

TENNESSEE VALLEY AUTHORITY  
NUCLEAR SAFETY REVIEW STAFF  
NSRS INVESTIGATION REPORT NO. I-85-133-SQN  
EMPLOYEE CONCERN XX-85-122-011

SUBJECT: ELECTRICAL AND PHYSICAL SEPARATION OF REDUNDANT  
CIRCUITS AND EQUIPMENT

DATES OF INVESTIGATION: JANUARY 27 - FEBRUARY 11, 1986

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## I. BACKGROUND

A Nuclear Safety Review Staff (NSRS) investigation was conducted to determine the validity of an expressed employee concern received by the Quality Technology Company (QTC)/Employee Response Team (ERT). The concern of record, as summarized on the Employee Concern Assignment Request Form from QTC and identified as XX-85-122-011, stated:

Electrical separation and physical separation of redundant wiring and cabling and for equipment and components are inadequate at all plants. CI expressed that detailed reviews need to be made, and are so extensive that a consultant probably should be used, providing independence from TVA.

Note: This was an anonymous concern received by QTC by letter; therefore, follow-up information was not available.

## II. SCOPE

Since follow-up information to determine the exact nature of the separation concern was not available, the following investigative plan was followed in order to overview some of the separations effort at Sequoyah. Documentation was reviewed to determine if previous separation concerns had been raised, cognizant personnel were interviewed, design requirements were examined, and some equipment and circuits were inspected to determine if separation requirements had been met. The scope included evaluating the results from the investigation to determine if a more thorough and comprehensive investigation by an outside reviewer was justified and should be recommended.

## III. SUMMARY OF FINDINGS

### A. Requirements and Commitments

1. Sequoyah Design Criteria SQN-DC-V-12.2, "Separation of Electric Equipment and Wiring," defined the design requirements for separation of the electric distribution equipment and wiring (control, power, and signal cables) for class 1E electric systems and components. The document stated its intention was to provide guidance for designers in determining separation requirements of the electrical power, control, signal, and instrumentation installations which will enable these systems to meet their functional requirements under the conditions produced by any design basis event. The design criteria also referenced other documentation that gave additional criteria against hazards such as externally generated fires and pipe ruptures.



Specific separation requirements were given in the design criteria dependent on the type equipment, type circuits, building location, and the type hazard or event to protect against.

2. This information was also documented in Section 8.3.1.4.2 of the FSAR.
3. On Page 8-10 of the Sequoyah Safety Evaluation Report (SER), the following NRC comment addressed TVA's criteria for separation and independence of electrical equipment and circuits.

The provisions for physical independence made in the applicant's design of the plant electrical system is detailed in Final Safety Analysis Report Section 8.3.1.4 for the alternating current onsite system and 8.3.2.4 for the direct current system. The stated criteria for separation and independence are essentially identical to those set forth in Regulatory Guide 1.75, "Physical Independence of Electric Systems," even though the plant was laid out prior to the development of that Regulatory Guide.

#### B. Findings

The following areas in the plant were inspected and measurements taken to determine if the required separations were implemented.

##### 1. Control Room Panels

- a. Control Room Panel I-M-6 was inspected in regard to the separation between safety and nonsafety-related cables. Separate risers through the floor routed safety and nonsafety-related cables from the floor below into the panel. The risers were arranged with train A on one end of the panel, train B on the other end, and with the nonsafety-related risers in the middle of the panel. Separations appeared to meet all aspects of the design criteria, SQN-DC-V-12.2, Section 4.2.8.
- b. In Supplement No. 1 to the SER, the NRC stated the following in Section 7.2.5.

In the SER we reported that the design for separation and independence of control room rack wiring presented in the FSAR was acceptable. On the first site visit we were unable to determine that this design was properly implemented and had noted an



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apparent lack of separation between redundant circuit wiring in some areas. On a followup site visit we completed our review of these and other areas and found that adequate separation has been provided between redundant trains and channels. Where separation of 6 inches or more could not be maintained, acceptable barriers were provided. We find these actions to implement the separation criteria acceptable.

- c. In the same supplement, the following was stated concerning separations for the postaccident monitoring devices.

We stated in the SER that the applicant had committed to providing separation and independence between redundant post-accident monitoring channels and that we would report further on the implementation in a supplement report.

On a followup site visit we reviewed the implementation of these criteria. The post-accident monitoring channels are identified by color coding and train one cables run in rigid conduit while train two cables run in nondivisional, enclosed, signal-level raceways. Separation between meters is provided by metal barriers surrounding the terminals. The meter cases serve as the barrier between adjacent meters not separated by 6 inches or more. The use of the meter cases as barriers is acceptable because they are made of fire-retardant plastic materials (phenolic or fiberglass) and the energy levels available to initiate and maintain damaging events are low. We find that the applicant has properly implemented the separation criteria.

## 2. Cable Spreading Room

- a. The horizontal separation between cable tray JT-A and KJ-B was measured to be 38 inches. This meets the 36-inch requirement in the design criteria.

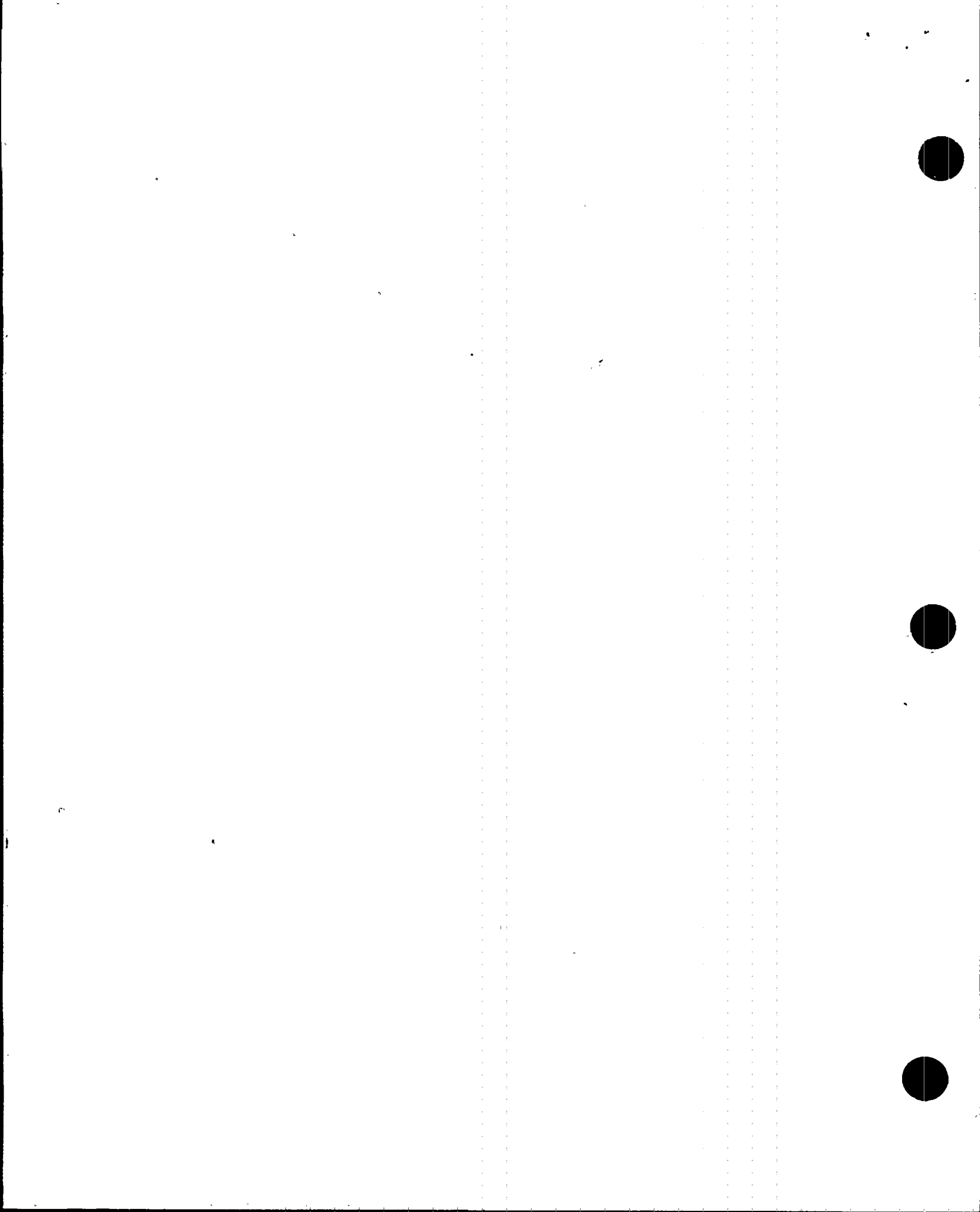




- b. The point at which cable trays of different safety divisions crossed one another was examined and measured. All crossovers met the minimum separation distance of 12 inches (per the design criteria). All crossovers but one met the requirement to have solid tray bottoms and tray covers at the crossover points. There was no cover on tray KC-B that crossed under JV-A (located at coordinates P-Q and C7-C8). Design drawing 45N880-1, note 11, required that covers be installed at all such crossovers.

### 3. Auxiliary Building

- a. The design drawings were examined to select several places where the trays of different safety divisions appeared to come the closest to one another, and measurements were taken of the horizontal separation distance.
- Coordinates A13 and V-U on elevation 749 - 36 inches between OV-A and NP-B.
  - A4-A4 and T-Q on elevation 734 - 36 inches between NZ-B and AN-A.
  - A8-A7 and U-V on elevation 669 - 36 inches between LD-B and MP-A.
  - Two trays were also checked at A13 and Q on elevation 669, and the separation was 36 inches.
  - In all cases the separation distance met the 3-foot requirement in the design criteria.
- b. The following crossovers were examined and the separation distance measured.
- Coordinates A5-A6 and U-V on elevation 759 - HN-B crossed under PJ-A with 12-inch separation. PJ-A had a solid bottom, but HN-B did not have a tray cover installed.
  - A13 and R-S on elevation 734 - GD-A crossed under GP-B with 12 inch-separation. Solid bottoms and covers were installed.



- A7 and S-T on elevation 669 - FA-A crossed under LF-B with 21-inch separation. Solid bottoms and covers were installed.
- A3-A4 and R-Q on elevation 714 - JY-B crossed under FW-A with greater than 5 feet separation. Solid bottoms and covers were installed.

All crossovers were separated in accordance with the design criteria except for the missing tray cover on HN-B.

#### 4. Auxiliary Instrument Room (Unit 1)

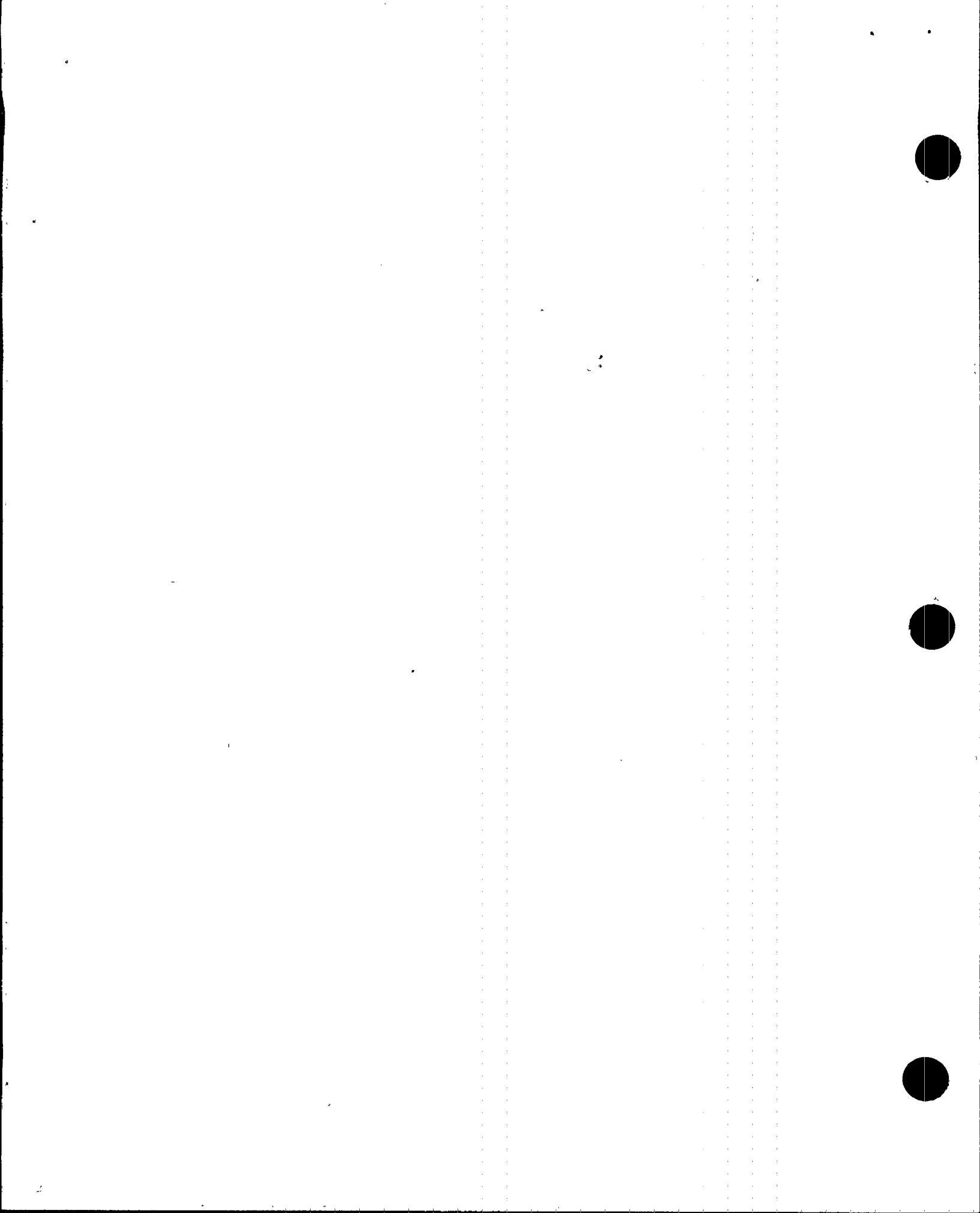
- a. The following channelized trays were in a stacked configuration: XX-I, XZ-II, XZ-III, and XY-IV. Each tray had solid bottoms and tray covers installed. The vertical distance between each channelized tray was 12 inches. This was in accordance with section 8.3.1.4.2 of the FSAR. However, section 4.2.7.2.3 of the design criteria (SQN-DC-V-12.2) needs clarifying in order to address the 12 inches with solid bottoms and covers.
- b. XZ-IV was separated vertically from XA-II by 36 inches. There were no solid bottoms or covers installed on these trays. The criteria stated 3 feet were required for open trays.
- c. Tray XY-I was separated horizontally from XZ-II by 6 feet. The criteria required at least 1 foot.

#### 5. Equipment

The following equipment was checked to determine if separations criteria were met: 6900-V shutdown boards, 480-V shutdown boards, reactor MOV boards, reactor vent boards, control and auxiliary vent boards, 125-V vital batteries and vital battery boards, and vital inverters. In all cases the criteria were met or exceeded.

The following information was obtained from documentation and personnel interviews.

6. The circuits for four backup control handswitches were checked on the design documentation to assure they had not been routed through the control building (per the criteria). Verification was made that HS62-136C, HS63-47C, HS63-6C, and HS70-85C circuits were not routed through the control building (unit 1).

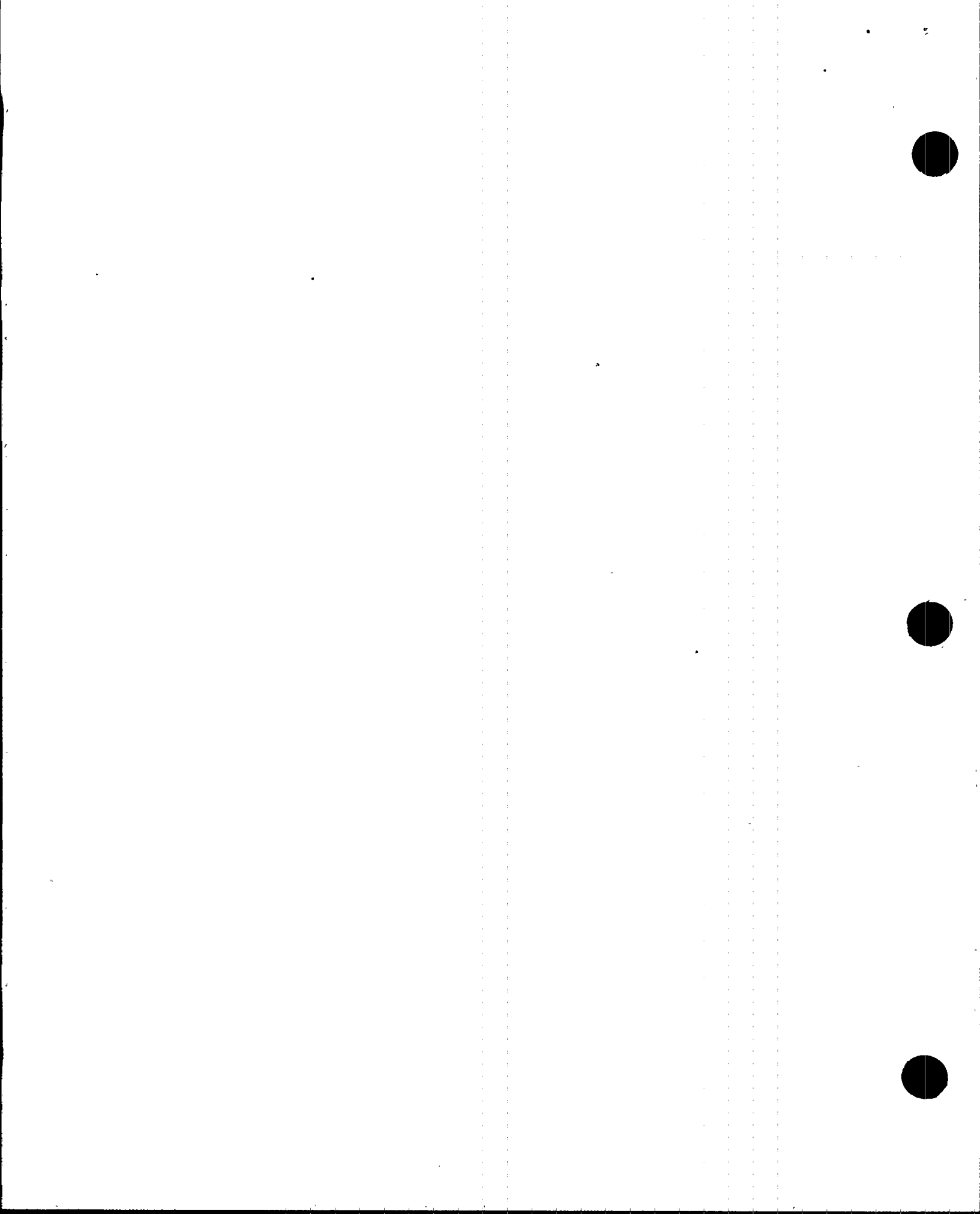


7. As a part of the environmental qualification studies (for 10CFR50.49.B.2) on Sequoyah, the Office of Engineering (OE) evaluated safety-related cabling in harsh environments. This evaluation included evaluating the nonsafety-related cables that had been routed in safety-related trays to determine if it was possible for the same cables to be routed in both train-A and train-B trays. The criteria allowed a nonsafety-related cable to be routed with one safety-related train as long as it always remained separated from the other train. The conclusion reached in OE calculation B25 851107 300 was that it could not happen.
8. OE performed studies to ensure that in the event of an accidental drop of a heavy load in the plant, adequate electrical separation existed to prevent redundant shutdown paths from being disabled. This was done in response to NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants." The results have been documented by design calculations issued 9/17/85 (B25 850917 802), 10/31/85 (B25 851031 805), and 10/4/85 (B45 851004 218).
9. The SER addressed several areas concerning electrical separation including: separation of reactor trip system actuation logic, solid state protection system general warning alarm circuits, wiring in solid state protection system multiplexer and demultiplexer, power cables in the cable spreading area, nondivisional cable trays routed between redundant divisional cable tray stacks, circuit breakers used as isolation devices, and separation of alternating and direct current instrument power.

The SER conclusion after appropriate analysis and modifications was the following.

We conclude that the applicant's implementation of his design for independence of the safety-related electrical, control and instrumentation systems meet the Commission's requirements as described above and are acceptable.

10. In order to comply with the electrical separation requirements imposed by 10CFR50, Appendix R, studies were conducted by TVA to ensure adequate separation existed between redundant shutdown paths in the event of a fire. Since this was beyond the original design requirements, deficiencies were identified. Modifications to the design were developed in order to comply with the Appendix R requirements. Based on discussions with site personnel, approximately 75 percent of the deficiencies have been corrected and, except for 25 items that are awaiting approval from the NRC, the remaining deficiency modifications are scheduled for completion by June 1986.



11. The Tracking and Reporting of Open Items (TROI) Report was reviewed for open items on audit findings and SCR/NCRs. No open items were identified.
12. Some exceptions to the Separations Design Criteria have been taken and approved by OE. These are presented as a part of the appendicies to the design criteria. An evaluation was performed for each exception to ensure safety was not jeopardized.

#### IV. CONCLUSIONS AND RECOMMENDATIONS

##### A. Conclusions

The concern related to extensive problems with electrical separation, and physical separation could not be substantiated. This conclusion was based on the results of plant inspections, personnel discussions, and review of pertinent documentation and requirements. If widespread problems existed, then significant evidence to support it should have been revealed during this investigation. The discrepancies discovered appeared to be isolated occurrences and not symptomatic of an extensive problem. Therefore, there is not sufficient evidence to recommend a more indepth review by an independent source.

Corrective action does need to be taken to correct the observed deficiencies.

##### B. Recommendations

1. I-85-218-SQN-01, Correct Deficiencies

Install cable tray covers on trays KC-B and HN-B in accordance with the design requirements at their crossover points with trays of the opposite safety division. Inspect all crossovers of this type, and ensure the cable tray covers are installed as required. [P1]

2. I-85-281-SQN-02, Clarify Separations Design Criteria

Clarify the Separations Design Criteria for separation of channelized cable trays in the Auxiliary Instrument Room. [P2]





DOCUMENTS REVIEWED IN INVESTIGATION I-85-133-SQN  
AND REFERENCES

1. Sequoyah Design Criteria, SQN-DC-V-12.2, "Separation of Electrical Equipment and Wiring"
2. Sequoyah FSAR, section 8.3.1.4.2
3. Sequoyah Safety Evaluation Report, NUREG-0011
4. Sequoyah Safety Evaluation Report, Supplement 1, NUREG-0011
5. Regulatory Guide 1.75, "Physical Independence of Electrical Systems"
6. OE Design Calculation issued 11/7/85 (B25 851107 300)
7. OE Design Calculation issued 9/17/85 (B25 850917 802)
8. OE Design Calculation issued 10/31/85 (B25 851031 805)
9. OE Design Calculation issued 10/4/85 (B45 851004 218)
10. Appendix R, Conduit and Grounding Design Drawings
11. Tracking and Reporting of Open Items (TROI) Report for Sequoyah
12. Design drawings 47W200-1 through -10





