TVA EMPLOYEE CONCERNS
SPECIAL PROGRAM

REPORT NUMBER: 238.3(B)

REVISION NUMBER: 2

REPORT TYPE: SEQUOYAH ELEMENT

TITLE: RACEWAY OVERFILLS AND CABLE PULLING

Cable Tray Overfills and Wall and Floor Penetrations

REASON FOR REVISION:

1. Revised to incorporate SRP and TAS comments, to expand discussion on electrical penetration fire stops, and to add CATD 238.03-SQN-10.

2. Revised to include Chronology in Section 9; to add Section 10 Corrective Action; and to revise Appendix A.

PREPARATION

PREPARED BY:

Robert H Kuhn — SIGNATURE — FEB 02 87 — DATE

REVIEWS

~~PEER~~ REVIEW COMMITTEE

H Parkinson, J Wiletter, R P Schmitz — SIGNATURE — 2/2/87 — DATE

TAS 2/4/87 — SIGNATURE — 2/4/87 — DATE

CONCURRENCES

Carl C. Lyles — 2/3/87

CEG-H: George R McNutt — 2-3-87

SRP: James R Russell — 2-5-87

SIGNATURE — DATE — SIGNATURE* — DATE

APPROVED BY:

M W Rudolphi — ECSP MANAGER — 2/5/87 — DATE

N/A — MANAGER OF NUCLEAR POWER — DATE

CONCURRENCE (FINAL REPORT ONLY)

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

1. CHARACTERIZATION OF ISSUES:

Concerns:	Issues:
OW-85-007-002 "Electrical cable in trays runs completely outside of the trays, especially in bends. Many cable trays are grossly over capacity. These conditions work against the cable trays' purpose of supporting and protecting the cable."	a. Cable trays are overfilled. b. Cable tray fill criteria for cables violate the National Electrical Code and industry practice. c. Trays do not provide support (cables hang loose) and protection to cables running outside of them as a result of overfill. Tray covers cannot be installed as a result of overfill.
IN-85-186-003 "Cable trays are over full in the spreading room, Elev. 729 in both units. Other cable trays in other areas may have the same problem."	d. Plant procedures contain no requirement prohibiting overfilling of cable trays. More cables are being added to overfilled trays.
WI-85-100-011 "Cable tray fill criteria of 60% for I&C cables is inadequate. The National Electrical Code allows 40% and 50% fill on an exception basis. TVA violates this code. This industry practice is 40% fill. This situation is made even worse with the addition of spray-on fire retardant materials which take up space in trays."	e. Cable tray penetrations are overfilled. More cables are pulled through already overfilled penetrations. Possible cable damage may result from cable pulling through overfilled penetrations (addressed in Sequoyah Element Report 238.1). f. Overfilled tray penetrations may not be qualified as a pressure boundary as it is almost impossible to apply the RTV silicone foam.
IN-85-798-004 "Cable tray in Aux. Bldg, El. 713 located at the T4 and R line is too full. 5-6 cables are hanging loose, but the tray is being loaded with more cables."	g. Damaged cables would not be discovered until they short out (addressed in Sequoyah Element Report 238.1).
IN-86-238-003 "Many cable trays, Unit 1 and 2, are too full of cables."	

Concerns (continued):

IN-86-232-002
"Due to overfilling of cable trays with cable, the penetration seals may not be able to pass a pressure test. The RTV Silicone seal foam was almost (in many instances) impossible to apply due to the number of cables in the penetration."

IN-85-688-N05
"Inspector on Unit 1 reported to CI one instance of cable tray overfilling."

IN-85-919-001
"Electrical cable tray penetrations are full and cable is still being pulled through these penetrations located in the control bldg." "Concerned about possible damage to cables in these penetrations resulting from the cable pulls."

IN-85-432-002
"Over-filled cable trays, trays filled to the maximum, covers can not be installed."

IN-85-688-001
"Plant procedures contain no requirement prohibiting overfill of cable trays in safety related installation. Instances where safety related overfills have occurred were not provided."

IN-85-856-003
"Conduit and cable trays are too full."

PH-85-003-023
"The cable trays are overfilled plant wide."

IN-86-028-002
"National Electrical standards are not being followed. Example cable trays and conduits are overfull."

IN-85-312-001
"Cable trays in (SIC) conduits are overfilled with cable. The cables could be damaged and not discovered until it shorts out."

IN-85-734-001
"Conduits/cable trays/penetrations in Units 1 and 2 are generically overfilled/overloaded."

IN-86-262-001
"Units 1 and 2. The conduits and cable trays are too full. It often takes 4-5 days just to pull the fish tape through. This overcrowding is an unsafe condition."

IN-85-832-001
"Overloaded cable tray penetration El 729' Turbine Bldg. & Control Bldg. El. 737' Aux. Bldg. and Control Bldg. 741. Conduits being filled beyond National Elec. Code allowance. Possible damage to cables that other cables are being dragged over."

Concerns (continued):

IN-85-207-001
"Engineering is routing/scheduleing cables to be pulled through "closed" penetrations, due to the amount of cable fill, the cable jackets and conductors are damaged during cable tray through penetration in Auxiliary building Elev. 737'. Q line and A3 also, penetration O-CTP-290-62, approx. location N line and C-10 elev. 729' in Control Bldg. was full, yet additional cable was routed and pulled through during August 1985. Construction Department concern. CI has no more information."

IN-85-519-001
"Cable trays overloaded, Aux. Bldg. Units 1 & 2, 713' and 737' Elev."

WI-85-100-015
Cable trays are too heavily filled, and the cables are not properly derated. CI has no further information. Anonymous concern via letter."

2. HAVE ISSUE(S) BEEN IDENTIFIED IN ANOTHER SYSTEMATIC ANALYSIS? YES X NO

Documentation Identifiers:

- Identified by TVA SQN SCR

  Date 06/27/86

  SCR - SQNECB8601 R0 (B42 860707 014), Cable Tray Fill Design Criteria Exceeded

- Identified by TVA SQN SCR

  Date 03/21/86

  SCR - SQNEEB8620 R1 (B43 860410 910), Cable Tray Loading

- Identified by TVA SQN SCR

  Date 01/06/86

  SCR - SQNEEB8601 R0 (B43 860117 919), Cable Weights and Outside Diameters Not Available From a QA Source

- Identified by TVA SQN GCTF

  Date 05/20/86

  TVA, SQN, GCTF Report, Overfill of Cable Trays and Conduits, R1

- Identified by TVA SQN NSRS

  Date 02/18/86

  NSRS Report No. I-86-251-SQN, Attachment 1, Review of Generic Concern Issue, Electrical Cables

- Identified by TVA SQN GCTF

  Date 04/25/86

  TVA, SQN, GCTF Report, Plant Procedures on Overfill of Cable Trays R1

- Identified by TVA SQN GCTF

  Date 02/09/86

  TVA, SQN, GCTF Report, Overfill of Cable Trays

- Identified by TVA SQN GCTF

  Date 05/16/86

  TVA, SQN, GCTF Report, Cable Tray Fill Criteria, R1

- Identified by TVA SQN NCR

  Date 04/11/85

  SQN Nonconformance Report NCR SQNECB8501 (B42 850412 004), Verification of Computer Cable and Raceway Programs and Data

- Identified by TVA SQN ECTG

  Date 10/21/86

  TVA, SQN ECTG Report, No. 304.02, Cable and Conduit, Electrical Penetration Breached, R1

o Identified by TVA SQN SCR

Date 03/10/86

SQN Significant Condition Report (SCR) No. SQNCEB8602 R1, (B25860925 004), Cable Tray Supports.

o Identified by TVA SQN ECSP

Date 09/19/86

TVA, SQN ECSP Report No. C01900-SQN, Cable, R1

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

No further information is available. The employee concerns are general in nature and address overall generic problems of overfilled trays and tray penetrations, and possible cable damage during installation.

4. INTERVIEW FILES REVIEWED

The following files were reviewed and no additional unreviewed information for Sequoyah was identified for the concerns in this report.

OW-85-007	IN-85-919	IN-86-262
IN-85-186	IN-85-432	IN-85-832
WI-85-100	IN-85-856	IN-85-207
IN-85-798	PH-85-003	IN-85-519
IN-86-238	IN-86-028	
IN-86-232	IN-85-312	
IN-85-688	IN-85-734	

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 FSAR and existing applicable TVA Design Standards for commitments and requirements regarding tray fill.

c. Reviewed cable routing and raceway fill tracking procedures for adequacy.

d. Reviewed Construction Specification G-38 and Modifications and Additions Instructions - M&AI-4, -7, -13, and -14 for cable installation practices and procedures, and for inspection instructions.

e. Reviewed existing TVA reports (e.g., GCA-01-46 and GCA-03-48) to assess extent to which existing reports and corrective actions satisfy the concerns.

f. Reviewed existing TVA Construction (e.g., C010900-SQN), QA/QC, Operations, and Material Control reports for the TVA Employee Concerns Special Program for applicability to the concerns discussed in this report.

g. Performed walkdowns for the visual assessment of cable tray and cable tray penetration fills.

h. Assessed overall adequacy of SQN cable installation practices and identified areas that may require further investigation and corrective action.

9. DISCUSSION, FINDINGS, AND CONCLUSIONS:

Chronology:

02/85:	Trays, firestops, and pressure seals acknowledged by TVA as approaching maximum fill
05/85:	Tray drawings revised to indicate full trays and to prevent further use of same
06-12/85:	Concerns received by TVA
12/85:	Modification and Additions Instruction, M&AI-04, revised to prevent adding cable above tray side rails
01/86:	Calculation issued to justify 60 percent fill for instrumentation and control trays
01/86:	SCR SQNEEB 86011 identifies use of non-QA cable values to calculate tray fill and tray loading
02/86:	GCTF report (reissued in 04/86) indicates no design requirement prevents cables from extending above tray side rails but revised M&AI should prevent recurrence
02/86:	NSRS Report I-86-251-SQN finds overfills mostly in nonsafety-related trays
03/86:	SCR SQNEEB 8620 identifies lack of tracking abandoned cables that could affect tray fill, power cable ampacity, and tray supports
03/86:	SCR SQNEEB 8622 finds that original design of tray supports may not have considered all loading conditions
04/86:	Engineering review of non-QA cable values indicates that nuclear safety is not impacted
05/86:	GCTF issues report on employee concerns that cable trays are overfilled
05/86:	A limited Engineering review of abandoned cables indicates there are no cable ampacity or tray support problems. Recommends additional evaluation of tray loading
05/86:	GCTF issues report to address applicability of NEC to utilities

06/86: SCR SQNECB 8601 identifies violations made by cable routers resulting in cable fills exceeding fill criteria

09/86: SCR SQNCEB 8622 corrective action indicates that 30 worst-case tray supports have been evaluated and that additional tray supports remain to be analyzed

09/86: Engineering procedures issued to control preparation and issue of cable schedules

09/86: ECSP Report C010900-SQN identifies only one or two instances of unsupported cables

10/86: Calculation SQN-E2-016 indicates that the loading of some vertical cable trays exceeds design limits

10/86: ECTG Report 304.02-SQN indicates that firestops have been breached in the past without known cable damage

11/86: Calculation SQN-E2-017 indicates that the loading of some horizontal cable trays exceeds design limits

Discussion:

Overfill of cable trays can increase the loads on tray supports and increase the cable insulation temperature where power density is high (e.g., power trays). Where trays are overloaded, assurance must be provided that design limits for supports and cable insulation are not exceeded.

a. Overfilled Cable Trays

The 02/21/85 memo from H. C. Abercrombie to Those Listed (App. A, 5.a) addressed the concern that trays and firestops/pressure seals on Sequoyah are approaching the maximum fill. The memo proposed that the Office of Engineering (OE) develop criteria for determining that a tray or firestop/pressure seal is physically full.

The memo also proposed that Quality Assurance (QA) then incorporate the OE criteria into procedures for cable pulls and firestop/pressure seal penetrations. Such procedures would include a mechanism to physically label the penetrations as physically full and notify OE to incorporate this into the cable routing program. QA will perform a survey of firestops/pressure seals using the OE criteria to ensure that those seals presently full are identified and properly closed.

The 03/28/85 memo from J. P. Vineyard to H. B. Rankin (App. A, 5.b) acknowledged the conditions described in the Abercrombie memo and proposed that OE use cable tray single-line drawings to document filled firestops/pressure seals and tray segments and correct the existing problems. This requirement has been incorporated in SQEP-06 (App. A, 5.aaa, 09/22/86).

The Vineyard memo also indicated that Construction Specification G-38 would be revised to include criteria for handling the identified condition of full cable trays and penetrations. Thus, when QA identifies the full areas, the OE/SQN will show these on the single-line tray drawings so the designers can provide jumper conduits or alternate routes. The evaluation team's review of several single-line tray drawings (App. A, 5.fff through 5.jjj) shows that the drawings do indicate physically full areas and jumper conduits. These drawings were revised on 05/01/85. However, although criteria for handling the identified condition of full cable trays and penetrations for SQN are not covered in G-38 (App. A, 5.ff, 03/17/86), they are covered in M&AI-04. Adequacy of procedures is further covered in subsection 9.d of this discussion.

The 02/18/86 NSRS Report I-86-251-SQN, Attachment 1, (App. A, 5.t) contains findings that investigators made regarding tray overfill from their observations and interviews with site personnel. The report states that:

- The disorderly arrangement of cables in trays was the primary reason for the appearance of overfilled trays
- Cables in safety-related trays had been installed in a more orderly fashion than in nonsafety-related trays
- Very few safety-related trays appeared to be full

Power trays observed were not physically full and cables appeared to be installed in accordance with the design requirements. However, the Flamemastic coating made it difficult to observe the spacing between power cables. In general, the trays that were full or that had cables above the side rails carried nonsafety-related instrumentation and control cables. These findings were also identified in the 05/20/86 Generic Concern Task Force (GCTF) report (App. A, 5.s). The NSRS report recommended completion of the corrective action indicated by SCR SQNEEB8601 (discussed in b. below), evaluation of cable tray physical loading, and improved definition and control of full cable trays.

The 05/14/86 Engineering Report (ER) (App. A, 5.f) for CAQ SCR SQNEEB8620 R0 (App. A, 5.e; 03/21/86) included a review of instrumentation and control cable tray overloading based on selected cable tray profiles which were totally filled with known and unknown (abandoned) cables and covered with 1/4-inch Flamemastic cable coating. The review identified several trays that were filled above the side rails. All these profiles were, however, for non-class 1E trays as determined in the review by the evaluation team.

The ER concludes that overload of cable trays resulting from abandoned cables not being removed or accounted for does not present a cable ampacity problem. Since the abandoned cables are deenergized and do not dissipate additional heat, the evaluation team concurs with the general approach that additional derating may not be required for the active power cables if the active power cables do not exceed the maximum allowable cable tray fills; however, additional analysis is required to support this. Furthermore, as indicated below, sampled class 1E power trays GG-A and GR-A do not appear to be overfilled, at least with active power cables. Regarding tray supports, the ER indicates that the worst-case sampling used to resolve the SCR was not sufficiently broad-based to address the adequacy of the cable tray supports. Subsequently, SCR SQNCEB8622 R1 (App. A, 5.uu) was issued on 03/10/86 to require an additional evaluation to resolve cable tray support overloading. The corrective action stated in SCR SQNCEB8622 indicates that an evaluation has been performed to identify 30 worst-case tray supports. In addition, "an additional number of cable tray supports would be analyzed after restart to provide a minimum of a 95 percent confidence level that no more than 5 percent of the supports would exceed design allowables."

The above program ultimately resulted in substantially larger number of worst-case tray supports requiring analysis because a significant number of selected trays exceeded the design limits. This evaluation is documented in SQN calculations SQN-E2-016 (App. A, 5.kkk) and SQN-E2-017 (App. A, 5.lll). Review of these documents by the evaluation team determined that the program did not cover the review of trays in areas other than the Control and Auxiliary Buildings (e.g.: Reactor and Diesel Generator Buildings) and no justification for not covering other areas has been identified. Also the review revealed that the approach and assumptions for this evaluation are adequate except for:

- The assumption that the applied thickness of Flamemastic is 1/4-inch cannot be verified since instances exist where additional cables were added to trays after the initial application of coating. Coating of the new cables could create thicknesses greater than assumed. Although this is not expected to have a significant impact on the overall weight of the tray segment, using only 1/4-inch of Flamemastic requires justification.

- The assumption that computed weights of known cables equal to or greater than 14 pounds per foot for vertical trays and 16 pounds per foot for horizontal trays will be sufficient to identify overloaded tray segments requires further justification. Considering that the accuracy of the raceway fill tracking system is not verified and that a large number of selected trays exceeded the design limits during the evaluation, no certainty exists at this time that 14 and 16 pounds per foot will be the limiting weights to properly identify overloaded tray segments.

The results of the program indicate that the Design Basis loading criteria specified in Design Criteria SQN-DC-V-1.3.4 (App. A, 5.mmm) have been exceeded for some of the vertical and horizontal cable trays in the Control and Auxiliary Buildings. Although TVA indicated that this condition will primarily impact vertical tray supports, the evaluation team did not review any resolution or corrective action to this problem as documentation of the analysis of overloaded supports was in progress at time of evaluation. However, TVA indicated that corrective actions have been identified to correct deviations from design basis requirements. Completion of this program should also resolve the following NRC observations at Sequoyah that resulted from an inspection performed during July 21-25, 1986 for design baseline verification (App. A, 5.ddd):

- "Review of cross sections of cable trays identified cable masses outside the trays. Consideration should be given to securing the cables and to evaluating resulting eccentricities. An example of this condition was found in the plant at Elevation 714' and Coordinates A12S."

- "A few locations in the cable tray systems appeared to contain large unsupported spans. These locations were identified to technical personnel involved in the evaluation of these systems accompanying the team. This situation was noted at elevation 714 and coordinates A1Q and A2Q, at elevation 734 at unspecified coordinates, and at elevation 685 in the auxiliary relay room."

In response to employee concerns about overfilled cable trays at Watts Bar, the GCTF issued a report on 05/20/86 (App. A, 5.s) to document the review for Sequoyah. The report's review scope was limited to walkdowns of cable trays in the Auxiliary Building and the cable spreading room. Upon field examination of several cable tray segments that were indicated as being full by cable tray diagrams, some cases were found where the grouped cables and the Flamemastic coating extended well above the cable tray side rails. The GCTF report found that the ER for CAQ SCR SQNEEB8620 used a lower than actual weight per cubic foot for the Flamemastic coating and recommended that calculations be revised to reflect this. The evaluation team's review of calculations SQN-E2-016 and SQN-E2-017 revealed that the correct (revised) Flamemastic coating weight was used. Medium and low voltage power trays were not observed to be overfilled during the GCTF walkdown. Some divisional trays appeared overfilled, but closer visual examination revealed loose packing and voids because of the random lay of cables, the use of multiple pulls, and the use of Flamemastic.

All this is partly the result of the fact that during the construction phase SQN did not have requirements to prevent filling cable trays above the side rails. Although Construction Specification G-38 Rev. 8 specifies that "cable trays shall not be filled above the side rails except at intersections and where cables enter or exit the tray," this statement is limited to plants beginning with Bellefonte. However, requirements that cable trays not be filled above the side rails except at intersections and where cables enter or exit the tray were added for SQN on 12/31/85 in Rev. 8 of the Modification and Additions Instruction (M&AI-04). During a plant walkdown, the evaluation team observed (App. A, 7.c, 10/09/86) several trays with cables above the tray side rails (e.g., KZ-A node 88-130, NN-A node 132-187, KY-A, node 196-197, GG-A node 103-104, GR-A node 62-63). Although no determination could be made of whether an actual overfill exists since cables are covered with Flamemastic, a review of the computer cable tray fill printout indicates that

calculations based on 18-inch by 4-inch cable trays, show that KZ-A, NN-A, and KY-A are overfilled above 60 percent. Power trays GG-A and GR-A are filled below 30 percent and, therefore, not considered overfilled. However, the accuracy of the raceway fill tracking system is not verified (this is discussed in detail in Seouoyah Element Report 239.0).

b. Cable Tray Fill Criteria

This issue questions the SQN cable tray fill criteria for conformance to the National Electrical Code (NEC) and industry practice. The maximum fill of 60 percent for instrumentation control and cables and 30 percent for power cables is stated in the SNP FSAR (App. A, 5.aa) and Design Criteria SQN-DC-V-11.3 (App. A, 5.bb).

The GCTF report regarding Employee Concern No. WI-85-100-011 (App. A, 5.w; 05/16/86) for SQN addresses the applicability of NEC tray fill criteria. This report found that the electrical utility portion of TVA is excluded from the requirements of this code per NEC Article 90, Section 2 (b), paragraph 5. Since power plants are not subject to follow the NEC requirements, the evaluation team concurs with the conclusion of the GCTF report.

The GCTF report further identified a calculation (App. A, 5.z; 01/31/86) used to justify the 60 percent fill. Five representative tray sections known to be filled with control cables to 60 percent of the tray cross-sectional area were analyzed. The fullest tray section was used to show that the heat producing cables (carrying control power less than 30 amperes) did not account for more than 30 percent of the tray section fill (30 percent is the maximum fill allowed in a power tray). This approach, modified to accommodate a limited number of heat dissipating cables, agrees with acceptable practices for justifying I&C raceway fills provided that the tray fill information is accurate and trays carrying control power cables are properly selected. However, the choice of representative tray sections was based on unverified computer printout data that are needed to determine tray fill. Thus, verification of the Computer Cable Routing Program discussed in Sequoyah Element Report 239.0 may impact the justification.

SCR SQNECB8601 RO (App. A, 5.c, 06/27/86) states that the criteria for cable tray fills (30 percent for power trays with cables above 30 amperes and 60 percent for instrumentation and control trays) have been violated. The SCR points out that during the review of the SQN Cable Routing System program, it was discovered that cable tray overfill conditions were created by system users raising the maximum allowable tray fill to permit the addition of cables to already full trays. Note that raising the maximum allowable tray fill capacity allows the Computerized Cable Routing System (CCRS) to route cables that would otherwise have been rejected by the computer program.

Engineering Report SCR SQNECB8601 RO (App. A, 5.d; 08/04/86) concludes that the cable tray loading (fill) was conservative because fill quantity was based on 3-inch deep cable trays whereas 4-inch trays were installed at SQN. The ER also states that there are no known cases of cable tray loading that violate the design criteria (as discussed earlier, ER SCR SQNEEB8620 contradicts this statement).

SQN SCR SQNEEB8601 RO (App. A, 5.j) was issued on 01/06/86 to address the generic problem of unverified values of cable outside diameters (OD) and weights. These unverified ODs were used to calculate the cable tray cross-sectional fill. Although verified values are required for these calculations, the cable outside diameters were not available from a documented source and the origin of the values used was unknown. The 04/14/86 ER CAQ SCR SQNEEB8601 RO (App. A, 5.k) stated that the unverified values have been evaluated and no major inconsistencies were found. The ER concluded that past calculations and the design that was based on these values "will not result in a failure that would impact nuclear safety." An attachment to the 09/04/86 memo from M. J. Scruggs to W. S. Raughley (App. A, 5.vv) compares the original cable cross-sectional areas and cable ODs with the new (actual) average values. The Scruggs memo indicates that of the 210 cable mark numbers reviewed, "150 mark numbers show the original OD to be larger than the new, 57 mark numbers show the new OD to be larger than the original OD and three were the same." The Scruggs memo also indicates that there are still some cable mark numbers at Sequoyah for which verified ODs are not yet available, but efforts are being made to determine the values. T. W. Roberts was instructed by a 09/23/86 memo from W. S. Raughley (App. A, 5.oo) to change the resident data of cable physical dimensions and weights in the SQN Cable Routing System using the new verified values. TVA indicated that this effort was completed and that new verified values were used in previously discussed calculations SQN-E2-016 and SQN-E2-017.

The evaluation team believes that although the ER for SCR SQNEEB8601 R0 conclusion is reasonable in that nuclear safety is not impacted, no analysis was included to support the conclusion.

The cable OD differences discussed above could have an effect on cable ampacities and derating because cable ampacities in cable trays depend on the cable tray fill. Furthermore, as part of a program to correct the problems with cable tray fill, a memo from Raughley (10/07/86, App. A, 5.qq) directs all the nuclear plants to establish "a sampling program to determine the adequacy of electrical cables with respect to their ampacity ratings." (The induction and heating issues are addressed in detail in Sequoyah Element Report 240.0.) Although TVA indicated (10/08/86, App. A, 7.e) that the extent of cable tray overfill at SQN will be determined as a byproduct of this sampling program, the program itself is not clear in this respect as the memo does not specifically require the sampling program to include evaluation of overfilled raceways. No results of this program are available yet.

Design Criteria document SQN-DC-V-11.3 uses the industry criterion of 30 percent fill for power trays. The industry criterion for instrumentation and control (I&C) trays generally allows fills to be between 40 to 50 percent, and, with appropriate justification, the fill may exceed 50 percent. Because of the low energy level of the cables generally installed in I&C trays, the heating effect is not a consideration except when control power cables are mixed with the I&C cables. However, this is also acceptable, if it can be demonstrated that control power cables do not account for more than 30 percent of the cable tray fill and that an acceptable power dissipation level per linear foot is not exceeded. Fills in these trays are limited primarily for the sake of an orderly installation appearance, to provide access to cables, and to allow the installation of tray covers when required.

c. Lack of Support and Protection for Cables

This issue refers to some cables being run completely outside the trays, especially in bends, and some cables "hanging loose." In addition, tray covers cannot be installed because trays are overfilled.

TVA ECSP Report C010900-SQN (App. A, 5.ww; 09/19/86) discusses the investigation of cables improperly routed outside of cable trays. It concludes that this routing has occurred in one or two instances, but that there is no massive amount of unsupported cable at Sequoyah, unlike Watts Bar where many instances were discovered. However, the Watts Bar cables were found to be temporary construction and security cables. Because of a misinterpretation of Construction Specification G-38 Section 3.2.1.8.2(b), "site personnel believed before December 31, 1985" that "it was acceptable to run cable outside of cable trays." The ECSP report also concludes that a walkdown is needed to verify that all permanent cables are in cable trays to ensure that G-38 has not been misinterpreted at SQN. The report does not, however, identify the walkdown as a corrective action item.

The evaluation team conducted a walkdown on 10/09/86 (App. A, 7.c) and did not observe cables running outside of trays or hanging loose from trays as a result of overfills. The team did observe cables lying on top of the Flamemastic coating but not fastened to existing cables or the tray. However, G-38 and M&AI-04 do not require such cables to be fastened.

Regarding the concern that cable tray covers cannot be installed because the trays are overfilled, the evaluation team has reported in Sequoyah Element Report 242.0 that cable tray covers are properly installed on safety-related trays. This observation is based on walkdowns of the cable spreading room and of the auxiliary instrument room. A subsequent walkdown (App. A, 7.c) of other areas in the plant indicated that there are several tray sections where tray covers could not be installed if they were required, but the evaluation team found that tray covers were not required in any of these cases because divisional separation was not required or because the tray sections are non-class 1E.

d. No Plant Procedure Requirements To Prohibit Overfilling

This issue is concerned with whether there are procedures to prevent cable tray overfills. In the discussion of issue "a," it was noted that TVA had recognized the overfill problem and proposed a plan to identify the overfilled trays and penetrations and to provide alternate routes.

The FSAR states that tray fills will be limited to 30 percent for power trays and 60 percent for instrumentation and control trays. Engineering design standards also impose this limitation.

GCTF reports (App. A, 5.u and 5.v) issued on 02/09/86 and 04/25/86 address SQN plant procedures on overfill of cable trays. The reports limited the investigation to instrumentation and control trays because fill restrictions on power trays are more stringent. The reports state that there is no design requirement that cables cannot extend above the side rails of cable trays and that M&AI-04 (App. A, 5.gg) was revised to instruct maintenance and construction personnel to install jumper conduits "to bypass blocked areas as determined by the cognizant engineer." Blocked areas are interpreted by the evaluation team as tray segments where additional cables, if installed, would protrude above the cable tray side rails. The reports conclude that these instructions will prevent cables from being installed above the cable tray side rails and that acceptable cable tray fill controls and procedures are in place at SQN.

Review of M&AI-04 by the evaluation team indicates that the field cognizant engineer must obtain DNE approval before deviating from a designed routing for a cable. This requires his coordination with DNE to resolve a routing problem or to provide alternate routing. DNE will in turn issue a new cable card with the agreed changes. However, the M&AI is not specific regarding coordination with DNE when jumper conduits are added to prevent installation of cables above the cable tray side rails.

On 09/22/86 TVA issued the Sequoyah Engineering Procedures, SQEP-06 (App. A, 5.aaa), to provide instructions for writing, routing, issuing, and revising cable schedules. The procedures give specific instructions for consideration of abandoned cables and tray loading. These include:

- Early warning when instrumentation and control trays are approaching maximum fill -- which was reduced (effective 03/01/86) from 60 percent of an 18-inch by 4-inch tray to 60 percent of an 18-inch by 3-inch tray (the actual tray side rails are 4 inches)

- Checking each new computer-generated route for I&C cables to ensure that it does not use filled (above 60 percent of the 18-inch by 3-inch tray) or blocked tray sections

- Recommendation of Civil evaluation of tray support loading conditions if there is any suspicion of established values being exceeded

The evaluation team finds that the procedural controls in place at SQN apply to modifications, additions, and maintenance during the operations phase and not to the construction phase. No evidence, however, exists that the actual tray fills identified as part of the programs to verify adequacy of tray supports and cable ampacities will be reflected in the raceway fill tracking system for future use. The procedures, M&AI-04, and SQEP-06 are considered sufficient to prevent future overfilling of I&C trays only. SQEP-06 does not provide specific instructions for power trays.

e.&f. Overfill of Cable Tray Penetrations

These two issues are concerned with possible cable damage and possible loss of penetration pressure integrity resulting from pulling cables through overfilled penetrations. (A related concern that overfilled cable penetrations may have to be evaluated for impact on cable ampacity is addressed in Sequoyah Element Report 240.0.)

Cable tray penetrations are sealed so that the pressure integrity or fire boundary of the wall or floor is not compromised. The following discussion summarizes the evaluation team's assessment of overfilled penetrations and methods used to breach the penetrations.

In addition to the potential ampacity and high temperature problems of power tray penetrations and fire stops, overfills may compromise the fire stop/pressure integrity because cables are packed tightly in the penetration. This may leave no room between the cables for the fire seal compound (RTV silicone foam). This also applies to cable tray penetrations which require pressure seals. Although no clear definition currently exists of what should be considered an overfilled penetration, the evaluation team observed potential overfills during a walkdown performed on 11/04-06/86 (App. A, 7.d). This overfill assessment was based on potentially overfilled trays going through these penetrations and was primarily observed at the instrumentation and control cable tray penetrations. The integrity of completed fire stops and pressure seals is not easily verifiable since they are covered with Ceroform boards and Flamemastic coating. However, installation and repair procedures for these penetrations are detailed in M&AI-13 (App. A, 5.xx) discussed below.

The ECTG Report 304.02-SQN dated 10/21/86 (App. A, 5.tt) addresses a concern about incorrect breaching of cable tray penetration fire seals. The concern was that steel fish-tape is being used in lieu of nonmetallic rods to break penetration seals, resulting in possible damage to existing cables in the breached penetrations. Although breaching tools made of nonmetallic materials are preferred and recommended, M&AI-13, Rev. 6 (App. A, 5.xx) does allow the use of metallic breaching tools at the discretion of the responsible engineer. Steel fish-tapes were used only where space restrictions prohibit the use of longer, inflexible probes. Although the report concludes that the use of a nonmetallic probe does not preclude cable damage if misused by the craft, various nonmetallic breaching tools and fish-tape have been used since 1979 (in accordance with M&AI-13) without any known cable damage. Therefore, the report determined that the concern is not valid at SQN.

M&AI-13 establishes requirements for installation and repair of electrical pressure seals, fire stop barriers, and fire retardant coating. The M&AI permits use of a metallic breaching tool at the discretion of the responsible engineer. However, the foreman shall note and sign the comment section on the data sheet, "Breaching and Resealing the Pressure Seals and Firestops," that the metallic tool is free of burrs and sharp edges. A hold point for QA signoff on the same data sheet requires verification that the breached pressure seal or fire stop has the required silicone foam applied around the added cable, that the Ceroform boards are replaced, and that Flamemastic is applied to the cable. Thus, the evaluation team finds that M&AI-13 properly includes hold points for QA inspection of the installation process and instructions for documentation records to be completed by the QA inspector to ensure integrity of the pressure seals and fire stops.

Also, Surveillance Instruction SI-233.2 provides for visual inspection for electrical penetration of fire barriers. The inspections are performed at least every 18 months to meet Technical Specification requirements and prior to returning a fire barrier to service after repairs or maintenance.

The evaluation team considers that TVA has adequate procedures and controls for installing and breaching tray penetrations seals, and for subsequent inspection of the work to verify restoration of the pressure or fire integrity of the breached barrier. M&AI-13 covers both pressure and fire stop sealing, and SI-233.2 covers periodic visual inspection of fire stops. Also, various tests were conducted between 1975 and 1977 by TVA and others (App. A, 5.ooo through ttt) on fire stop configurations similar to configurations used or to be used at Sequoyah and other plants. These tests demonstrated the adequacy of these configurations from a fire stop as well as pressure seal standpoint. The NRC approved the Sequoyah electrical penetration fire stops in 1980 (App. A, 5.nnn). Chemtrol Corporation (App. A, 5.ooo) indicated that tests by Factory Mutual Research (App. A, 5.ttt) were conducted for cable loadings of 50% of the tray area. TVA tests (App. A, 5.qqq and rrr) are not specific regarding the percentage of cable tray loading used for the tests. Although the evaluation team agrees, based on the review of these tests, that the adequacy of configurations of fire stop penetrations for SQN has been properly demonstrated, no evidence was identified to prove that they will be equally effective under penetration overfilled conditions.

The cable damage aspect is addressed in detail in Sequoyah Element Report 238.1. Although this report is primarily directed at cable pulling in conduits, the evaluation team's assessment and conclusions regarding cable damage during installation are equally applicable to cables going through cable tray penetrations.

Findings:

a. Review of cable tray fills revealed the following:

- Power cable trays did not appear to be overfilled. However, no final assessment can be made until the accuracy of the raceway fill tracking system is verified. Also, no analysis has been identified to support the assumption that no additional derating is required for power cables when the overfill is the result of abandoned (deenergized) cables.

- The raceway fill tracking system, although not verified, indicates that a number of I&C trays are overfilled. This is supported by the effort performed under SCR SQNCEB8622. In fact, the fills determined from the profiles obtained during the walkdowns are generally larger than the fills in the raceway fill tracking system.

In addition, review of the current program under SCR SQNCEB8622 to determine the adequacy of cable tray supports indicates that:

- Insufficient evidence exists to justify that computed weights of known cables equal to or greater than 14 pounds per foot for vertical trays and 16 pounds per foot for horizontal trays are adequate cut off points to provide an acceptable level of confidence regarding identification of overloaded tray segments.

- The program covers only review of cable trays in the Control and Auxiliary Buildings.

- Multiple application of Flamemastic cable coating (as is the case at SQN) may result in thicknesses greater than 1/4-inch. The cable coating weight is, however, calculated based on a maximum thickness of 1/4-inch.

- Weights for a number of trays exceeded the Design Basis loading criteria in Design Criteria SQN-DC-V-1.3.4. Documentation of the analysis for resolution of deficiencies and implementation of needed corrective actions was in progress at time of evaluation.

b. The NEC does not require utilities (TVA) to comply with code requirements; therefore, TVA is not obliged to follow NEC for tray fills. Current SQN fill criterion of 30 percent for power trays is consistent with industry standards. Although the 60 percent fill criterion for I&C trays exceeds the industry standard of 50 percent, it is acceptable if adequately justified. The current approach to justify the 60 percent fill agrees with acceptable practices; however, no evidence exists that the representative tray sections were properly selected to assure that control power cables do not account for more than 30 percent of the cable tray fill and that an acceptable power dissipation level per linear foot is not exceeded. Furthermore, the ongoing sampling program to determine cable adequacy with respect to ampacity rating does not clearly address the evaluation of overfilled raceways.

c. A walkdown performed by the evaluation team did not find cables running outside of cable trays. The concern that tray covers cannot be installed on class 1E trays that require tray covers was not verified by the walkdowns performed.

d. Plant procedures to prohibit overfill of trays and penetrations have been established in SQEP-06 and M&AI-04 only recently. However, these procedures are not clear in the areas of conduit jumpers and power trays. Also, no evidence exists that the actual tray fills identified as part of SQN's ongoing programs will be reflected in the raceway fill tracking system for future use.

e. The concerns that cable tray penetrations are overfilled could not be confirmed by the evaluation team through walkdowns or examination of the design documents. Also, no documents were identified defining allowable cable fill in penetrations. Overfilled penetrations may affect cable derating (discussed in Sequoyah Element Report 240.0) and may result in cable damage (discussed in Sequoyah Element Report 238.1). However, current procedures that will prevent overfills in cable trays should automatically prevent overfills in cable tray penetrations.

f. M&AI-13 addresses the installation and repair of electrical penetration pressure seals and fire stops; current procedures adequately address installation, repair, and inspection of electrical penetration fire stops and pressure seals to ensure their integrity; and includes adequate requirements for QA inspection of the installation process. SI-233.2 covers periodic visual inspection of fire stops. No evidence, however, exists that fire stop penetration configurations, as originally tested by TVA and others, and approved for use at SQN based on these tests, will be equally effective under penetration overfilled conditions.

Conclusions:

a. The issue regarding tray overfills is valid, particularly for I&C trays. Regarding the overfill effect on cable ampacities, no analysis has been identified to support assumptions regarding the effect of abandoned cables on cable ampacities. TVA is currently carrying out a program to resolve the issue of overfill effect on cable tray supports. Proper implementation of the program and completion of corrective actions should settle the issue. Completion of the program should also adequately resolve the NRC observations during inspection for baseline verification.

b. The issue about NEC applicability for cable tray fill is considered not valid as TVA is not obliged to follow NEC for raceway fills. TVA criteria for cable tray fill are in general agreement with industry standards although current justification for 60 percent in I&C trays cannot be confirmed.

c. The issue of loose cables outside of trays could not be validated in the walkdowns by the evaluation team. Although these were not exhaustive walkdowns, they are considered adequate to determine that cable installation outside of cable trays is not a problem at SQN. Likewise, the issue that tray covers could not be installed (where required) is not valid.

d. The concern that plant procedures do not contain requirements to prohibit overfill of trays is valid as procedures to prevent overfills have only recently been established. TVA's present procedures (SQEP-06 and M&AI-04) should prevent future overfilling of trays once actual tray fills, conduit jumpers, and power tray aspects are clarified.

e. Although a number of tray penetrations appeared to be overfilled, a visual inspection during walkdowns by the evaluation team could not determine the validity of the issue about overfilled tray penetrations. However, current TVA programs should resolve the problems associated with potential overfills and current procedures should prevent recurrence.

f. SQN has adequate procedural controls for applying and inspecting the pressure seal process. However, the issue of pressure boundary integrity is valid to the extent that tests conducted to demonstrate the adequacy of electrical penetration fire stops for Sequoyah did not address overfilled conditions in penetrations.

10. CORRECTIVE ACTION:

Nine corrective action plans (CAPs) have been developed by TVA and transmitted by TCAB-056, January 13, 1987 (App. A, 5.uuu).

All CAPs satisfy the CATDs if properly implemented.

o CATD 238.03-SQN-01 indicates that an analysis is lacking showing that abandoned cables have no or a negligible effect on ampacities in raceways. The CAP commits to perform an analysis to determine the effects of abandoned cables on ampacity in electrical tray and conduit. Cable ampacities will be

recalculated if the effect is found to be significant. Procedure SQEP-06 Rev. 0 of 09/22/86 ensures that future abandoned cables will be accounted for. The condition has been identified by CAQ-document SCR SQN EEB 86178. TVA's plan satisfies CATD 238.03-SQN-01.

- CATD 238.03-SQN-02 indicates that because the raceway fill tracking system was not verified, the computed weights of cables, 14 lb/ft for vertical and 16 lb/ft for horizontal trays, are inadequate to identify overloaded trays. The CAP indicates that the raceway fill tracking system will be verified by TVA as part of the corrective action for CATDs 239.00-SQN-01 and 02. This action will verify the proper calculation of known cable weights, allowing identification of overloaded tray segments, and will adequately address CATD 238.03-SQN-02.

- CATD-238.03-SQN-03 indicates that tray supports in the control and auxiliary buildings only were reviewed. The CAP states that TVA plans to justify limiting the review of tray support adequacy to the control and auxiliary buildings only. A telephone conversation of January 13, 1987 (App. A, 7.f) clarified this further by establishing that the design requirements for tray supports in the control and auxiliary building are generally higher than in other plant areas due to seismic requirements. Since tray supports for other areas are designed using the same requirements, the supports are designed with sufficient conservatism to obviate review. If this rationale cannot be clearly developed, TVA has committed to expand the review of tray supports to other plant areas until an acceptable level of confidence is reached. This CAP satisfies CATD 238.03-SQN-03.

- CATD 238.03-SQN-04 indicates that weights for a number of trays exceeded the design basis loading criteria. To close out this issue, TVA will provide the resolution and corrective actions for the deficiencies that have been identified in SCR SQNECB8622. This action adequately addresses CATD 238.03-SQN-04.

- CATD 238.03-SQN-05 indicates that evidence is lacking that tray sections selected in the sampling program to determine cable adequacy, were representative with regard to fill and ampacity. As part of the CAP TVA will revise Electrical Engineering Calculation EEB-CSTF-0001 to show that the tray sections selected are representative for tray fill and for cable ampacities. The subject of raceway overfill and its effect on cable ampacity is part of element 240.0. TVA has committed to resolve this issue in CATD 240.00-SQN-04. This will satisfactorily address CATD 238.03-SQN-05.

- CATD 238.03-SQN-06 indicates that Engineering Procedure SQEP-06 is not clear concerning fill criteria for power trays and conduit jumpers. Similarly, CATD 238.03-SQN-07 indicates that the current M&AI adequately deals with the prevention of future tray overfills; however, it too is not clear in the area of conduit jumpers. As part of the CAP for these two CATDs, TVA will review both SQEP-06 and the M&AI and revise these documents to ensure that they adequately define the fill requirements of power trays and prevent overfill of conduit jumpers. TVA has also committed to a field inspection to determine if conduit jumpers are overfilled. The CATDs 238.03-SQN-06 and 07 are adequately addressed by these TVA activities.

- CATD 238.03-SQN-08 indicates that multiple Flamemastic applications in trays may have resulted in coatings exceeding 1/4 inch. The extra Flamemastic weight may not have been considered in the calculations for the cable tray supports. The CAP indicates that TVA calculations SQN-E2-016 and SQN-E2-017, in the section that covers assumptions, show that the volume of any excess Flamemastic is assumed to be occupied by cables whose average weight is higher than Flamemastic. Therefore the calculations are conservative and cover the issue of 238.03-SQN-08. No corrective action is required.

- CATD 238.03-SQN-09 indicates that there is no evidence that tray fills identified during raceway verification programs are entered in the raceway fill tracking system for future use. The CAP commits to reflect the actual tray fills in the raceway fill tracking system for future use. The condition will also be addressed as part of the followup for Significant Condition Reports SCR SQN-EEB-8620 and SCR SQN-CEB-8622. CATD 238.03-SQN-09 is therefore satisfied.

- CATD 238.03-SQN-10 indicates that effectiveness of firestops at tray penetrations with overfilled trays needs to be established. The CAP indicates that TVA will review the firestop test configuration to determine the effect of overfilled conditions on its effectiveness. A maximum allowable fill will also be established at which the firestop qualification can be maintained. TVA committed to identify all overfilled trays that pass through a fire stop and justify or, where necessary, modify the existing configuration to assure acceptable conditions. Other trays which pass through firestops will have their fill limited to established values in the cable program. The issues of CATD 238.03-SQN-10 are therefore adequately covered.

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5. DOCUMENTS REVIEWED RELATED TO THE ELEMENT:

a. TVA memo from H. L. Abercrombie to Those Listed, "Sequoyah Nuclear Plant (SQN) - Loading of Cable Trays and Fire Stops/ Pressure Seals," (L04 850220 930), (02/21/85)

b. TVA memo from J. P. Vineyard to H. B. Rankin, "Sequoyah Nuclear Plant - Loading of Cable Trays and Fire Stops/ Pressure Seals," (B25 850328 009), (03/28/85)

c. SQN Significant Condition Report (SCR) No. SQNECB8601 R0, B42 860707 014), (06/27/86)

d. SQN Engineering Report CAQ SCR SQNECB8601 R0, (S56 860804 820), (08/04/86)

e. SQN Significant Condition Report (SCR) No. SQNEEB8620 R1, (B43 860410 910), (03/21/86)

f. SQN Engineering Report CAQ SCR SQNEEB8620 R0, S01 860521 871), (05/14/86)

g. WBN Significant Condition Report (SCR) No. WBNEEB8589 R0 (B43 851231 925), (12/27/85)

h. WBN Significant Condition Report (SCR) No. WBNEEB8590 R0 (B43 851231 928), 12/27/85)

i. WBN Engineering Report CAQ SCR WBNEEB8589 and WBNEEB8590 (B45 860113 280), (01/13/86)

j. SQN Significant Condition Report (SCR) No. SQNEEB8601 R0 (B43 860117 919), (01/06/86)

k. SQN Engineering Report CAQ SCR SQNEEB8601 R0 (B25 860416 007), (04/14/86)

l. BLN, Problem Identification Report (PIR) No. PIRBLNEEB8601 (B43 860116 934), (01/13/86)

m. TVA memo from Chitwood to Raulston, "Watts Bar Nuclear Plant Unit 1, 50.55(e) Interim Report Input - Significant Condition Report 8589 R0," (B43 860123 908), (01/15/86)

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n. TVA memo from Chitwood to Raulston, "Watts Bar Nuclear Plant Unit 2, 50.55(e) Interim Report Input - Significant Condition Report 8590 R0," (B43 860123 909), (01/16/86)

o. TVA memo from Raulston to Gridley, "Watts Bar Nuclear Plant - Units 1 and 2 - Non-QA Values for Cable Weights and Outside Diameters Used in Calculations, 10CFR50.55(e) Report No. 1, (Interim), NCR WBNEEB8589 and WBNEEB8590," (B45 860218 256), (02/18/86)

p. TVA memo from Raughley to Raulston, "Watts Bar Nuclear Plant - Units 1 and 2 - Non-QA Values for Cable Weights and Outside Diameters Used in Calculations - NCR WBNEEB8589 and WBNEEB8590 - 10CFR50.55(e) Report No. 2 (Interim)," (B43 860602 907), (06/02/86)

q. OE Calculation (B43 860331 928), "Determination of Class 1E Electrical Cable Weight/Foot and Outside Diameter," All TVA Nuclear Plants, (12/20/85)

r. TVA memo Cantrell and Mason, "Evaluation of The Adequacy of Installed Class 1E Cables," (B43 851203 915), (12/02/85)

s. TVA, SQN, GCTF Report, "Overfill of Cable Trays and Conduits," Rev. 1, (05/20/86)

t. NSRS Report No. I-86-251-SQN, Attachment 1, Review of Generic Concern Issue, "Electrical Cables," (02/18/86)

u. TVA, SQN, GCTF Report, "Plant Procedures on Overfill of Cable Trays," Rev. 1, (04/25/86)

v. TVA, SQN, GCTF Report, "Overfill of Cable Trays," (02/09/86)

w. TVA, SQN, GCTF Report, "Cable Tray Fill Criteria," Rev.1, (05/16/86)

x. TVA memo from Wigington to Electrical Engineering Files, "WBN Units 1 and 2 - Documentation of the Effect of Vimasco Cable Coating on Cable Ampacity," (B43 860121 947), (01/22/86)

y. Factory Mutual Research Report No. J.I. OFOQ5 AF, "Examination of the Effect of Vimasco Cable Coating No. 2-B on Ampacity in Cable Trays," (12/19/80)

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z. OE Calculation (B43 860131 925), "Justification of TVA's Ampacity Tables as Related to NV-3, NV-10 and NV-11 Cable Trays, Conduits and Underground Conduit Banks," (01/31/86)

aa. SNP FSAR, Section 8.3.1.4.1, "Cable Derating and Cable Tray Fill," and Section 8.3.1.4.4, "Fire Detection and Protection in Areas Where Cables Are Installed"

bb. Design Criteria SQN-DC-V-11.3, "Power, Control and Signal Cables for Use in Category 1 Structures," Section 6.2.2, "Cable Tray Loading," Rev. 5, (09/30/85)

cc. Electrical Design Standard DS-E12.1.13, Rev. 2, "Cable-Class 1E Cable ODs and Weights," (04/15/86)

dd. Electrical Design Standard DS-E12.1.4, Rev. 0, "Cable - Class NC Cable ODs and Weights," (04/15/86)

ee. National Electrical Code, NFPA-70-1984

ff. General Construction Specification No. G-38, "Installing Insulated Cables Rated Up to 15,000 Volts," Rev. 8, (03/17/86)

gg. SQN Modifications and Additions Instructions M&AI-4, R8 and R9, "Installation of Control, Power and Signal Cables," (12/31/85) (08/13/86)

hh. SQN Modifications and Additions Instruction M&AI-7, "Inspection Criteria of Cables or Internal Panel Wiring," Rev. 8, Section 5.0 (07/24/86)

ii. J. Stolpe, "Ampacities for Cables in Randomly Filled Trays," IEEE Transactions Paper, (07/31/70)

jj. SQN Technical Specification, Surveillance Requirements, Section 3.0 (09/17/80)

kk. SQN Technical Specification, Surveillance Requirements, Section 4.0 (09/17/80)

ll. SQN Inspection Instruction No. 10, Sections 7 and 8, "Interconnection Cable Termination and Insulation Inspection," Rev. 16, (04/04/83)

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mm. SQN Nonconformance Report NCR SQNECB8501 (B43 850402 004), (04/11/85)

nn. SQN Nonconformance Report NCR SQNEEB8501 R2, (B43 850501 953), (04/25/85)

oo. TVA memo from W. S. Raughley to T. W. Roberts, "Sequoyah Nuclear Plant - Cable Weights and Outside Diameters (OD)," (B43 860923 908), (09/23/86)

pp. TVA memo from W. S. Raughley to Those Listed, "All Nuclear Projects - Coordinated Response to Cable Routing SCRs," B43 860929 904), (09/29/86)

qq. TVA memo from W. S. Raughley to Those Listed, "All Nuclear Plants - Corrective Action and Sampling Program for Electrical Cable Ampacity," (B43 861008 909), (10/07/86)

rr. TVA memo from C. H. Sudduth to Electrical Engineering Files, "SQN Units 1 and 2, Evaluation of Test Results and Cable Ampacity Tests for Completed Fire Stop Penetrations," (EEB 770211 908), (02/10/77)

ss. 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 Tennessee Bank Building in Knoxville, TN (06/23/86)

tt. TVA, SQN, ECTG Report, "Cable and Conduit, Electrical Penetration Breached", No. 304.02, Rev. 1 (10/21/86)

uu. SQN Significant Condition Report (SCR) No. SQNCEB8622 R1, (B25860925 004), (03/10/86)

vv. TVA memo from M. J. Scruggs to W. S. Raughley, "Sequoyah Nuclear Plant - Cable Weights and Outside Diameters (OD)," (B25860904 001), (09/04/86)

ww. TVA, SQN, ECSP Report No. C010900-SQN, Rev. 1 "Cable," (09/19/86)

xx. SQN Modifications and Additions Instruction M&AI-13, Rev. 6, "Electrical Pressure Seal, Firestop Barrier and Flame Retardant Cable Coating," (01/28/85)

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yy. TVA, Electrical Design Standard DS-E13.5.1, Rev. 0, "Electrical Penetration Fire Stops and Pressure Seals" (12/05/77)

zz. SQN, Special Maintenance Instruction SMI-0-317-36, "Walkdown of Cable Tray Supports for All Areas" (excluding the Annulus Area), Rev. 0, (06/20/86)

aaa. Sequoyah Engineering Procedures, SQEP-06, Section VIII, "Conduit and Cable Procedure," Rev. 0 (09/22/86)

bbb. Letter from R. L. Gridley, TVA, to B. J. Youngblood, NRC, "In the Matter of the Tennessee Valley Authority Docket Nos. 50-327 and 50-328," cable pulling questions (L44 861031 811), (10/31/86)

ccc. Unimplemented Design Item Evaluation (B25 860310 714), "SCR SQNEEB8620, Cable Tray Loading" (03/07/86)

ddd. Letter from J. M. Taylor, NRC, to C. C. Mason, TVA, Subject: Report Nos. 50-327/86-45 and 50-328/86-45, (10/31/86)

eee. Surveillance Instruction, SI-233.2, R0, "Visual Inspection of Penetration Fire Barriers-Electrical," (10/02/85)

fff. SQN Drawing 45N881-12 R5, "Conduit & Grounding Cable Tray Single Line Node Voltage Level 10, 11," (05/01/85)

ggg. SQN Drawing 45N881-17 R4, "Conduit & Grounding Cable Tray Single Line Node Voltage 4, 12, & 13 (480V)," (05/01/85)

hhh. SQN Drawing 45N881-18 R3, "Conduit & Grounding Cable Tray Single Line Node Voltage Level 4, 12, & 13 (480V)," (05/01/85)

iii. SQN Drawing 45N881-21 R6, "Conduit & Grounding Cable Tray Single Line Node Voltage Level 3, 10, & 11," (05/01/85)

jjj. SQN Drawing 45N881-22 R3, "Conduit & Grounding Cable Tray Single Line Node Voltage Level 3, 10, & 11," (05/01/85)

kkk. SQN Calculation SQN-E2-016, "Control and Auxiliary Building Vertical Cable Tray Loading," (B25 861010 800), (10/10/86)

lll. SQN Calculation SQN-E2-017, "Control and Auxiliary Building Horizontal Cable Tray Loading," (B25 861106 809), (11/06/86)

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mmm. Design Criteria SQN-DC-V-1.3.4 R0, "Category I Cable Tray Support Systems," (08/20/75)

nnn. SNP SER, Supplements No. 1 and No. 2, Section 9.5, "Fire Protection System," (02/80) (08/80)

ooo. Chemtrol Corporation, "Floor Slab Fire Test," (10/28/75)

ppp. TVA memo from F. W. Chandler to R. M. Pierce, "Sequoyah Nuclear Plant Units 1 and 2 Design of Electrical Fire Stop Penetrations," (01/17/77)

qqq. TVA memo from C. H. Sudduth to Electrical Engineering Files, "Sequoyah Nuclear Plant Units 1 and 2 Design of Electrical Fire Stop Penetrations," (05/05/76)

rrr. TVA "Browns Ferry Nuclear Plant Design Changes for the Recovery from the Fire of March 22, 1975," R0 (06/09/75), R1 (07/10/75), R2 (08/14/75), R3 (12/09/75), and R4 (01/07/76)

sss. TVA memo from C. H. Sudduth to Electrical Engineering Files, "Watts Bar Nuclear Plant Units 1 and 2 Evaluation of Test Results of Fire Test on Completed Electrical Penetration Fire Stops," (EEB 770721 931), (07/21/77)

ttt. Factory Mutual Research, "Fire Endurance Test on Penetration Seal Systems In Precast Concrete Floor Utilizing Silicone Elastomers," (10/28/75)

uuu. Letter from G. R. McNutt, TVA, to G. L. Parkinson, Bechtel, "Employee Concern Evaluation Program - Sequoyah Restart Program - Corrective Action Plan," (TCAB-056), (01/13/87)

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

a. SNP FSAR, Section 8.3.1.4.1, "Cable Derating and Cable Tray Fill," and Section 8.3.1.4.4, "Fire Detection and Protection in Areas Where Cables Are Installed"

b. Design Criteria SQN-DC-V-11.3, "Power, Control and Signal Cables for Use in Category I Structures"

c. Electrical Design Standard DS-E12.1.4, "Cable - Class NC Cable ODs and Weights"

d. Electrical Design Standard DS-E12.1.13, "Cable-Class 1E Cable ODs and Weights"

APPENDIX A (cont'd)

e. General Construction Specification No. G-38, "Installing Insulated Cables Rated Up to 15,000 Volts"

f. SNP SER, Supplements No. 1 and No. 2, Section 9.5, "Fire Protection System," (02/80) (08/80)

g. Sequoyah Engineering Procedures, SQEP-06, Section VIII, "Conduit and Cable Procedures," Rev. 0 (09/22/86)

h. Surveillance Instruction, SI-233.2, R0, "Visual Inspection of Penetration Fire Barriers - Electrical," (10/02/85)

i. Design Criteria SQN-DC-V-1.3.4, R0, "Category I Cable Tray Support Systems," (08/20/75)

j. SQN Modifications and Additions Instructions M&AI-13, R6, "Electrical Pressure Seal, Firestop Barrier and Flame Retardant Cable Coating," (01/28/85)

k. SQN Modifications and Additions Instructions M&AI-4, R8 and R9, " Installation of Control, Power and Signal Cables," (12/31/85) (08/13/86)

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

a. Telecon between Jack Wheeler, Bechtel, and Jack Prince, TVA, SQN, Review of actual tray fill quantities versus cable schedule printouts, IOM 320, (10/16/86)

b. Bechtel memos from D. Knudsen to I. Don-Doncow regarding review of cable installation records and personnel interviews, "Summary of Interviews Conducted with Responsible Individuals Concerning Cable Pulling Practices Past and Present at the Sequoyah Nuclear Plant," IOM 521 (12/04/86); "Megger Test Records," IOM 522 (01/09/87)

c. Walkdown performed by J. Wheeler, Bechtel, and G. Bell, TVA, BLT-106, (10/09/86)

d. Walkdown performed by D. Knudsen, Bechtel, between 11/04/86 and 11/06/86, IOM 565, (11/10/86)

e. Raughley, McNutt, Skinner, TVA, Shea, Stone & Webster, Jordan, Don-Doncow, Wheeler, Rifai, Bechtel, meeting at Knoxville, BLT-061, (10/08/86)

APPENDIX A (cont'd)

f. Telecon between P. H. Kuhn, Bechtel, and P. B. Nesbitt/T. M. Shea, TVA, Discussion of CAP for CATD 238.03-SQN-03, BET 270, (01/13/87)

CATD LIST

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

238.03(B)-SQN-01 (01/12/87)
238.03(B)-SQN-02 (01/12/87)
238.03(B)-SQN-03 (01/12/87)
238.03(B)-SQN-04 (01/12/87)
238.03(B)-SQN-05 (01/12/87)
238.03(B)-SQN-06 (01/12/87)
238.03(B)-SQN-07 (01/12/87)
238.03(B)-SQN-08 (01/12/87)
238.03(B)-SQN-09 (01/12/87)
238.03(B)-SQN-10 (01/12/87)

CATEGORY: EN DES PROCESS & OUTPUT SUBCATEGORY: 23803 CABLE TRAY OVERFILLS

CONCERN NUMBER	CAT	SUB CAT	S H R D	PLT LOC	GENERIC APPL B F	B L	S Q	W B	QTC/NSRS INVESTIGATION REPORT	P S R	CONCERN DESCRIPTION	KEYWORD A / KEYWORD B / KEYWORD C / KEYWORD D
IN -85-186-003 T50017	EN	23803	N	WBN	Y	Y	Y	Y K-FORM		SR	CABLE TRAYS ARE OVER FULL IN THE SPR EADER ROOM, ELEVATION 729 IN BOTH UN ITS. OTHER CABLE TRAYS IN OTHER ARE AS MAY HAVE THE SAME PROBLEM.	SPECIFICATIONS / NONCONFORMANCE / ELECTRICAL / CABLE
IN -85-207-001 T50157	EN	23803	N	WBN	Y	Y	Y	Y REPORT		SR	ENGINEERING IS ROUTING/SCHEDULING CA BLES TO BE PULLED THROUGH "CLOSED" P ENETRATIONS, DUE TO THE AMOUNT OF CA BLE FILL, THE CABLE JACKETS AND COND UCTORS ARE DAMAGED DURING CABLE TRAY THROUGH PENETRATION IN AUXILLIARY B UILDING ELEV. 737'. Q LINE AND A3 AL SO, PENETRATION Q-CTP-290-62, APPROX . LOCATION N LINE AND C-10 ELEV. 729 ' IN CONTROL BLDG, WAS FULL, YET ADD ITIONAL CABLE WAS ROUTED AND PULLED THROUGH DURING AUGUST 1985. CONSTR. DEPT. CONCERN. CI HAS NO INFORMATI ON. NO FOL	DESIGN PROCESS / INSTALLATION / ELECTRICAL / CABLE
IN -85-312-001 T50188	EN EN	23801 23803	S	WBN	Y	Y	Y	Y K-FORM		SR	CABLE TRAYS IN CONDUITS ARE OVERFILL ED WITH CABLE. THE CABLES COULD BE DAMAGED AND NOT DISCOVERED UNTIL IT SHORTS OUT. LOCATION 737' AUX BUILD ING AND 741' AND 749' CONTROL BUILDI NG AND SPREAD ROOM. CI COULD NOT PR OVIDE ANY SPECIFIC CONDUIT OR CABLE TRAY NUMBERS. NO ADDITIONAL INFORMA TION AVAILABLE. CONSTRUCTION CONCER N. UNIT 1 & 2.	NONCONFORMANCE / CONST PROCESS / ELECTRICAL / CABLE TRAYS
IN -85-432-002 T50041	EN	23803	N	WBN	Y	Y	Y	Y K-FORM		SR	OVER-FILLED CABLE TRAYS. TRAYS FILL ED TO THE MAXIMUM, COVERS CANNOT BE INSTALLED. CONTROL BUILDING & REACT OR BUILDING.	DESIGN REVIEW / NONCONFORMANCE / ELECTRICAL / CABLE TRAYS
IN -85-519-001 T50033	EN	23803	N	WBN	Y	Y	Y	Y REPORT		SR	CABLE TRAYS OVERLOADED. AUX. BLDG. U NITS 1 & 2, 713' & 737' ELEV.	NONCONFORMANCE / INSTALLATION / ELECTRICAL / CABLE TRAYS
IN -85-688-N05	EN	23803	N	WBN	Y	Y	Y	Y REPORT		SR	NRC IDENTIFIED THE FOLLOWING CONCERN BASED ON REVIEW OF THE QTC FILE. " INSPECTOR ON UNIT 1 REPORTED TO CI O NE INSTANCE OF CABLE TRAY OVERFILLIN G." THIS CONCERN PERTAINS TO IN-85- 688-001	

CATEGORY: EN DES PROCESS & OUTPUT SUBCATEGORY: 23803 CABLE TRAY OVERFILLS

CONCERN NUMBER	CAT	SUB CAT	SHRD	PLT LOC	GENERIC APPL B F	B L	S Q	W B	QTC/NSRS INVESTIGATION REPORT	PSR	CONCERN DESCRIPTION	KEYWORD A / KEYWORD B / KEYWORD C / KEYWORD D
IN -85-688-001 T50080	EN	23803	N	WBN	Y K-FORM	Y	Y	Y		SR	PLANT PROCEDURES CONTAIN NO REQUIREMENT PROHIBITING OVERFILL OF CABLE TRAYS IN SAFETY RELATED INSTALLATION. INSTANCES WHERE SAFETY RELATED OVER FILLS HAVE OCCURRED WERE NOT PROVIDED. NAMES AND OTHER DETAILS ARE KNOWN TO QTC. NO FURTHER DETAILS AVAILABLE FROM CI.	PROCEDURES / NONCONFORMANCE / ELECTRICAL / CABLE TRAYS
IN -85-734-001 T50069	EN EN	23801 23803	S	WBN	Y K-FORM	Y	Y	Y		SR	CONDUITS/CABLE TRAYS/PENETRATIONS IN UNITS 1 & 2 ARE GENERICALLY OVERFILLED/OVERLOADED. NO LOCATIONS/SPECIFICS PROVIDED. NO FOLLOW-UP REQUIRED.	NONCONFORMANCE / CONST PROCESS / ELECTRICAL / CABLE TRAYS
IN -85-798-004 T50152	EN	23803	N	WBN	Y K-FORM	Y	Y	Y		SR	CABLE TRAY IN AUXILLIARY BUILDING, ELEVATION 713' LOCATED AT THE T4 AND "R" LINE, IS TOO FULL. 5-6 CABLES ARE HANGING LOOSE, BUT THE TRAY IS BEING LOADED WITH MORE CABLES. CONSTR. DEPT. CONCERN. CI HAS NO FURTHER INFORMATION. NO FOLLOWUP REQUIRED.	NONCONFORMANCE / CONST PROCESS / ELECTRICAL / CABLE TRAYS
IN -85-832-001 T50086	EN EN	23801 23803	S	WBN	Y K-FORM	Y	Y	Y		SR	OVERLOADED CABLE TRAY PENETRATION ELEV. 729' TURBINE BUILDING AND CONTROL BUILDING ELEV. 737' AUX. BUILDING AND CONTROL BUILDING 741', CONDUITS BEING FILLED BEYOND NATIONAL ELEC. CODE ALLOWANCE. POSSIBLE DAMAGE TO CABLES THAT OTHER CABLES ARE BEING DRAGGED OVER.	NONCONFORMANCE / STANDARDS / ELECTRICAL / CABLE TRAYS
IN -85-856-003 T50094	EN EN	23801 23803	S	WBN	Y K-FORM	Y	Y	Y		SR	CONDUIT AND CABLE TRAYS ARE TOO FULL. UNIT #1 AND #2. NO MORE INFORMATION AVAILABLE. NO FOLLOW UP REQUIRED.	NONCONFORMANCE / CONST PROCESS / ELECTRICAL / CABLE TRAYS
IN -85-919-001 T50094	EN	23803	N	WBN	Y K-FORM	Y	Y	Y		SR	ELECTRICAL CABLE TRAY PENETRATIONS ARE FULL AND CABLE IS STILL BEING PULLED THROUGH THESE PENETRATIONS LOCATED IN CONTROL BUILDING, Q LINE AND N LINE WALL, AND AUXILLIARY BUILDING FLOOR ELEV. 757 TO 737. C/I IS CONCERNED ABOUT POSSIBLE DAMAGE TO CABLES IN THESE PENETRATIONS RESULTING FROM THE CABLE PULLS. C/I DOES NOT KNOW PENETRATION OR CABLE NUMBERS.	NONCONFORMANCE / CONST PROCESS / ELECTRICAL / CABLE TRAYS

CATEGORY: EN DES PROCESS & OUTPUT SUBCATEGORY: 23803 CABLE TRAY OVERFILLS

CONCERN NUMBER	CAT	SUB CAT	SHD	PLT LOC	GENERIC APPL B F	B L	S Q	W B	QIC/NSRS INVESTIGATION REPORT	PSR	CONCERN DESCRIPTION	KEYWORD A / KEYWORD B / KEYWORD C / KEYWORD D
IN -86-028-002 T50110	EN EN	23801 23803	S	WBN	Y REPORT	Y	Y	Y		SS	NATIONAL ELECTRICAL STANDARDS ARE NOT BEING FOLLOWED. EXAMPLE: CABLE TRAYS AND CONDUITS ARE OVER FULL. CI HAS NO ADDITIONAL INFORMATION.	NONCONFORMANCE / CONST PROCESS / ELECTRICAL / CABLE TRAYS
IN -86-232-002 T50141	EN	23803	N	WBN	N REPORT	N	Y	Y		SR	UNIT #1, ELEVATION 755', CONTROL ROOM. DUE TO OVERFILLING OF CABLE TRAYS WITH CABLE, THE PENETRATION SEALS MAY NOT BE ABLE TO PASS A PRESSURE TEST. THE RTV SILICONE SEAL FOAM WAS ALMOST (IN MANY INSTANCES) IMPOSSIBLE TO APPLY DUE TO THE NUMBER OF CABLES IN THE PENETRATION. CONSTRUCTION DEPT CONCERN. CI HAS NO FURTHER INFORMATION.	NONCONFORMANCE / CONST PROCESS / ELECTRICAL / PENETRATION
IN -86-238-003 T50141	EN	23803	N	WBN	Y K-FORM	Y	Y	Y		SS	MANY CABLE TRAYS, UNIT 1 & 2, ARE TOO FULL OF CABLES. CONSTRUCTION DEPT CONCERN. CI HAS NO FURTHER INFORMATION.	NONCONFORMANCE / CONST PROCESS / ELECTRICAL / CABLE TRAYS
IN -86-262-001 T50148	EN EN	23801 23803	S	WBN	Y REPORT	Y	Y	Y		SR	UNITS 1&2. THE CONDUITS AND CABLE TRAYS ARE FAR TOO FULL. IT OFTEN TAKES 4-5 DAYS JUST TO PULL THE FISH TAPE THROUGH. THIS OVERCROWDING IS AN UNSAFE CONDITION. CONSTRUCTION DEPT CONCERN. CI HAS NO FURTHER INFORMATION. NO FOLLOWUP REQUIRED	NONCONFORMANCE / CONST PROCESS / ELECTRICAL / CABLE TRAYS
OW -85-007-002 T50224	EN	23803	N	WBN	Y K-FORM	Y	Y	Y		SR	ELECTRICAL CABLE IN TRAYS RUNS COMPLETELY OUTSIDE OF THE TRAYS, ESPECIALLY IN BENDS. MANY CABLE TRAYS ARE GROSSLY OVER CAPACITY. THESE CONDITIONS WORK AGAINST THE CABLE TRAYS' PURPOSE OF SUPPORTING AND PROTECTING THE CABLE. TYPICAL TRAYS ARE IN AUX BLDG. 737' EL, ABOVE HEAT EXCHANGERS. CI HAS NO FURTHER INFORMATION CONSTRUCTION DEPARTMENT CONCERN NO FOLLOW UP REQUIRED.	NONCONFORMANCE / CONST PROCESS / ELECTRICAL / CABLE
PH -85-003-023 T50106	EN	23803	N	WBN	Y K-FORM	Y	Y	Y		SS	THE CABLE TRAYS ARE OVER-FILLED PLANT WIDE. CI HAS NO MORE INFORMATION NO FOLLOW UP REQUIRED	NONCONFORMANCE / CONST PROCESS / ELECTRICAL / CABLE TRAYS

CATEGORY: EN DES PROCESS & OUTPUT SUBCATEGORY: 23803 CABLE TRAY OVERFILLS

CONCERN NUMBER	CAT	SUB CAT	S H R D	PLT LOC	GENERIC APPL B F	B L	S Q	W B	QTC/NSRS INVESTIGATION REPORT	P S R	CONCERN DESCRIPTION	KEYWORD A / KEYWORD B / KEYWORD C / KEYWORD D
WI -85-100-011 T50211	EN	23803	N	WBN	Y	Y	Y	Y	K-FORM	SR	CABLE TRAY FILL CRITERIA OF 60% FOR I&C CABLES IS INADEQUATE. THE NATIONAL ELECTRICAL CODE ALLOWS 40%, AND 50% FILL ON AN EXCEPTION BASIS. TVA VIOLATES THIS CODE. THIS INDUSTRY PRACTICE IS 40% FILL. THIS SITUATION IS MADE EVEN WORSE WITH THE ADDITION OF SPRAY-ON FIRE RETARDANT MATERIALS WHICH TAKE UP SPACE IN TRAYS. CI HAS NO ADDITIONAL INFORMATION. ANONYMOUS CONCERN VIA LETTER.	NONCONFORMANCE / CORRECTIVE ACTION / ELECTRICAL / CABLE TRAYS
WI -85-100-015 T50212	EN	23803	N	WBN	Y	Y	Y	Y	REPORT	SR	CABLE TRAYS ARE TOO HEAVILY FILLED, AND THE CABLES ARE NOT PROPERLY DERATED. CI HAS NO FURTHER INFORMATION. ANONYMOUS CONCERN VIA LETTER.	NONCONFORMANCE / CONST PROCESS / ELECTRICAL / CABLE TRAYS

20 CONCERNS FOR CATEGORY EN SUBCATEGORY 23803