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MEMORANDUM FOR: Chairman Palladino

FROM: William J. Dircks, Executive Director for Operations

SUBJECT: ELECTRICAL CABLE SEPARATION AT NUCLEAR POWER PLANTS

REFERENCE: Memorandum for William J. Dircks, EDO from Nunzio J. Palladino, Chairman, "Electrical Cable Separation at Beaver Valley, Unit 2," dated September 21, 1984

The referenced memorandum requested that the staff provide information on the electrical cable separation requirements that includes a discussion of:

1. The nature and extent of the problem in plants under construction.
2. How the problem came about.
3. Whether implementation of the current criteria could result in a less safe plant configuration than if the old criteria now in place at Beaver Valley Unit 1 were met in a new plant such as Beaver Valley Unit 2.
4. Alternative methods for resolution that the staff is considering.

The enclosure provides the requested information.

(Signed) William J. Dircks

William J. Dircks
Executive Director for Operations

Enclosure:
As stated

cc: Commissioner Roberts
Commissioner Asselstine
Commissioner Bernthal
Commissioner Zech
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*See previous sheet for concurrence-retyped in DEDROGR office

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NAME	:Knox	:Srinivasan	:Rubenstein	:Bernero	:Case	:Denton	:Dircks 11/21/84

ENCLOSURE

ELECTRICAL CABLE SEPARATION IN NUCLEAR POWER PLANTS

I. BACKGROUND

1. Introduction

General Design Criteria (GDC) 17 of 10 CFR 50 Appendix A, "Electric Power System", provides that Class 1E (safety related) power systems "shall have sufficient independence,...to perform their safety functions assuming a single failure."

GDC 21, "Protection System Reliability and Testability," provides that the "independence designed into the protection system shall be sufficient to assure that (1) no single failure results in loss of the protection function...."

The Institute of Electrical and Electronic Engineers (IEEE) Standard 384, "Criteria for Independence of Class 1E Equipment and Circuits," first published in 1974 provides criteria for physical independence of redundant Class 1E power systems and redundant protection system channels required by the above-referenced regulations. IEEE Standard 384 is endorsed by Regulatory Guide (RG) 1.75, "Physical Independence of Electric System" with some clarifications.

The Standard Review Plan first published in 1975, identified in Section 8.1 the above-referenced IEEE Standard and RG as acceptance criteria for physical separation of cable systems.

2. Cable Separation Criteria

The cable separation criteria of IEEE Standard 384 cover both Class 1E circuits and those non-Class 1E circuits that have a potential for adverse interactions with Class 1E circuits. IEEE Standard 384 prescribes the following physical separation between redundant Class 1E circuits and between Class 1E and non-Class 1E circuits:

- 1) In general, plant areas where potential hazards, such as missiles, external fires, and pipe whip are excluded, the minimum separation distance between redundant Class 1E cable trays shall be 3 feet horizontally and 5 feet vertically between trays.

- ii) In cable spreading areas, the minimum separation distance between redundant Class 1E cable trays shall be 1 foot horizontally and 3 feet vertically.
- iii) In control boards, the minimum separation distance between redundant Class 1E equipment and circuits shall be 6 inches.
- iv) The non-Class 1E circuits shall be physically separated from Class 1E circuits by the above stated criteria or they become associated circuits and shall conform to all requirements for Class 1E circuits. Non-Class 1E circuits can become associated with Class 1E circuits by sharing power supplies, raceways or enclosures.
- v) In plant areas where minimum separation criteria cannot be maintained, engineering analyses or tests shall be performed to demonstrate that the Class 1E circuits are not degraded below an acceptable level as a result of electrical faults in non-Class 1E circuits.

The minimum separation distances set forth above in IEEE Standard 384 were based on engineering judgment and considered fires initiated by electrical faults and failures internal to the electrical circuits in a cable system design to be a credible hazard.

The minimum separation distances were not selected as protection against such hazards as external fires, pipe whip and missiles.

The separation requirements of Appendix R for safe shutdown systems are based on exposure (external) fires and are more restrictive than those of RG 1.75.

3. Staff Implementation Practices

All plants with construction permit SER's issued on or after February 1, 1974 are required to describe the extent to which the recommendations of RG 1.75 are followed. It has been staff practice to use RG 1.75 as a guideline in evaluating the adequacy of independence of Class 1E equipment and circuits for operating license applications reviewed since February 1974. Prior to this date, no specific regulatory requirements were defined for the separation of redundant cable circuits. The industry used separation distances based on engineering judgement and experience. The staff reviewed these pre RG 1.75 design practices on the same basis.

II. RESPONSES TO CHAIRMAN'S SPECIFIC QUESTIONS

Question No. 1:

The nature and extent of the problem in plants under construction.

Response

The majority of the plants under construction recently reviewed at the OL stage by the staff were essentially designed to the separation criteria of RG 1.75. Some plants, such as Limerick and WNP-2, were allowed some exceptions to the requirements of RG 1.75, mostly in the minimum separation between Class 1E and non-Class 1E circuits. These exceptions were not identified in the FSAR's but were found by the NRC staff as the result of inspections during the construction phase of the plants. They were typically resolved by use of one or more of the following:

- i) Re-routing the cables to meet the separation criteria.
- ii) Installing adequate barriers.
- iii) Performing analysis or tests to demonstrate the adequacy of the lesser separation.

Since RG 1.75 became effective 22 plants were reviewed by the staff for electrical cable separation conformance to the guide. Based on a survey of PSB reviewers, we believe that 18 plants did not encounter any significant problems in implementing the recommendations of RG 1.75. Whatever deviations were identified were resolved at the reviewer level. Four plants (Limerick, WNP-2, LaSalle and Shoreham) contained a number of exceptions to the RG minimum separation guidelines, especially in the area of separation between Class 1E and non-Class 1E circuits. These exceptions were mostly justified by analysis and tests. In the case of WNP-2 and Shoreham, cable system modifications such as installation of barriers were necessary in addition to analysis/tests.

Question No 2:

How the problem came about.

Response

We believe that the cause for these problems is that some old plant layout designs were not modified to accommodate the current cable separation guidelines. As the construction with the pre RG 1.75 layout

design progressed, deviations from the required separation criteria occurred in the installed systems. The staff became aware of the majority of the deviations to the separation criteria either during the staff's own site visits or through regional staff inspections.

Question No 3:

Whether implementation of the current criteria could result in a less safe plant configuration than if the old criteria now in place at Beaver Valley Unit 1 were met in a new plant such as Beaver Valley Unit 2.

Response:

Plants such as Beaver Valley Unit 2 that conform to RG 1.75 separation criteria do not compromise safety and are not less safe than those plants such as Beaver Valley Unit 1 that were not required to conform with RG 1.75.

The physical separation that exists in pre RG 1.75 plants is primarily between redundant Class 1E circuits. Whereas, plants that conform with RG 1.75 assure physical separation not only between redundant Class 1E circuits but also between Class 1E and non-Class 1E circuits. This important separation aspect minimizes the potential for any adverse interactions affecting safety between non-Class 1E and Class 1E circuits. Therefore, the staff believes that there are some safety gains in plants that conform to RG 1.75 separation criteria specifically in the areas of adverse Class 1E and non- Class 1E circuit interactions.

Question No. 4:

Alternative methods for resolution that the staff is considering.

Response:

So far, the deviations to the RG 1.75 cable separation criteria that have been identified in plants undergoing OL review have been satisfactorily resolved and did not result in any major modifications to the plant cable systems. This is because the following approaches to minimize the cable separation problems have been used by the staff:

- 1) Applicants have been requested to identify deviations from RG 1.75 separation criteria early in the OL review, and to provide justifications so that staff can systematically evaluate the acceptability of these deviations before implementation.
- 2) Applicants have been made aware that the separation criteria for external fire protection for safe shutdown circuits as set forth in Appendix R are more restrictive than those contained in RG 1.75 for internal electrical faults.

DISTRIBUTION (EDO 14807) - Memo to the Commissioners,
"Electrical Cable Separation at Nuclear
Power Plants"

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PSB Reading File

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