office of Inspection and Enforcement, Information Notice No. 86-53, "Improper Installation of Heat Shrinkable Tubing," (06/26/86)

h. SQN, Corrective Action Report No. SQ-CAR-86-058, (12/19/86)

i. TVA, SQN, ECTG Report No. 304.03, "Cable Problems in Manholes," R1, (10/21/86)

j. TVA memo from R. W. Cantrell to K. W. Whitt, "Employee Concern Evaluation: Concern No. IN-85-392-001 - Underground Electrical Splices - Watts Bar Nuclear Plant," (07/16/85)

k. TVA, Special Maintenance Instruction SMI-0-317-4, R0 (1979)

l. TVA, Electrical Standard Drawing SD-E12.5.3, "Cable Splicing Medium Voltage (5-15 kV) Insulated Conductors," R0, (09/13/77), R2, (05/03/84), R3, (05/20/86)

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m. TVA, Electrical Standard Drawing SD-E12.5.6, "Cable Splicing 600 V (or less) Insulated Cable," R6, (03/20/81), R8, (09/19/86)

n. TVA, Electrical Standard Drawing SD-E12.5.8, "Cable Splicing and Term. 600 V (or less) Multi-conductor Insulated Cable," R2, (02/27/84), R4, (07/31/86)

o. 3M Product Data Sheets for Tape and Inline Taped Splices, 5-25 kV No. C-2047, Rev. A1, (10/26/71)

p. Raychem Nuclear Products Guide

q. Thomas and Betts Products catalog, Compression Connectors

r. Raychem High Voltage Splice Kit, 8 kV Class, Dwg. No. HVS-A3-2-4/0-TVA (05/31/77)

s. Raychem High Voltage Splice Kit, 8 kV Class, Dwg. No. HVS-A3-250-500-TVA (05/31/77)

t. Raychem High Voltage Splice Kit, 8 kV Class, Dwg. No. HVS-A3-750-1000-TVA (05/31/77)

u. Design Criteria SQN-DC-V-12.4, "Design Criteria for Cable Support Systems for Capability of Testing Cables for the Design Basis Flood," Rev. 1, (04/26/74)

v. Raychem, Immersion Tests for TVA, Interim Report, TSL4618, (02/14/75)

w. Raychem, Immersion Tests for TVA, Report #2, (Raychem WCSF-N Cable Splices), TSL4618, (06/27/75)

x. Raychem, Water Immersion Testing, Interim Report #1, TVA Cable 5-8 kV Splice Testing, TVA 8 kV Shielded Power Cables, (06/18/76)

y. Raychem, Water Immersion Testing of 5-8 kV Raychem Splice on TVA 8 kV Shielded Power Cable, (10/15/76)

z. TVA, Electrical Standard Drawing 30B1041, R5, "Straight Splice, Types ROSJ, PSJ and CPSJ 5-15 kV Shielded Cable," (06/06/51)

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aa. TVA, Electrical Standard Drawing 30B1043, R2, "Straight Splice, Type AVCSB, 5-8 kV Shielded Cable, (06/06/51)

bb. General Construction Specification G-4, "Installing Insulated Cables Rated Up to 15,000 Volts Inclusive," (01/09/73)

cc. SQN Modifications and Additions Instruction M&AI-4, "Installation of Control, Power and Signal Cables," R0, (10/30/79), R9 (08/13/86)

dd. SQN FSAR, Section 8.3.1.4.2, Amendment 1, "Cable Routing and Separation Criteria"

ee. Design Criteria SQN-DC-V-12.2, "Separation of Electrical Equipment and Wiring," Rev. 3, (08/23/74)

ff. SNP Construction Procedure No. P-8, "Preparation, Review, Handling, and Temporary Storage of Quality Assurance Records," R0, (04/24/72), (SQN 831017 037), R1, (01/25/74), (SQN 831017 038), R16, (02/17/83), (SQN 831017 063), retitled "Quality Assurance Records"

gg. TVA SQN, Special Maintenance Instruction SMI-0-317-42, "Walkdown Procedure for 10CFR50.^9 Splices," R2, (01/06/87)

hh. TVA memo from F. W. Chandler to R. M. Pierce, "Sequoyah and Watts Bar Nuclear Plants, Units 1 and 2, Waterproof Splice for 8-kV Cable - SQN-127A and WBN-127A," (EEB 761116 932), (11/15/76) and attached "Criteria and Procedures for Making Splices of Insulated Cables in Manholes and Handholes"

ii. IEEE Std 48-1975 "Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations, (05/09/75)

jj. Letter from G. R. McNutt to G. L. Parkinson, TCAB-076, "Corrective Action Plan," (02/17/87).

kk. Letter from G. R. McNutt to G. L. Parkinson, "Corrective Action Plan," TCAB-083, (03/31/87)

ll. Corrective Action Plan of Employee Concern Investigation Checklist, ECTG Report/CATD Number 304.03-SQN-03, (12/06/86)

APPENDIX A (cont'd)

6. WHAT REGULATIONS, LICENSING COMMITMENTS, DESIGN REQUIREMENTS OR OTHER APPLY OR CONTROL IN THIS AREA?

a. SQN FSAR, Section 8.3.1.4.2, Amendment 1, "Cable Routing and Separation Criteria"

b. Design Criteria SQN-DC-V-12.2, "Separation of Electrical Equipment and Wiring," Rev. 3, (08/23/74)

c. Design Criteria SQN-DC-V-12.4, "Design Criteria for Cable Support Systems for Capability of Testing Cables for the Design Basis Flood," Rev. 1, (04/26/74)

d. General Construction Specification G-38, "Installing Insulated Cables Rated Up to 15,000 Volts," R2, (07/25/73) and R8, (03/17/86)

e. SQN Inspection Instruction No. 10, Sections 7 and 8, "Interconnection Cable Termination and Insulation Inspection," R7, (05/26/77), (SQN 840322 018), R16, (03/30/83)

f. SNP Construction Procedure No. P-8, "Preparation, Review, Handling, and Temporary Storage of Quality Assurance Records," R0, (04/24/72), (SQN 831017 037), R1, (01/25/74), (SQN 831017 038), R16, (02/17/83), (SQN 831017 063), retitled "Quality Assurance Records"

g. TVA, Electrical Standard Drawing SD-E12.5.3, "Cable Splicing Medium Voltage (5-15 kV) Insulated Conductors," (09/13/77)

h. TVA, Electrical Standard Drawing SD-E12.5.6, "Cable Splicing 600 V (or less) Insulated Cable," R6, (03/20/81)

i. TVA, Electrical Standard Drawing SD-E12.5.8, "Cable Splicing and Term. 600 V (or less) Multi-conductor Insulated Cable," R2, (02/27/84)

j. SQN Modifications and Additions Instruction M&AI-7, "Inspection Criteria of Cables or Internal Panel Wiring," R0, Section 3.0, (11/08/79)

k. SQN Modifications and Additions Instructions M&AI-12, "Interconnecting Cable Termination and Insulation Inspection," R0, Section 7.0 (10/30/79)

APPENDIX A (cont'd)

7. LIST REQUESTS FOR INFORMATION, MEETINGS, TELEPHONE CALLS, AND OTHER DISCUSSIONS RELATED TO ELEMENT.

a. Telecon between F. Jaksche and I. Don-Doncow, Bechtel, and P. Nesbitt and G. Clift, TVA, Information on cable splicing procedures and standards at SQN, IOM 573 (12/30/86)

b. Telecon between F. Jaksche, Bechtel, and G. Clift, TVA, Information on earlier issues of cable splicing standards and procedures at SQN. IOM 574 (01/10/87)

c. Bechtel memo from S. Mabie to I. Don-Doncow, "SQN Electrical Splices Located Underground." Review of cable installation records and personnel interviews, IOM 575 (01/25/87)

d. Telecon between F. Jaksche, I. Don-Doncow, Bechtel, and C. Lyke, TVA, Revision of CAP for CATD. 241.01 SQN 01, IOM 656 (02/18/87).

CATD LIST

The following CATDs identify and provide corrective actions for the findings included in this report:

241 01 SQN 01 (02/13/87; CAP revised 03/31/87)
241 01 SQN 02 (02/13/87)
241 01 SQN 03 (02/13/87; CAP revised 03/31/87))

CATEGORY: EN DES PROCESS & OUTPUT SUBCATEGORY: 24101 INAD SPLICING & TERMINATION PRACTICES & PROCEDURES

CONCERN NUMBER	CAT	SUB CAT	S H R D	PLT LOC	1 REPORT APPL 2 SAF RELATED BF BL SQ WB	HISTORICAL REPORT	CONCERN ORIGIN	CONCERN DESCRIPTION
IN -85-392-00101 T50012	EN	24101	N	WBN	1 Y Y Y Y 2 NO NO NO NO	IN-85-392-001	QTC	WHAT WOULD HAPPEN WITH THE LARGE NUMBER OF ELECTRICAL SPLICES LOCATED UNDERGROUND IF THE SYSTEM BECAME FLOODED 1. WOULD THE SPLICE HOLD UP UNDER LONG EXPOSURE TO MOISTURE? 2.IF THE SPLICE FAILED WOULD A SAFETY RELATED PROBLEM OCCUR? 3. WOULD A BACK-UP SYSTEM BE ACTIVIATED?

1 CONCERNS FOR CATEGORY EN SUBCATEGORY 24101