UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of LONG ISLAND LIGHTING COMPANY (Shoreham Nuclear Power Station, Unit 1)	Docket No. 50-322 (O.L.)

PREPARED DIRECT TESTIMONY OF
RICHARD B. HUBBARD AND GREGORY C. MINOR
ON BEHALF OF SUFFOLK COUNTY (SC)

REGARDING

SC CONTENTION 31 AND SOC CONTENTION 19(g)

ELECTRICAL SEPARATION

MAY 4, 1982

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SUMMARY OF TESTIMONY ON SC CONTENTION 31 AND SOC 19(g)

The design and construction of Shoreham electrical systems fail to provide adequate physical independence of electrical cables and raceways, thus violating the NRC's General Design Criteria.

Evidence of deficiencies in LILCO's design criteria for separation, and of inadequate implementation of the electrical separation criteria during construction, is provided in this testimony. A number of examples are provided which demonstrate that the design criteria for physical separation and electrical isolation of circuits and equipment, as committed to by LILCO in the FSAR, fail to comply in important aspects with the required regulatory practices. Further, even if one assumes that the LILCO separation criteria on paper do comply with the regulations, which we do not, it is also clear, as demonstrated by examples in this testimony, that the separation criteria have not been adequately implemented during the construction of Shoreham. Also, the Shoreham SER fails to document the continuing NRC review of this safety item.

Accordingly, we recommend to this Board that the Shoreham separation criteria be revised to comply with the normal regulatory practices, that the FSAR commitments be confirmed by a

formal review of plant systems, and that a 100 percent field audit of cable separation be conducted. The results of such a review should form the basis for required plant modifications which should be backfitted prior to the issuance of any operating license for Shoreham.

Absent such improvements and analyses, there can be no finding that Shoreham is constructed in accordance with the license application. In addition, there can be no finding that Shoreham complies with the General Design Criteria necessary to ensure the required protection to public health and safety.

Exhibits

1. Stone & Webster Specification No. SH1-159, "Specification For Electrical Installation: Separation Criteria For Raceways and Cables," Cover and pages 3-54 to 3-69, Revision 5 dated December 19, 1979 with pages dated November 28, 1979.

2. Sargent & Lundy Specification, "Separation of Electric Equipment: Plant Wide Field Audit Procedure," LaSalle County Station, July 1, 1980, pages 1 to 11.

3. LILCO Letter to NRC No. SNRC-677, March 11, 1982, Response to NRC Inspection 82-02 Concerning Deviation From FSAR Commitments.

4. Shoreham FSAR Table 223.12-3, Cable Tray Separation In Non Hazardous Areas.

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I. INTRODUCTION

1. This testimony was jointly prepared and edited by Richard B. Hubbard and Gregory C. Minor.[1/] A statement of qualifications of Messrs. Hubbard and Minor has been separately provided to this Board.

II. STATEMENT OF CONTENTION

2. The purpose of this testimony is to address Suffolk County Contention 31 (SOC Contention 19(g) is a subpart thereof)[2/] as admitted by the Board as follows:

Suffolk County contends that 10 CFR § 50.57 and § 50.109 requirements have not been made (sic) because:

1/ The primary/secondary authors for the major portions of this testimony are as follows:

III.A: R. B. Hubbard/G.C. Minor
III.B: R. B. Hubbard/G. C. Minor
III.C: G. C. Minor/R. B. Hubbard
III.D: R. B. Hubbard/G. C. Minor

R. B. Hubbard was responsible for overall coordination.

2/ SOC Contention 19(g) consists of the exact wording in subparagraph (a) of SC Contention 31. Thus, with the exception of the opening sentence by SC, where reference is made to 10 CFR § 50.57 and § 50.109, the SC and SOC contentions are identical.

(a) Regulatory Guide 1.75 -- The design of the Shoreham electrical system fails to provide adequate physical independence of electrical cables and raceways as set forth in Revision 2 to Regulatory Guide 1.75 and therefore does not comply with 10 CFR § 50.55a and Part 50, Appendix A, Criteria 3, 17 and 21. In addition, the minimum separation criteria for Shoreham stated in Section 3.12 of the FSAR have not been followed as noted in Inspection Report 50-322/79-07 dated August 21, 1979 and subsequent reports from the Office of Inspection and Enforcement. Accordingly, each deficiency in separation for Shoreham electrical cables and raceways must be adequately demonstrated using one of the following options:

1. Correct the deficiency by meeting the electrical equipment separation criteria set forth in Section 3.12 of the Shoreham Final Safety Analysis Report;

2. Correct the deficiency by meeting Regulatory Guide 1.75, "Physical Independence of Electric Systems," Revision 2 dated September, 1978;

3. Correct the deficiency by installing an acceptable barrier; or

4. Justify the deficiency by performing a specific analysis for each cable or raceway where the minimum separation is not met to demonstrate that a failure will not propagate because of the insufficient separation.

3. The results of our review of some of the important matters encompassed by SC Contention 31 are summarized in the following paragraphs.

III. DISCUSSION OF ISSUES

III.A: Overview and Definitions

4. This testimony addresses two interrelated questions concerning the physical independence of the circuits and equipment comprising or associated with Class 1E systems at Shoreham. The physical independence questions are:

(a) Do the criteria for physical separation and electrical isolation of circuits and equipment, as set forth in the FSAR, comply with the NRC regulatory practices; and

(b) Have the separation and isolation criteria been adequately implemented during the construction of Shoreham?

The term "independence", when used in this testimony, is defined as follows:[3/]

> "independence: The state in which there is no mechanism by which any single design basis event, such as flood, can cause redundant equipment to be inoperable."

3/ IEEE 384-1981, IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits, p. 7. Earlier versions of the standard were IEEE 384-1977 and IEEE 384-1974. IEEE 384 provides the underlying basis, with certain exceptions, for Reg. Guide 1.75.

5. Both physical separation and electrical isolation are required in order to maintain the independence of Class 1E circuits and equipment so that the safety functions required during and following any design basis event can be accomplished. Class 1E is defined as the safety classification of electric equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or are otherwise essential in preventing a significant release of radioactive material to the environment. There are various acceptable methods of achieving independence. For example, the physical separation of circuits and equipment can be achieved by the use of safety class structures, separation distance or barriers, or any combination thereof. Electrical isolation can be achieved by the use of separation distance, isolation devices, shielding and wiring techniques, or combinations thereof.[4/]

III.B: Background and Description of Requirements

6. The NRC has set forth rules regarding nuclear plant electrical systems. The chief requirements relevant to this testimony are as follows:

4/ Ibid 3. The useage of terms throughout this testimony is consistent with the "definitions" provided in IEEE Std 384-1981.

(a) Section 50.55a, "Codes and Standards," of 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," requires in paragraph (h) that protection systems meet the requirements set forth in the Institute of Electrical and Electronics Engineers (IEEE) Standard 279, "Criteria for Protection Systems for Nuclear Power Generating Station." Section 4.6 of IEEE 279-1971 (also designated ANSI N42.7-1972) requires, in part, that channels that provide signals for the same protective functions be independent and physically separated.

(b) General Design Criterion 3, "Fire Protection," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50 requires, in part, that structures, systems, and components important to safety be designed and located to minimize, consistent with other safety requirements, the probability and effect of fires.

(c) General Design Criterion 17, "Electric Power Systems," requires, in part, that the onsite electric power supplies, including the batteries, and the onsite electric distribution systems

have sufficient independence to perform their safety functions assuming a single failure.

(d) General Design Criterion 21, "Protection System Reliability and Testability," requires, in part, that independence designed into protection systems be sufficient to ensure that no single failure results in loss of protective function.

7. In addition, 10 CFR Section 50.57 requires, in part, that an operating license can only be issued upon finding that construction of the facility has been substantially completed in conformity with the construction permit and the application, and that there is reasonable assurance: (a) that the activities authorized by the operating license can be conducted without endangering the health and safety of the public; and (b) that such activities will be conducted in compliance with the regulations. Further, the NRC may, as prescribed in 10 CFR Section 50.109, require the backfitting of a facility if it finds that such action will provide substantial, additional protection which is required for the public health and safety or the common defense and security.

8. Regulatory Guide 1.75 describes a method acceptable to the NRC Staff of complying with IEEE 279-1971 and Criteria 3, 17, and 21 of Appendix A to 10 CFR Part 50 with respect to the

physical independence of the circuits and electric equipment comprising or associated with the Class 1E power system, the protection system, systems actuated or controlled by the protection system, and auxiliary or supporting systems that must be operable for the protection system and the systems it actuates to perform their safety-related functions. Additional criteria for protection of Class 1E items against the effects of fires are provided in Reg. Guide 1.120, "Fire Protection Guidelines for Nuclear Power Plants."

9. For Shoreham, the criteria for physical independence are set forth in Section 3.12 of the Final Safety Analysis Report (FSAR). Further clarification of the independence criteria is provided by LILCO in the FSAR in response to NRC questions 223.12 and 223.67; the degree of compliance with Regulatory Guide 1.75 is summarized in paragraph 3B-1.75 of Appendix 3B to the FSAR.

10. The NRC Staff's assessment of the adequacy of the Shoreham electric separation and isolation criteria for design is principally set forth in Sections 7.6.6, 8.4.4, and 8.4.10 of the Shoreham Safety Evaluation Report (SER).[5/] The Staff's evaluation of implementation of separation during construction is provided by the Staff's personnel responsible for Inspection and Enforcement (I&E).

5/ NUREG-0420, Shoreham SER, April, 1981.

III.C: The Shoreham Criteria For Physical Independence of Class 1E Electrical Systems Do Not Comply with NRC Requirements

11. There can be no question that the Shoreham separation and isolation criteria used for design of Class 1E systems are not in full compliance with the current or past NRC requirements for physical independence, as augmented by the guidance in Regulatory Guide 1.75. LILCO has itself stated that:

a. "The Shoreham Nuclear Power Station does not comply with Reg. Guide 1.75 (Rev. 1) in every detail." 6/

b. "The electrical systems do not fully comply with Regulatory Guide 1.75 due to the advanced stage of design at the time of issuance of the guide . . . . Within the limitations imposed by the systems and equipment design, an effort was made, to the maximum extent practicable, to comply with the guide." 7/. (emphasis added)

c. "The resulting installations (systems listed in FSAR Section 3.12.3.1) satisfy the criteria of IEEE 279-1971, General Design Criteria 3, 17, and 21, as further clarified and limited below." 8/ (emphasis added)

6/ LILCO's response to SOC's Third Set Of Interrogatories and Request For Production Of Documents To Long Island Lighting Co., April 2, 1982, p. 5.

7/ Shoreham FSAR, Appendix 3B, p. 3B-18. Also see Shoreham FSAR, Response to Question 223.12, p. 223-12a.

8/ Shoreham FSAR, p. 3.12-5.

d. "Arrangement of wiring is designed to eliminate, insofar as practical, all potential for fire damage to cables and to separate the RPS, NSSSS, ECCS, and other safety systems divisions so that fire in one division does not propagate to another division." 9/ (emphasis added)

e. "Wherever possible (for BOP panels internal wiring separation) non-Class 1E circuits are not run in the same wire bundles or wireways used by any group of the redundant Class 1E cables." 10/ (emphasis added)

Further, in the March 26 response by LILCO to Suffolk County's second set of interrogatories, LILCO explicitly acknowledges that the cable design and physical arrangement of the Shoreham cable spreading room do not comply with either IEEE 384-1977 or Regulatory Guide 1.75, Revision 2.

12. The Stone and Webster (S&W) Specification No. SH1-159 for electrical installation[11/] includes the following specific limitations in the separation criteria:

> "As a minimum in nonhazardous areas, redundant conduit shall be separated vertically 5 ft and horizontally 3 ft. For the cable spreading area, relay room, and control room redundant conduit shall be separated vertically 3 ft and horizontally 1 ft. Safety and nonsafety conduit shall be separated by a minimum of 1 in. Where the above criteria cannot be met the separation must be to

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9/ Shoreham FSAR, p. 3.12-9.

10/ Shoreham FSAR, Response to Question 223.12, p. 223-12d.

11/ The cover and pages 3-54 to 3-69 concerning separation criteria for raceways and cables excerpted from S&W Specification No. SH1-159 are included herein as Exhibit 1.

> the extent physically possible and the exception shall be documented by construction. For hazardous areas separations of raceways are evaluated by engineering and design and shall be as defined in applicable drawings. No major deviation in routing of raceway from the drawings should be taken without approval by engineer." 12/ (emphasis added)

In other cases, the S&W criteria introduce artificial means to offset less than the desired separation in that:

> If the design of the equipment is not conducive to 6 in. separation or approved barrier installation, the cable jacket shall be left on the cable for mechanical protection to the extent possible within the panel. . . . Other equipment where separation/ barriers are not provided should be documented by E&DCR for disposition by the Engineers. 13/ (emphasis added)

13. The preceding S&W design criteria are deficient both in technical content and in the procedure for the resolution of non-conformances. First, the design criteria are technically deficient with regard to separation distances. For example, the minimum separation within conduit groups drop to 1 inch for critical cabling between any of the four Reactor Protection System (RPS) scram groups in the areas over the Hydraulic Control units at Elevation 78 of the reactor building.14/ A more complete description of deficiencies in the design criteria

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12/ S&W Specification SH1-159, p. 3-55.

13/ S&W Specification SH1-159, p. 3-58.

14/ S&W Specification SH1-159, p. 3-56. A comparison between the separation distances specified in IEEE 384 and Reg. Guide 1.75 and the distances specified for Shoreham are summarized by LILCO in FSAR Table 223.12-3. The LILCO table is included herein as Exhibit 4.

for establishing minimum separation distances is described in Section III.C.1 of this testimony. Second, any procedure which allows the Shoreham engineers to routinely approve deviations from the design criteria stated in the FSAR or PSAR appears to be directly contrary to the requirement of 10 CFR Part 50.57(a)(1) that no operating license may be issued until the NRC finds that construction of the facility has been substantially completed in conformity with the construction permit and the application as amended. Additional examples of LILCO's failure to implement the FSAR commitments at Shoreham are described in Section III.D of this testimony.

14. Further, the LILCO commitment related to physical independence for future design changes or backfitting which may occur during the life of the Shoreham plant is not in full compliance with the regulatory requirements in that LILCO's promise is limited as follows:

> "Whenever new design changes are incorporated, the requirements of Regulatory Guide 1.75 (including separation of Class 1E and non-Class 1E circuits) are considered and incorporated to the maximum extent possible. 15/ (emphasis added)

15. Thus, by LILCO's and S&W's own admission, the current Shoreham design does not comply with either the guidance

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15/ Shoreham FSAR, Response to Question 223.67, p. 223.67b.

for physical independence in Reg. Guide 1.75 or the regulations, except to the extent practicable or possible. Likewise, LILCO has failed to commit to meeting the regulations or Reg. Guide 1.75 guidance for future design changes. This vague guidance, to the extent possible or practical, is nowhere defined in the FSAR or to our knowledge in LILCO procedures. It stands rather as an empty promise that regulatory requirements will be met. Therefore, we believe there can be no assurance that the current design of Shoreham, or future design changes at Shoreham, will provide the required physical independence of electric systems necessary to protect the public health and safety.

III.C.1: Specific Deficiencies in Physical Independence at Shoreham

16. A number of specific non-compliances with the normal regulatory practices in separation for Shoreham electrical cables are described in the FSAR in the LILCO responses to NRC questions 223.12 and 223.67. Since these exceptions, and the justification for these exceptions, are already documented in the FSAR, no additional description of these areas of non-compliance are repeated in this testimony. However, we do question the validity of the justification for these exceptions. In particular, we question the justification for the acceptance of the reduction in separation distance (compared to NRC criteria) set forth in the Shoreham FSAR and summarized herein in Exhibit 4.

17. While LILCO acknowledges that the Shoreham design is not in full compliance with the physical independence criteria prescribed by the NRC's regulatory practices, LILCO asserts that the areas of noncompliances are adequately offset by the use of halogenated cables, and by the total flooding CO_2 fire protection systems in the cable spreading/relay room, diesel generator rooms and battery rooms. In addition, LILCO relies on a Cable Separation Study (SNRC-527, December 31, 1980) to confirm its judgment that a level of safety equivalent to that of Reg. Guide 1.75 is achieved at Shoreham.[16/] We disagree with these conclusions as set forth in the following paragraphs.

18. First, the preceding Cable Separation Study we believe is in reality limited to a fire hazard analysis, rather than being a true electrical equipment separation study. System interactions of a dynamic nature are not postulated, nor is the misinformation which might result in operator errors considered in the LILCO analysis. In addition, an update of the LILCO analysis will need to be made at a later date when "as-built" drawings become available to assure that the final installation does not invalidate the shutdown analysis. Thus, LILCO acknowledged the ongoing nature of the review in SNRC-526 in that:

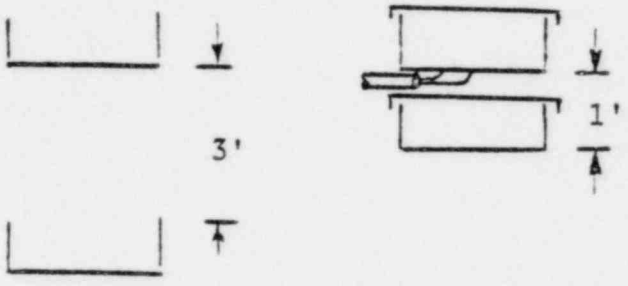
16/ LILCO's response to SOC's Third Set of Interrogatories and Request for Production of Documents to Long Island Lighting Company, April 2, 1982, p. 5.

"This analysis will be an ongoing effort which will terminate with the completion of the installation of all Class 1E cables and associated equipment. At that time, an engineering and construction "as-built" review will be performed to reaffirm the analysis results."

19. We concur that an "as-built" review of separation should be completed prior to operation of Shoreham. Suggested procedures for such a review are set forth in Section III.D.2 of this testimony and are amplified in Exhibit 2, which documents such a plant-wide field audit procedure which was implemented recently at the LaSalle Nuclear Station. Further, we continue to believe that a systems interaction study, as previously outlined in our testimony on SC Contention 7B, should be conducted to confirm that all items of electrical systems important to safety have been properly recognized, classified, and physically separated in the Shoreham design and construction.

20. Second, LILCO and S&W have placed a strong reliance on alternate devices and techniques to make up for less than standard cable separation distances. For example, IEEE 384 and Reg. Guide 1.75 specify a separation distance of three feet between adjacent surfaces of stacked trays (e.g., from the bottom of the upper tray to the top of the lower tray should not be less than three feet). LILCO has set this distance at one foot from bottom-to-bottom, thus making the actual separation less than one foot - actually about eight to nine inches. The

distance is further reduced by allowing entry of exposed cables between the two separated trays.[17/] (See following illustration.)



IEEE 384 LILCO

CABLE TRAY SEPARATION CRITERIA

To overcome these extreme reductions of separation distances, LILCO has committed to add solid covers to the cable trays.[18/] However, the trays are generally a ladder-type construction (i.e., open on the bottom except for metal cross rungs spaced several inches apart).[19/] Thus, there is still an exposure

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17/ Specification for electrical installation: Shoreham Unit 1 SH1-159 Rev. 5, December 19, 1979, Figure 9, also, FSAR Table 223.12-3. Footnote (2). (Part of Exhibit 1).

18/ FSAR Table 223.12-3, footnote (3).

19/ Ibid 17, Figure 9, note 2.

of one surface of the tray. The IEEE 384 standard allows less than three feet vertical separation but only for enclosed raceways (i.e. trays with solid-bottom, solid-top construction).

21. LILCO also permits side-to-side separation of cable trays of only one inch. This cannot be considered adequate fire separation for ladder-type cable trays such as used at Shoreham. By contrast, IEEE 384 calls for 1 foot horizontal separation between trays in the cable spreading room.[20/] The use of covers on the trays does not overcome the open nature of the ladder-type trays and, thus, this close a separation cannot assure independence of Class 1E circuits from non-Class 1E. LILCO does not explicitly justify this exception from IEEE 384.

22. Perhaps the greatest uncertainty in the adequacy of LILCO's separation is Lilco's strong reliance on solid covers over the cable trays to act as barriers which (it claims) justify the lesser separation distances. There can be no assurance that these covers will remain in place following revisions and rework of cables. The cable spreading room, without covers in place, would have serious difficulties in meeting the necessary separation characteristics. In addition, the ladder tray construction, absent the covers, provides a stacked array of cables which would be vulnerable to the propagat on of exposure fires.

20/ See also FSAR Table 223.12-3.

23. LILCO also relies on circuit breakers as isolation devices to justify its separation of Class 1E power sources from non-Class 1E loads. There is no discussion of how this complies with the statement of Reg. Guide 1.75 that limits the use of circuit breakers which are operated by fault currents.[21] The result may be a lack of separation of power sources and, thus, additional circuits which require separation but may not have been routed appropriately.

III.D: Lilco Has Not Complied With the Separation and Isolation Criteria Upon Which It Relies

24. Even if LILCO's separation and isolation criteria did comply with NRC regulatory practices (and we have stated previously they do not), it is clear that such criteria have not been followed by LILCO at Shoreham. Indeed, there have been repeated instances where LILCO has failed to meet even its own minimum separation criteria as stated in FSAR Section 3.12. Furthermore, these events cannot be characterized as a temporary phase or as mere aberration in the past; rather, they represent a problem which has been reoccurring since 1977 and continues in 1982.

21/ Reg. Guide 1.75, p. 1.75-2.

25. LILCO's failure to meet applicable separation and isolation criteria can best be illustrated through specific examples where a) NRC citations have been issued because separation criteria have not been met, and b) NRC citations have been issued because separation criteria have not been met and corrective action to prevent repetition has been inadequate. These examples are described below.

III.D.1: Citations Issued Because Separation Criteria Not Met and Inadequate Corrective/Preventative Action Taken

26. According to NRC Inspection and Enforcement records, there are two cases where LILCO has not only failed to meet specified separation criteria, but it has also failed to take corrective actions that would prevent repetition of the nonconforming items.

27. In the first case, which occurred during I&E Inspection 77-05, the NRC inspector observed on March 2, 1977, that safety-related and non-safety-related cable had been bundled together in switchgear enclosures. This is contrary to S&W Specification No. SH1-159 which states, in part, that:

> "field installed cables routed within equipment shall be arranged so that there is a minimum of six inches between unprotected differently colored cables. Color coded cables and non-color coded field installed wires and cables routed within equipment shall be bundles separately and an effort made to maximize separation.

Where separation stated above cannot be achieved, a barrier approved by engineering shall be installed." 22/

28. In response to the I&E violation notice, LILCO furnished the inspector with copies of Deficiency Correction Order (DCO) Nos. 10182E, 10185E, and 10187E which listed a number of cables, including some cables identified by the inspector, as being in nonconformance with the separation criteria. The DCO's specified cable separation as the corrective action, with completion and acceptance dated November 17, 1976. Given this information and the findings reported in I&E Inspection 77-05, it was concluded by the NRC inspector that the corrective actions specified and taken by S&W personnel in 1976 did not include corrective actions to preclude repetition of the non-conformances. Thus, in addition to the 1976 nonconformances, the NRC discovered failure to prevent repetition of the same type of violation.

29. LILCO disputed the NRC's categorization of the violation as an "infraction", contending that there had been no repetition of a previously significant condition adverse to quality. LILCO claimed that the two cases in question involved different conditions and referred to separate requirements of

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22/ I&E Report 77-05, p. 9.

Specification SH1-159. Therefore, LILCO contended, the 1977 violation was not repetitious of the conditions discovered in 1976.[23]/

30. The NRC rejected LILCO's position. While the NRC acknowledged that the conditions identified in each case did vary in detail, the NRC concluded both nonconformances involved LILCO's failure to comply with separation criteria. Had adequate corrective steps been taken following identification of the first nonconformance, LILCO should have provided for conformance with established separation criteria during construction rather than depending upon identification of nonconforming conditions by Field Quality Control following completion of construction.[24]/

31. The second case where LILCO failed both in meeting the separation criteria and in initiating adequate corrective actions to prevent repetition was disclosed in I&E Inspection 79-07. As of May 25, 1979, S&W Specification SH1-159 and associated Engineering Design Change Report E&DCR-F-19039 permitted installation of raceways which did not conform to the minimum separation criteria. It also permitted the subsequent

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23/ LILCO letter SNRC-186 to NRC, May 18, 1977.

24/ NRC Letter to LILCO, June 7, 1977. I&E Report 77-20 reported that LILCO had conducted training sessions on cable separation criteria, and that specifications and procedures had also been revised. Furthermore, the specific nonconforming conditions identified in I&E Inspection 77-05 had been corrected. Thus, the item was closed.

installation of cables in those nonconforming raceways. While documentation of each nonconformance was required by Specification SH1-159, and future disposition of the conditions was controlled by the E&DCR Control System, proper corrective action to prevent repetition had not been taken and additional nonconforming installations were being made.

32. More specifically, according to I&E Report 79-07, S&W Field Quality Control Procedure 12.1 Revision C requires that field QC inspectors verify that raceway separation criteria are adhered to prior to the installation of cable. But the E&DCR eliminated the work hold established by this requirement, by keying to a specification provision which permits deviation from quantitative "separation criteria" for raceways, as long as each case of deviation is documented in an E&DCR. The "separation criteria" thus became simply a matter of verifying existence of an E&DCR. Accordingly, E&DCR F-19039 had not been submitted for review or approval by divisions of Stone and Webster responsible for QCP-12.1, such as the field Quality Control Division, Chief Engineer of Quality Systems Division, Project QA Manager, or Construction Manager.

33. When questioned regarding the individual E&DCR's which identify deviations from the separation criteria in the FSAR, the Stone and Webster representatives stated that resolution

of these E&DCR's would be explained in conjunction with a study which would investigate the safety implications for hypothesizing destruction of various zones of the facility. As a result of that study, some of the E&DCR's may be accepted as is, while others would require removal of the cables and rework, or other actions. The NRC inspector stated that the FSAR appeared to commit to specific minimum separation criteria without recognition of such a study, and that the basis for classifying E&DCR F-19039 as "FSAR Change - No" was not clear.

34. We concur with the NRC that LILCO's conduct was unacceptable. We base this conclusion on the fact that:

a) LILCO continued construction under conditions contrary to the FSAR criteria,

b) LILCO handled the E&DCR without referral to concerned branches of the S&W organization, and

c) LILCO failed to provide FSAR impact identification.

Furthermore, the continued construction with nonconforming conditions appears to be contrary to a control principle inherent in the objectives of the QA program, in that E&DCR F-19039 involved aspects of a number of criteria of 10 CFR 50, Appendix B, including Criterion 16 which requires that nonconformances be promptly identified and corrected.

35. This matter of proper compliance with I&E Inspection 79-07 continues to be open at this time. LILCO initially argued that no violation had occurred, then later agreed to document necessary changes, but not to revise the FSAR.[25/] The NRC Staff disagreed with LILCO's position that the separation criteria were unchanged and that no change to the FSAR was required. Accordingly, the NRC Staff ordered LILCO to complete the analyses proposed by LILCO and submit them to the NRC.[26/] At this time LILCO is continuing its analyses, with this work scheduled for completion in the summer of 1982.[27/] No reference to this critical unresolved issue between LILCO and the NRC Staff is made in the Shoreham SER. Such an omission is misleading.

III.D.2: Recent Cases Where Separation Criteria Were Not Met

36. Despite the fact that LILCO had been cited twice in the late 1970's for failure to both properly implement its separation criteria and to prevent recurrence of such activities, areas of noncompliance continue to be disclosed. Indeed, there are two additional cases beyond those previously discussed,

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25/ LILCO letter SNRC-435 to NRC, September 27, 1979.

26/ NRC letter to LILCO, December 26, 1979.

27/ Phone contact with Jim Higgins, NRC Resident Inspector at Shoreham, April 22, 1982. This item will remain open until LILCO's analysis is complete, at which time the NRC will conduct a re-inspection with a scope as of yet undefined.

where LILCO has not complied with the criteria upon which it relies.

37. In the first case, which occurred during I&E Inspection 80-10, the NRC inspector observed on June 19, 1980 during an examination of cables associated with safety-related instrumentation, that the redundant safety-related conduit installation for system IG33 did not meet the separation criteria of Specification SH1-159, which required, in part, that:

> as a minimum...redundant conduit shall be separated vertically 4 feet and horizontally 3 feet...where above criteria cannot be met exception shall be documented by construction. 28/

38. Thus, as summarized in I&E Inspection 80-10, LILCO failed to follow quality control instructions which stated that: "...separation will be maintained in accordance with...SH1-159..."29/ Likewise, LILCO did not follow the requirements of the E&DCR.30/ Finally, documentation and/or

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28/ S&W Specification No. SH1-159, p. 3-55.

29/ QC Instruction QCI-FSI-F12.1-08E as noted in I&E 80-10 at p. 5.

30/ E&DCR No. 23640C, April 22, 1980 as noted in I&E 80-10 at p. 5.

tags indicating that this installation was not acceptable, were not available at the site.[31/]

39. The second recent case where LILCO has failed to meet its separation criteria occurred during I&E Inspection 82-02 and involved the loose parts monitoring system. LILCO states in the Shoreham FSAR that the loose parts monitoring system meets the requirements of Regulatory Guide 1.133.[32/] Regulatory Guide 1.133 specifies that instrument channels be physically separated where inaccessible during full power operation.[33/] Contrary to that requirement, as of January 13, 1982, instrument cables for different channels were not physically separated inside the drywell (which is inaccessible during full power operation); indeed the cables were run in the same conduits

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31/ LILCO's response to the notice (LILCO letter SNRC-507 to NRC, September 22, 1980) contended that the conduit was not identified and tagged as nonconforming at the time of the NRC inspection because Field Quality Control had not yet performed a final inspection. Nevertheless, LILCO reported in its response that corrective action had been taken in that a) the condition had been documented on a nonconformance report, and b) the conduit had been tagged to identify it as nonconforming. To prevent recurrence, LILCO assured that clarification of instructions was being promulgated, requiring that E&DCR's covering conditions where conduit separation could not be met, be issued prior to installation sign-off by Construction. These revisions would be monitored for compliance by Field Quality Control. I&E Report 81-05 recorded the corrective actions taken by LILCO in this matter as acceptable and the item was closed.

32/ FSAR, paragraph 4.4.6.

33/ Regulatory Guide 1.133, paragraph C.1.c.

and they utilized the same elctrical penetration. While this did not violate a specific NRC requirement, it did violate LILCO's commitment to follow the FSAR. Thus, a note of deviation was issued to LILCO.[34/]

40. In summary, it is clear based on the previous examples, that LILCO has repeatedly failed to meet even its own separation criteria. Put a different way, the Shoreham FSAR simply does not give an accurate reflection of the actual implementation at the plant with regard to meeting separation criteria. Further, we note that LILCO has both acknowledged this problem and made general plans for corrective action in that:

> "...we have initiated a formal Shoreham Configuration Review Program which involves a documented detailed comparison of the as-constructed configuration of major plant safety systems to the applicable FSAR descriptions. This review compares the systems to the FSAR, formally documents any discrepancies found, and initiates corrective actions/dispositions, as appropriate." 35/

34/ LILCO responded to the NRC in letter SNRC-677 dated March 11, 1982. Based upon LILCO's interpretation of Regulatory Guide 1.133, LILCO contended that the intent as well as the functional requirements of Regulatory Guide 1.133 were met by its current design and installation, although the literal interpretation was not. Consequently, it reported that paragraph 4.4.6 of the Shoreham FSAR would be revised to explicitly state the LILCO interpretation of Regulatory Guide 1.133. This matter remains open.

35/ LILCO letter SNRC-677 to NRC, March 11, 1982. The letter is included herein as Exhibit 3.

41. LILCO's FSAR review program appears to potentially be a step forward. However, the timing and scope of the review should be documented in the FSAR and assessed by the NRC in an SER supplement. To date, no mention of this safety issue has been cited in the Shoreham SER. In view of the history of the separation problem, we believe that LILCO should conduct a 100% field audit of cable separation. Such an inspection was, in fact, recently conducted at the LaSalle County Station, Unit 1. The LaSalle audit consisted of sampling approximately 10% of the total installed safety-related cables, associated cables and electrical equipment. A copy of the scope and general procedures utilized at LaSalle is set forth herein as Exhibit 2. In our opinion, an audit such as this, extended to 100% inspection, is the best way to positively demonstrate that LILCO has properly implemented its separation criteria throughout the critical Shoreham electrical systems.

III.D.3: NRC Review of RHR System Discloses Discrepancies Between As-Built Plant and FSAR and Deficiencies In Implementation of Cable Separation Criteria.

42. During the second and fourth week of February this year, a team of personnel from the Region I office of the NRC conducted a "walkdown" inspection of the Residual Heat Removal (RHR) system at Shoreham. The review consisted mainly of a comparison of actual physical installation versus the system descriptions

and diagrams provided in the licensing application including the FSAR and the system Piping and Instrument Diagrams (P&ID's). The inspection team made sample checks of hanger location, electrical conduit and support location, electrical separation, pipe separation, anchor bolt installations and the masonry walls surrounding the RHR heat exchanger.

43. While the summary report of the inspection has not yet been issued, the team leader during informal discovery on March 23, 1982 informed an author of this testimony of the two major findings. First, the NRC found that the FSAR was not up to date in that actual as built plant configurations differed from the system description and the P&ID's provided in the Shoreham FSAR. Second, the team found approximately one half dozen examples where Class 1E and non Class 1E cables were not separated as specified in the design documents and the Shoreham licensing application.[36/]

44. We believe that the preceding very recent discrepancies, as well as the history of similar discrepancies, clearly demonstrate that a complete review of the safety features of the as-built Shoreham facility as compared to the

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36/ Informal discovery by R. Hubbard with Lee Bettenhausen, Region I of the NRC, Test Program Section Chief, at King of Prussia, PA, on March 23, 1982.

licensing documents is required. Further, we believe that the NRC finding of separation discrepancies in its review of the RHR system add further justification, and clearly demonstrates the need, for the 100% inspection of electrical separation as previously suggested in this testimony. Absent such a review, and completion of the required backfitting activities, there can be no assurance that Shoreham is constructed in accordance with the license application and that the actual as-built physical independence of electrical cables and raceways complies with both the NRC's General Design Criteria and the commitments made by LILCO in the FSAR.

IV. CONCLUSION

45. Based on the foregoing, we conclude that the design and construction of the Shoreham electrical systems fail to provide adequate physical independence of electrical cables and raceways. Examples are cited in this testimony which demonstrate that the design criteria for physical separation and electrical isolation of circuits and equipment, as committed to by LILCO in the FSAR, fail to comply in important aspects with the required regulatory practices. Further, even if one assumes arguendo that the LILCO separation criteria do comply with the regulations, it is clear that in a number of examples

the independence criteria have not been adequately implemented during the construction of Shoreham, thus violating FSAR commitments. Also, the Shoreham SER fails to document the continuing NRC review of this unresolved safety item.

46. Accordingly, we recommend to this Board that the Shoreham separation criteria be revised to comply with the normal regulatory practices, that the FSAR commitments be confirmed by a formal review of plant systems, and that a 100 percent field audit of cable separation be conducted. The results of such a review should form the basis for required plant modifications. Such modifications should be backfitted prior to the issuance of an operating license for Shoreham in order to provide the required protection to public health and safety.

EXHIBIT 1

S&W SPECIFICATION FOR ELECTRICAL INSTALLATION:

SEPARATION CRITERIA FOR RACEWAYS AND CABLES

(Cover and pages 3-54 to 3-69 of S&W Spec #SH1-159)

(Revision 5 dated December 19, 1979)

SC 31/32

PSF

T. SPATZ LILCO PROJECT OFFICE

J.O.No. 11600.02
Spec. No. SH1-159

June 20, 1974
Rev. 1, September 20, 1974
Rev. 2, April 1, 1977
Rev. 3, April 1, 1978
Rev. 4, August 10, 1979
Rev. 5, December 19, 1979

APR 19 1982

Specification for

ELECTRICAL INSTALLATION

Shoreham Nuclear Power Station - Unit 1
Long Island Lighting Company
Brookhaven Township, Long Island, New York

Contractor: L. K. Comstock & Company, Inc.
T. Frederick Jackson, Inc.
A Joint Venture
P.O. No. 310541

APPROVED	Name	Date
Preparer		11/29/79
Lead Engr		11/29/79
Specialist		11/29/79
Proj Engr		12/19/79
Qual Assur		12-1-79
Mtrls Engg		12/6/79
Const Dept		12/4/79

3.7.10 Completing the Joint 39.48

After joints have been completed and fully inspected, clean 39.51
all unpainted conductors including the welds with thinner.

3.8 INSTALLING OVERHEAD CONDUCTORS 39.56

3.8.1 The Contractor shall string and sag the 138 kv cables 39.59
from the switchyard to the main transformer area. 40.1

3.8.2 All cables, insulators and connectors as specified in 40.5
the bills of material shall be furnished to the Contractors.
Insulators and insulator hardware shall be assembled and 40.6
installed by the Contractor as shown on the drawings. Care 40.8
shall be exercised in handling and erecting insulators to
prevent chipping of porcelain. Any chipped or damaged 40.10
insulators must be replaced by the Contractor.

Conductors shall be carefully strung to prevent kinking, 40.13
twisting or damaging in any manner.

All conductors and wires shall be sagged in accordance with 40.16
approved transmission practice and sag tables shown on the
drawings.

Jumpers and connections to substation equipment, conductor 40.19
terminals shall be included in this work.

3.9 SEPARATION CRITERIA FOR RACEWAYS AND CABLES 40.23

3.9.1 Purpose 40.26

3.9.1.1 The purpose of these criteria is to define the 40.28
requirement for separation of raceway and cable systems 40.29
which are not adequately covered by other sections of this 40.31
specification or are not shown on the drawings.

3.9.2 General Separation Criteria 40.34

3.9.2.1 All cables shall be separated into raceways by 40.36
service class such as power, control, instrumentation, etc. 40.37

Safety related cables of each service class shall also be 40.40
separated into raceways by redundant system divisions.
There are three divisions of separation for the Engineered 40.41
Safety Features Systems. To ensure proper separation, each 40.42
safety related cable and raceway shall be identified by a
color code marking. Division I shall be red, Division II 40.43
shall be blue, and Division III shall be orange.

Safety related cables of the reactor protection system shall 40.45
be run in rigid steel conduit. Cables and conduit shall be 40.46
identified by nine two color code markings.

Nonsafety related cables and raceways shall have no color code marking. 40.48

Cables having different color codes or color coded cables and noncolor coded cables shall not be run in the same raceway. 40.50 40.51

Refer to "Electrical Cable Schedule Information System" document for instructions in determining color code from the cable or raceway numbers which appear in the documents and design drawings. 40.53 40.54

3.9.3 Specific Separation Criteria 40.57

3.9.3.1 These separation criteria are based on the following except as otherwise noted: 40.59 41.1

1. Trays are ladder type. 41.5
2. Cable splices in raceways are prohibited. 41.6
3. All cables are fire-retardant construction. 41.7

3.9.3.2 Although conduit is shown diagramatically on the drawings, color-coded conduit shall follow the general location shown on the drawings where possible. As a minimum in nonhazardous areas, redundant conduit shall be separated vertically 5 ft and horizontally 3 ft. For the cable spreading area, relay room, and control room redundant conduit shall be separated vertically 3 ft and horizontally 1 ft. Safety and nonsafety conduit shall be separated by a minimum of 1 in. Where the above criteria cannot be met the separation must be to the extent physically possible and the exception shall be documented by construction. For hazardous areas separations of raceways are evaluated by engineering and design and shall be as defined in applicable drawings. No major deviation in routing of raceway from the drawings should be taken without approval by engineering. 41.11 41.13 41.14 41.15 41.16 41.17 41.18 41.19 41.20 41.21

Conduit may be grouped as indicated below, provided that a minimum separation of 1 in. is maintained between conduit within each group. 41.23 41.24

Conduit Code	Group I	41.27
R	Red (Div. I ECCS)	41.29
A	*Red/White (RPS Chan. IA)	41.30
C	Blue/White (RPS Chan. I.B)	41.31
N	Black (Nonclass IE)	41.32
I	**Red/Green (RPS Scram Gr. 3)	41.33
M	**Yellow/Green (RPS Scram Gr. 4)	41.34

Conduit Code	Group II	
		41.38
B	Blue (Div. II ECCS)	41.40
S	Red/Yellow (RPS Chan. IIA)	41.41
T	*Blue/Yellow (RPS Chan. IIB)	41.42
N	Black (Nonclass 1E)	41.43
J	**Blue/Green (RPS Scram Gr. 1)	41.44
L	**Purple/Green (RPS Scram Gr. 2)	41.45
Conduit Code	**Group III**	41.48
O	Orange (Div. III ECCS)	41.50
N	Black (Nonclass 1E)	41.51
K	Orange/Green (RPS Backup Scram)	41.52
Conduit Code	**Group IV**	41.56
G	***Green (LPCI)	41.58
Conduit Code	**Group V**	42.2
Y	Yellow (LPCI)	42.4

*Conduit containing APRM (1C51) cables between the transducers and panel 1H11*PNL-608 require four channel separation. These Conduit shall be separated from remainder of group. 42.10 42.11 42.12

**General grouping allowed; however, minimum separation between RPS scram groups within conduit group shall be a minimum of 2 ft except over the Hydraulic Control units at El. 78 ft or reactor building where separation may drop to 1 in. between any of four RPS scram groups. 42.14 42.15 42.16 42.17 42.18

***Low Pressure Core Injection 42.21

3.9.3.3 Cable tray spacing shall normally be shown on the drawings. Color coded horizontal trays shall be separated from horizontal trays of a redundant color by a minimum distance of 3 ft horizontally and 5 ft vertically in nonhazardous areas and 1 ft horizontally and 3 ft vertically in the cable spreading area. Horizontal separation shall be measured from the side rail of one tray to the adjacent side rail of the other tray. Vertical separation shall be measured from the bottom of the upper tray to the bottom of the lower tray (see Figure 1). 42.24 42.25 42.26 42.28 42.29

Color coded cable tray risers in nonhazardous areas shall be separated from trays of a redundant color code by a minimum distance of 3 ft. 42.31

Where space is a problem, the drawings may call for color coded cable to be run in solid trays with solid nonventilated covers. These trays shall be separated from trays of a different color by a minimum of 1 in., whether in a horizontal run or vertical riser configuration. Separation requirements for the above configurations are illustrated by Figures 3 and 4.

In nonhazardous areas, color coded horizontal trays shall be separated from noncolor coded horizontal trays by a minimum of 1 in. horizontally and 1 ft vertically. The separation distance shall be measured as described above. Color coded tray risers shall be separated from noncolor coded trays by a minimum of 1 ft measured from tray bottom to tray bottom and 1 in. measured side rail to adjacent side rail. The above configurations are illustrated by Figure 2.

Figure 7 illustrates acceptable methods of transferring cables from a vertical riser to a horizontal tray in a mixed bank of color coded and noncolor coded trays. Figure 8 illustrates a similar situation except, in this case, the noncolor coded cable must pass between two color coded trays.

Figures 3, 4, 5, and 6 illustrate acceptable schemes making use of barriers where separation is otherwise not acceptable.

Figure 9 illustrates various acceptable schemes for transferring cables from a horizontal bank of mixed color coded and noncolor coded trays to control and relay boards on the floor above.

Separation in hazardous areas (as defined in the Licensing document) shall be provided as indicated on the drawings.

3.9.3.4 Noncolor coded trays are generally separated vertically by a minimum of 1 ft measured from the bottom of a side rail of the upper tray to the bottom of the side rail of the lower tray. The drawings may indicate a separation or less than 1 ft where required by space limitations. Horizontal separation shall be 1 in. minimum measured from side rail to side rail.

3.9.3.5 Field installed cables routed within equipment shall be arranged to meet the following separation requirements:

Red	Blue	Orange / Green	Yellow
*Red/white	*Red/yellow		
*Blue/white	*Blue/yellow		

Red/green	Blue/green	43.13
Yellow/green	Purple/green	43.15
	**Black	43.17

Notes: Vertical lines in the above table indicate either a minimum of 6 in. air space properly installed flexible conduit over one color or an approved barrier similar to Figure 10 Section 3.9.5. 43.22 43.23

Horizontal lines in the table indicate separately bundled cables supported so that the different color coded bundles are not bound together. 43.26 43.27

*RPS/APRM (C51) wiring must meet four channel separation; i.e., 6 in. air space, properly installed flexible conduit or an approved barrier must be installed between Red/white and Blue/white and between Red/yellow and Blue/yellow. 43.28 43.30

**Black annunciator and computer cables may be bundled with safety related "x" cables where necessary. 43.31

The same separation philosophy shall be applied between unprotected field installed cables and exposed internal wiring. 43.32 43.33

If the design of the equipment is not conducive to 6 in. separation nor approved barrier installation, the cable jacket shall be left on the cable for mechanical protection to the extent possible within the panel. In this case, cable jackets shall be stripped back preferably only to the termination. This shall be done specifically for the 4,160 v switchgear. Other equipment where separation/barriers are not provided should be documented by E&DCR for disposition by the Engineers. 43.37 43.38 43.39 43.40 43.41 43.42

3.9.4 Tray Covers 43.45

3.9.4.1 Tray covers shall be provided in accordance with the following criteria: 43.47

3.9.4.2 In areas such as the turbine room, office and service building, radwaste building, certain manholes, auxiliary boiler room and motor generator rooms where Class 1E trays are not present, no covers are required except for the top tray of a bank under grating only. Solid 43.50 43.51 43.53

nonventilated covers shall be provided except on H and L trays which shall have solid side ventilated covers.

3.9.4.3 Solid trays shall have solid covers everywhere. 43.55

3.9.4.4 Types of covers and fastenings to be installed on cable trays shall be as follows: 43.57 43.58

1. For horizontal, ladder type, H and L trays, use side-ventilated corrugated covers, Husky Category No. COS-( ) with Category No. JCC cover clips. 44.2 44.3

2. For horizontal, ladder type, H and L trays which require raised covers because large triplexed cables extend above the side rail, use flanged solid covers, Husky Category No. CFF-( ) with 1 in. standoff cover clips, Husky Category No. JCS-1-0, Dwg. No. 52761. 44.6 44.7 44.9 44.11

3. For horizontal, ladder type, K, C, and X trays, use flanged solid covers, Husky Category No. CFF-( ) with Category No. JCC cover clips. 44.13 44.14

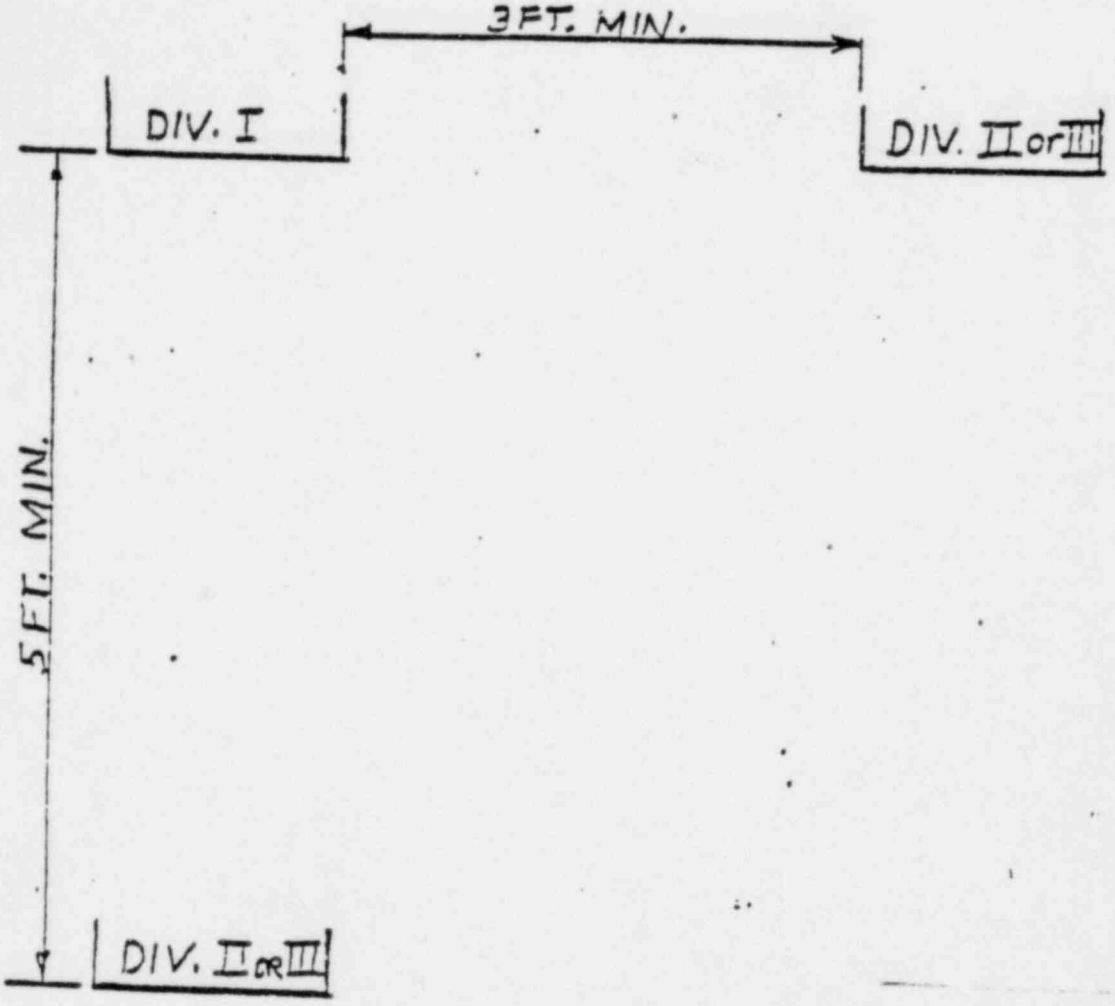
4. For vertical, ladder type, H, L, K, C, and X trays, use flanged solid covers, Husky Category No. CFF-( ) with Category No. JCC cover clips. 44.17 44.18

5. For vertical, ladder type, H and L trays which require raised covers because large triplexed cables extend above the side rail, use solid top hat covers, Husky Category No. C2S-( ) with Category No. JCC cover clips. 44.21 44.22 44.24

6. For vertical, solid type, H, L, K, C, and X trays, use flanged solid covers, Husky Category No. CFF-( ) with Category No. JCC clips. 44.27 44.28

7. For vertical, solid type, H and L trays which require raised covers because large triplexed cables extend above the side rail, use solid type top hat covers, Husky Category No. C2S( ) with Category No. JCC clips. 44.31 44.32 44.33

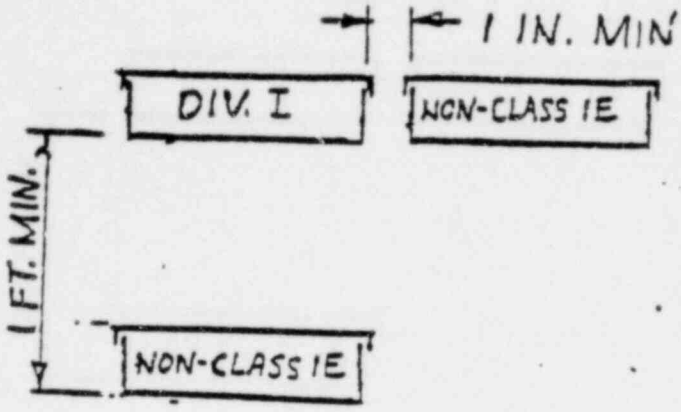
( ) Indicates Category No. of cover must be completed by inserting full Category No. of tray or fitting on which cover is to be used. 44.35 44.36



NOTES:

1. ALL TRAYS ARE LADDER TYPE.
2. SEPARATION DISTANCES ARE ACCEPTABLE FOR EITHER HORZ. RUNS OR VERT. RISERS.

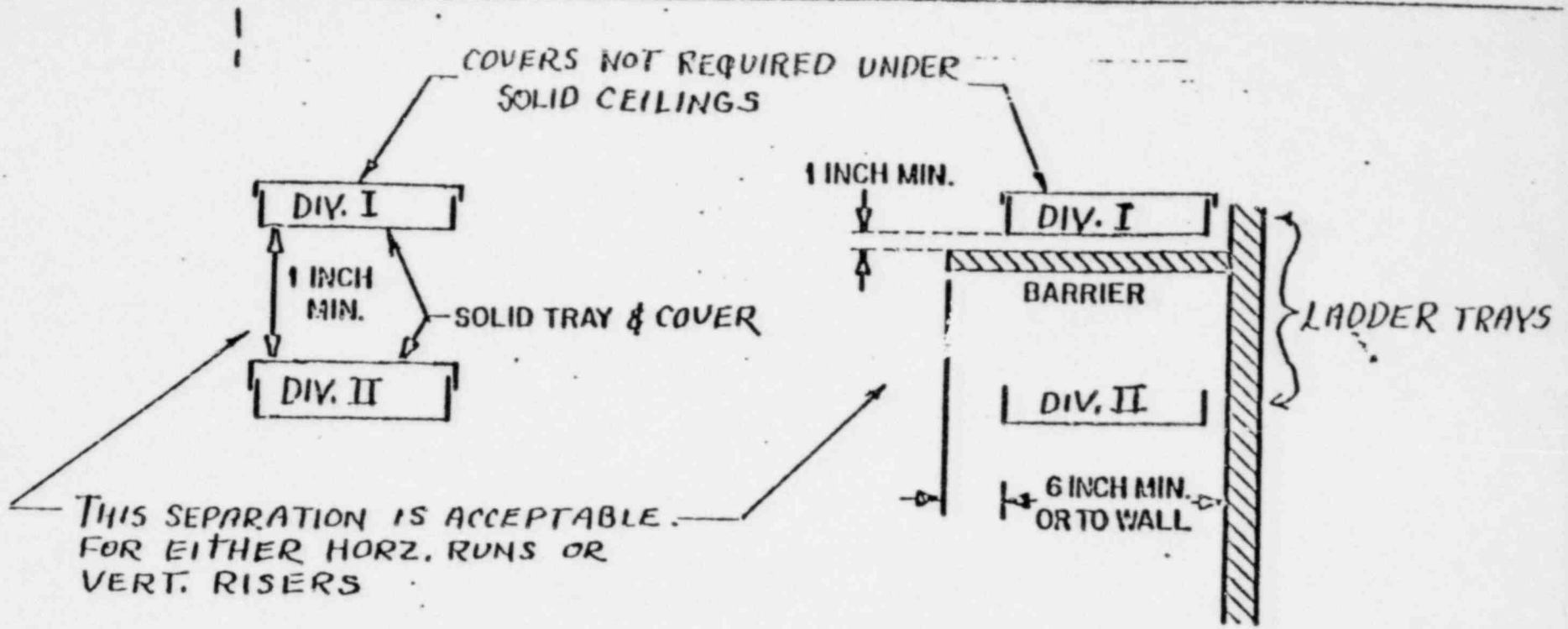
CHECKED		FIG. 1 EXAMPLE OF ACCEPTABLE SEPARATION IN NON-HAZARD. AREAS BY DISTANCE ONLY. SHOREHAM NUCLEAR POWER STA. - UNIT 1	
CORRECT			
APPROVED			
DATE			
REVISIONS			



NOTES:

1. TRAYS ARE LADDER TYPE WITH SOLID COVERS.
2. SEPARATION DISTANCES ARE ARE ACCEPTABLE FOR EITHER HORIZONTAL RUNS OR VERTICAL RISERS.

CHECKED		FIG. 2 EXAMPLE OF ACCEPTABLE SEPARATION IN NON HAZARDOUS AREAS BETWEEN CLASS 1E AND NON-CLASS 1E TRAYS. SHOREHAM NUCLEAR PWR. STA. - UNIT 1	
CORRECT			
APPROVED			
DATE			
REVISIONS			



J-62

FIG. 3

EXAMPLE OF ACCEPTABLE ARRANGEMENT WHERE VERTICAL SEPARATION DISTANCE CANNOT BE MAINTAINED-NON-HAZARD AREAS

SHOREHAM NUCLEAR POWER STATION - UNIT 1

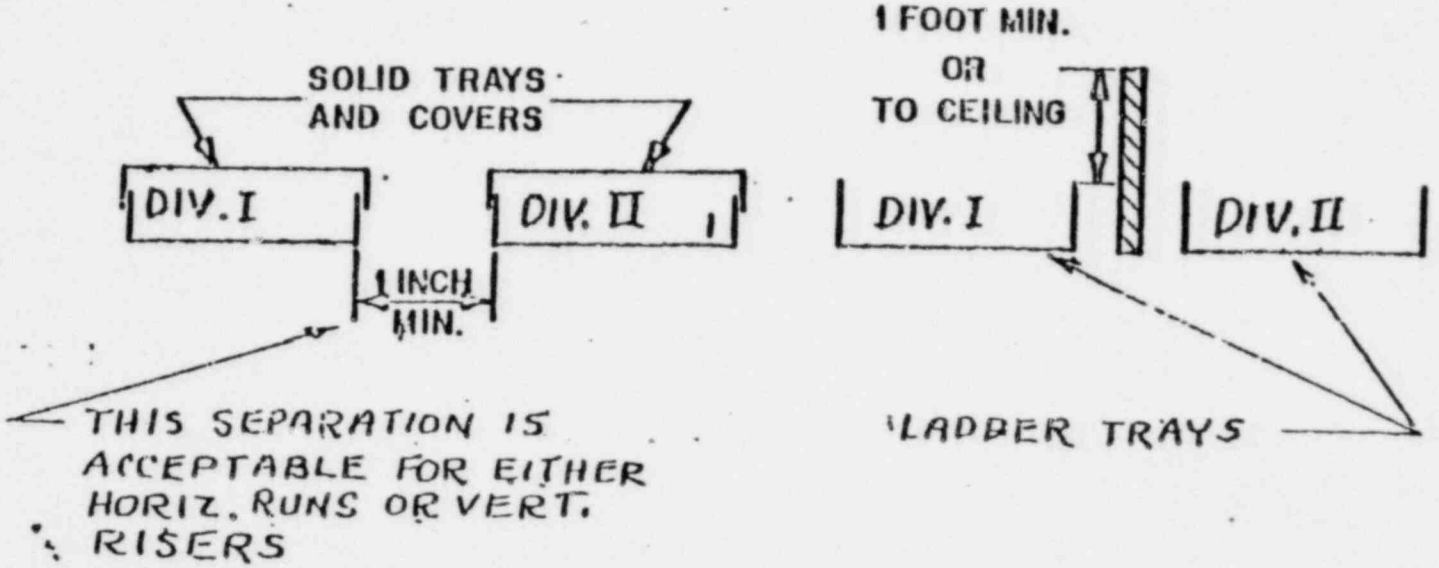
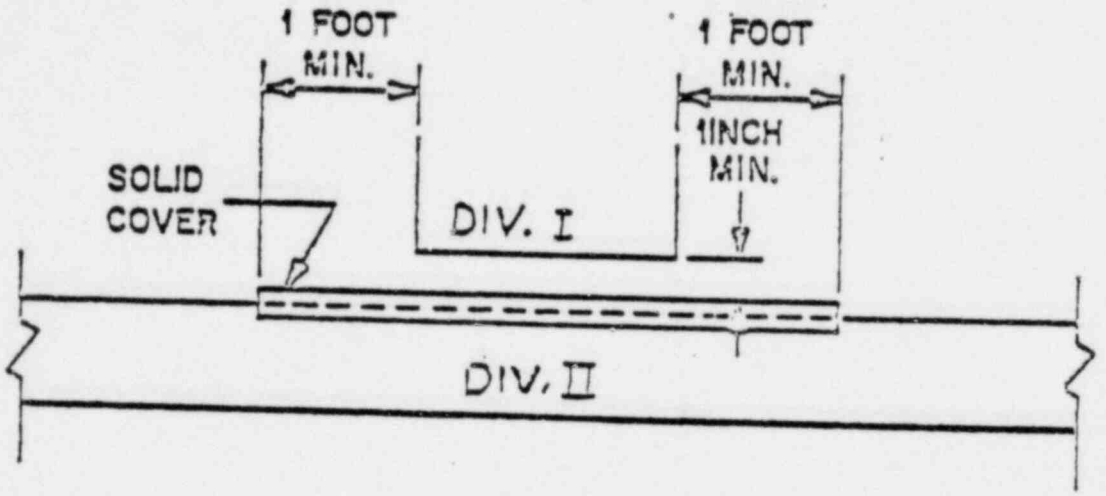


FIG 4

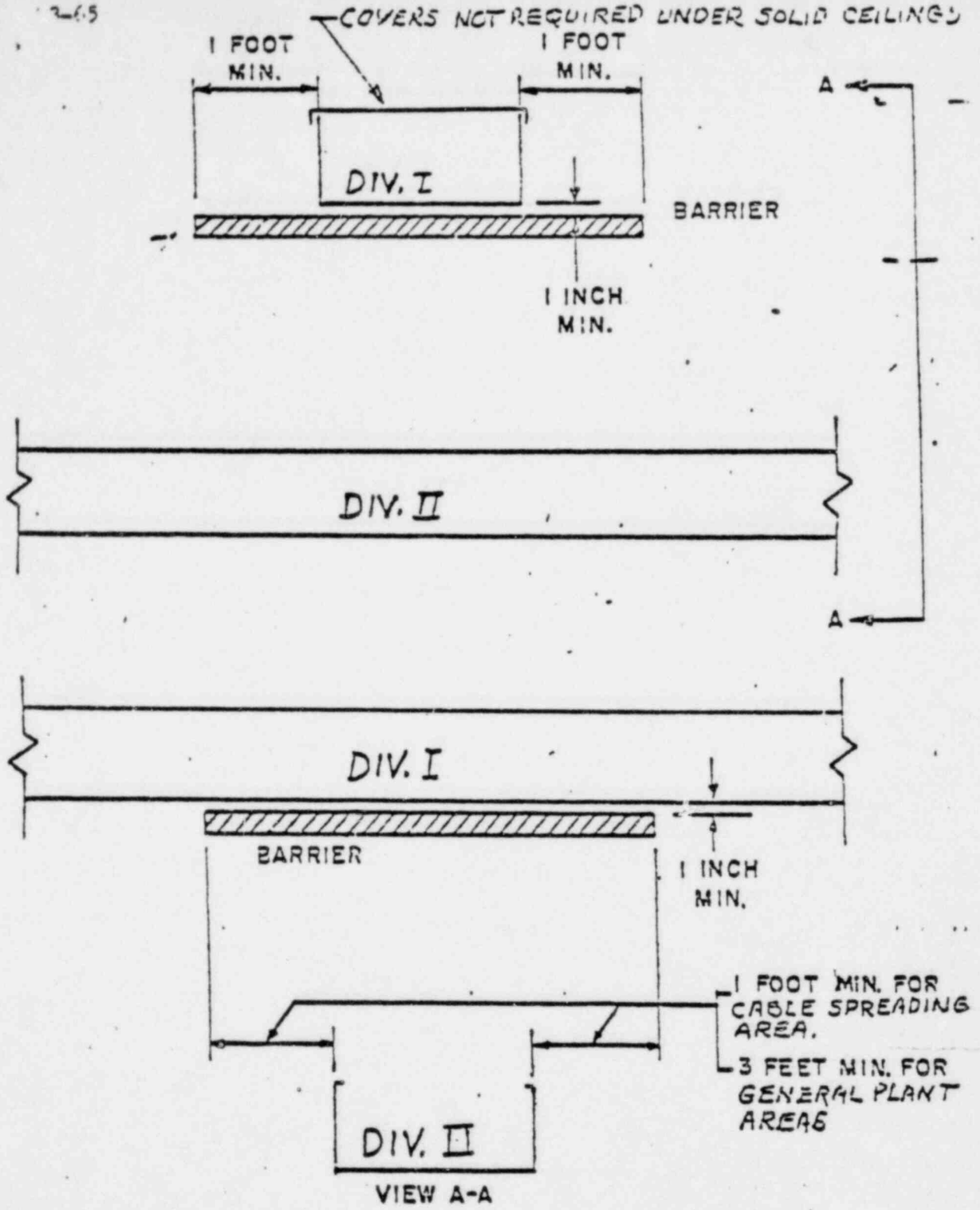
EXAMPLE OF ACCEPTABLE ARRANGEMENT IN NON-HAZARD. AREAS WHERE SEPARATION DISTANCE CAN NOT BE MAINTAINED

SHOREHAM NUCLEAR POWER STATION - UNIT 1



NOTE: TRAYS ARE LADDER TYPE

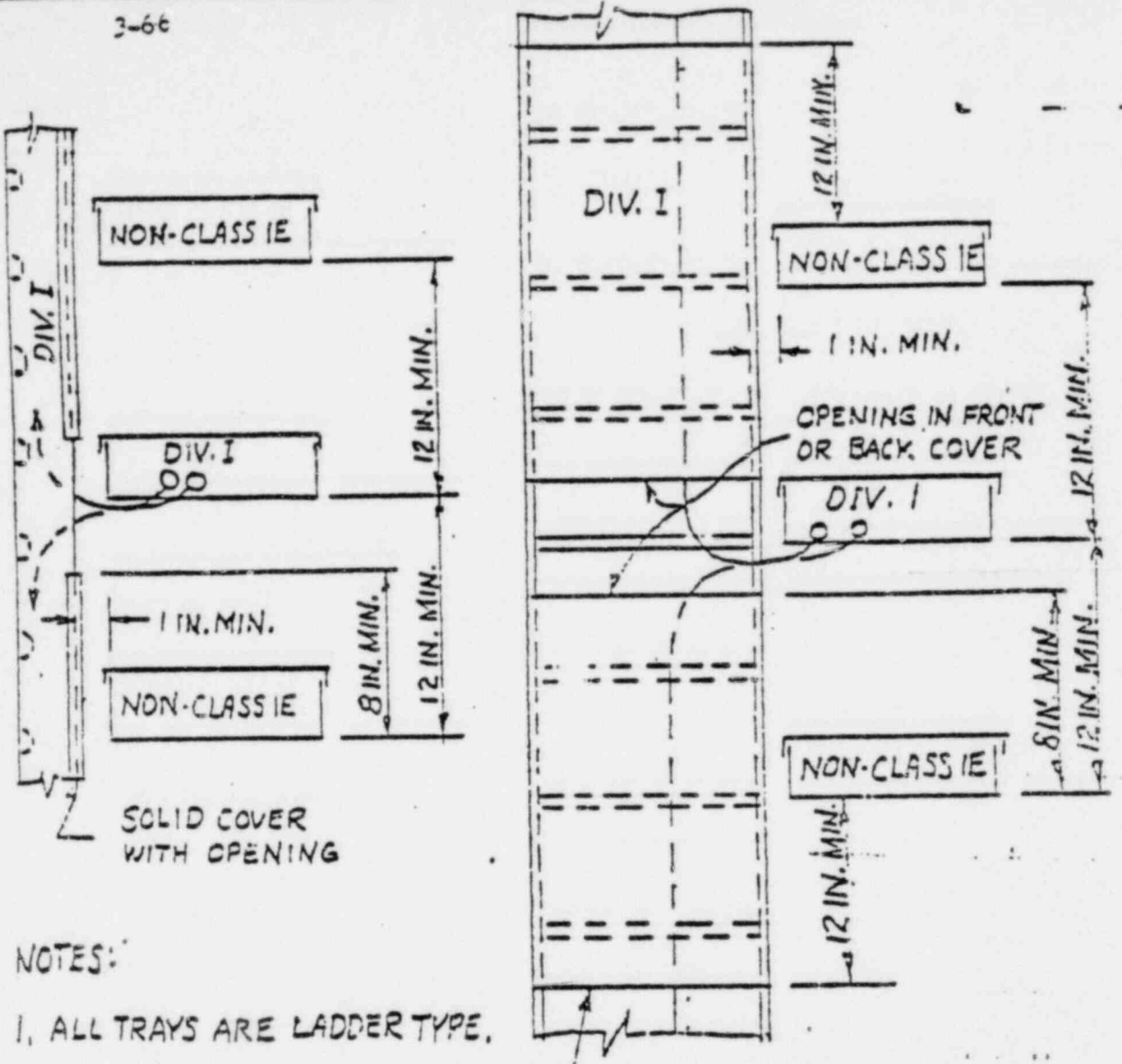
FIG. 5
EXAMPLE OF ACCEPTABLE ARRANGEMENT FOR REDUNDANT CABLE TRAY CROSSINGS IN NON-HAZARDOUS AREAS WHERE SEPARATION DISTANCE CAN NOT BE MAINT.
SHOREHAM NUCLEAR POWER STATION - UNIT 1



NOTE: TRAYS ARE LADDER TYPE

FIG. 6
EXAMPLE OF ACCEPTABLE ARRANGEMENT FOR REDUNDANT CABLE TRAY CROSSINGS IN NON-HAZARDOUS AREAS WHERE SEPARATION DISTANCE CAN NOT BE MAINT.
SHOREHAM NUCLEAR POWER STATION - UNIT 1

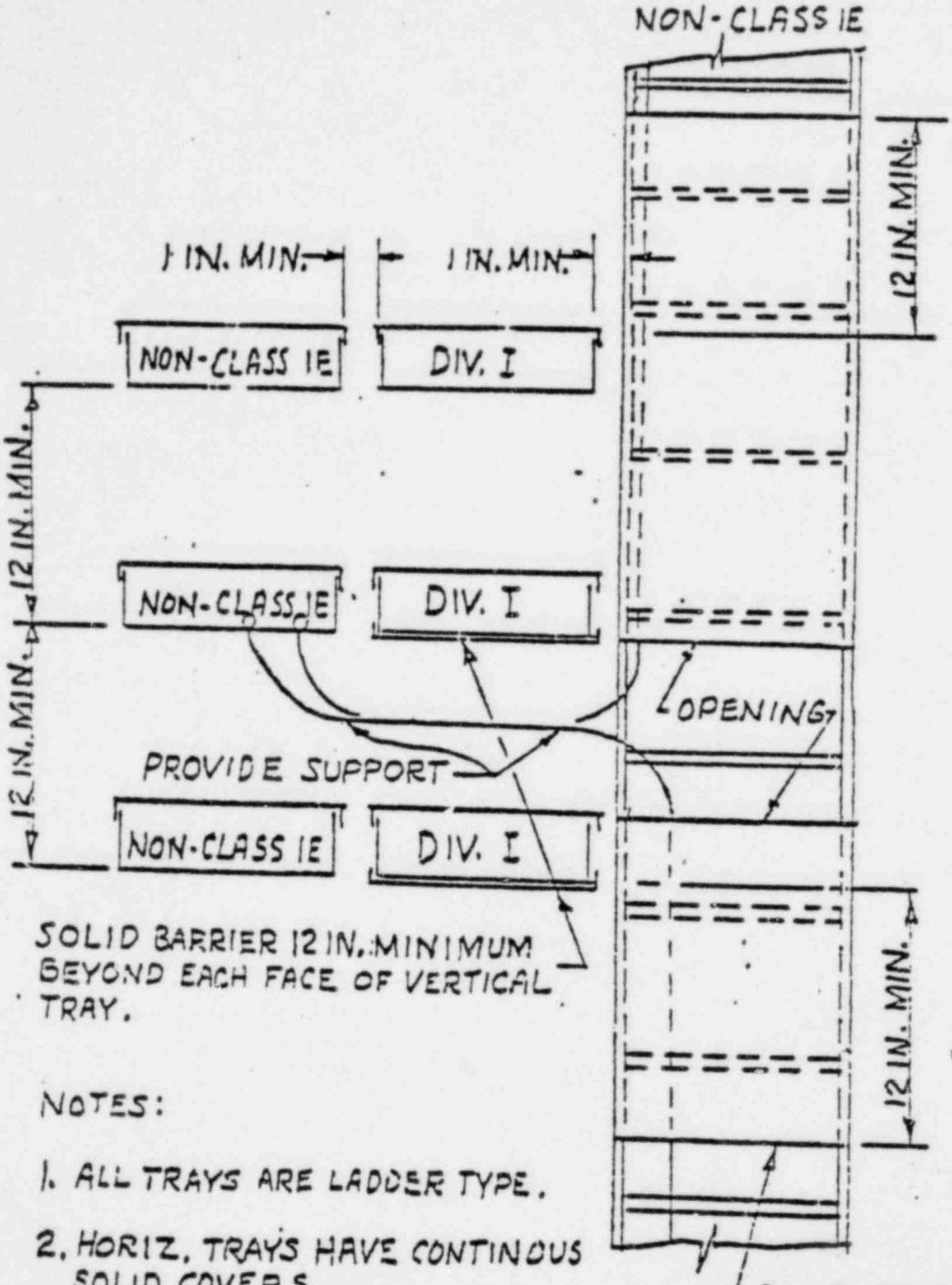
3-66



NOTES:

1. ALL TRAYS ARE LADDER TYPE.
2. HORIZ. TRAYS HAVE CONTINUOUS SOLID COVERS.
3. EDGES OF COVER OPENING SHALL BE ROLLER OR COVERED TO PROTECT CABLE.
4. THESE EXAMPLES SHALL ALSO APPLY WHEN DIV. I AND NON-CLASS IE TRAY POSITIONS ARE INTERCHANGED.

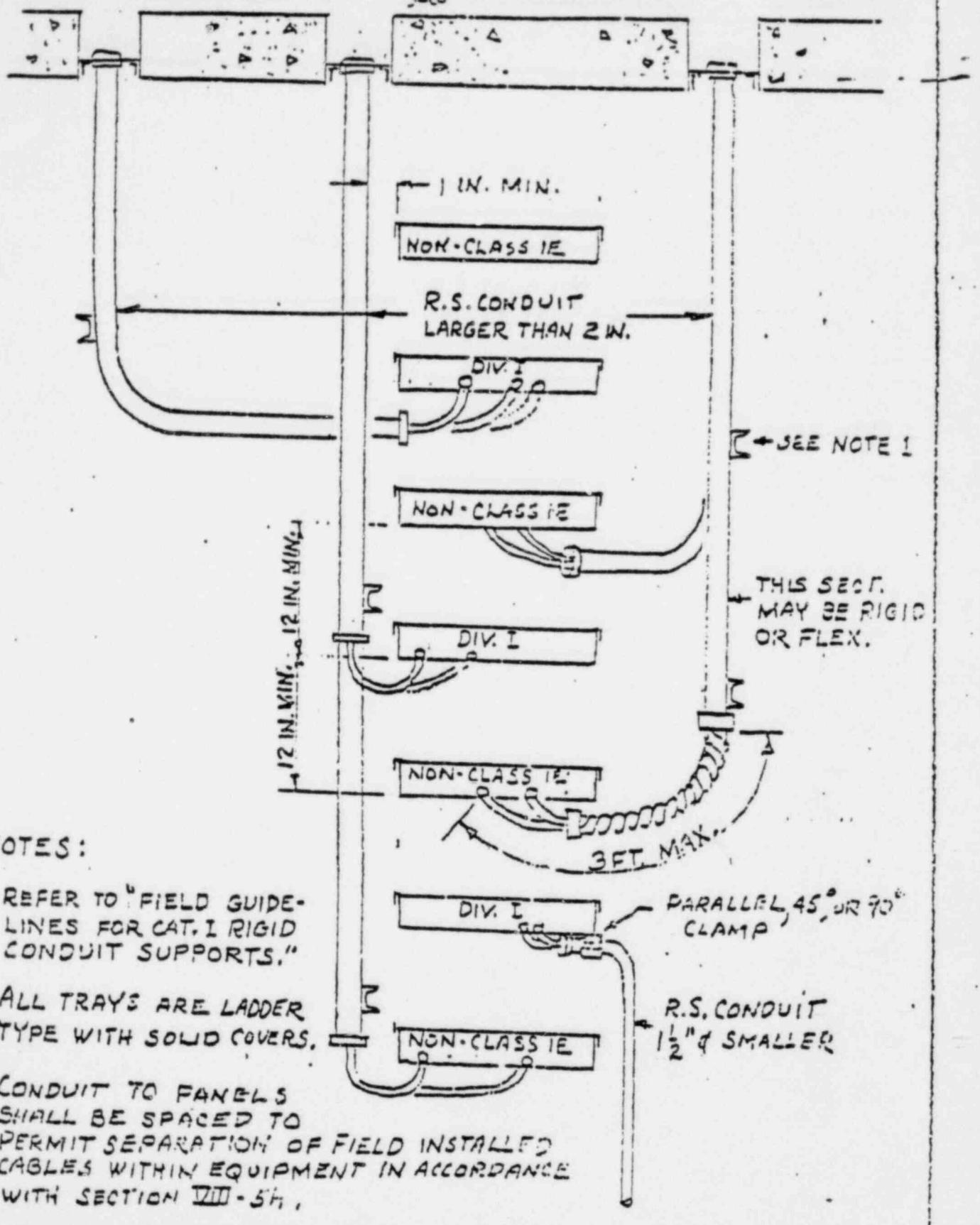
CHECKED		EXAMPLES OF ACCEPTABLE SEPARATION FOR NON-HAZARDOUS AREAS. SHORTHAM NUCLEAR POWER STA.-UNIT 1	FIG. 7
CORRECT			
APPROVED			
DATE			
REVISIONS			



NOTES:

1. ALL TRAYS ARE LADDER TYPE.
2. HORIZ. TRAYS HAVE CONTINOUS SOLID COVERS
3. EDGES OF COVER OPENING SHALL BE ROLLED OR COVERED TO PROTECT CABLE.
4. THIS EXAMPLE SHALL ALSO APPLY WHEN DIV. I AND NON-CLASS IE TRAY POSITIONS ARE INTERCHANGED

CHECKED		EXAMPLES OF ACCEPTABLE SEPARATION FOR NON-HAZARDOUS AREAS. SHOREHAM NUCLEAR POWER STA. UNIT 1	FIG. 8
CORRECT			
APPROVED			
DATE			
REVISIONS			



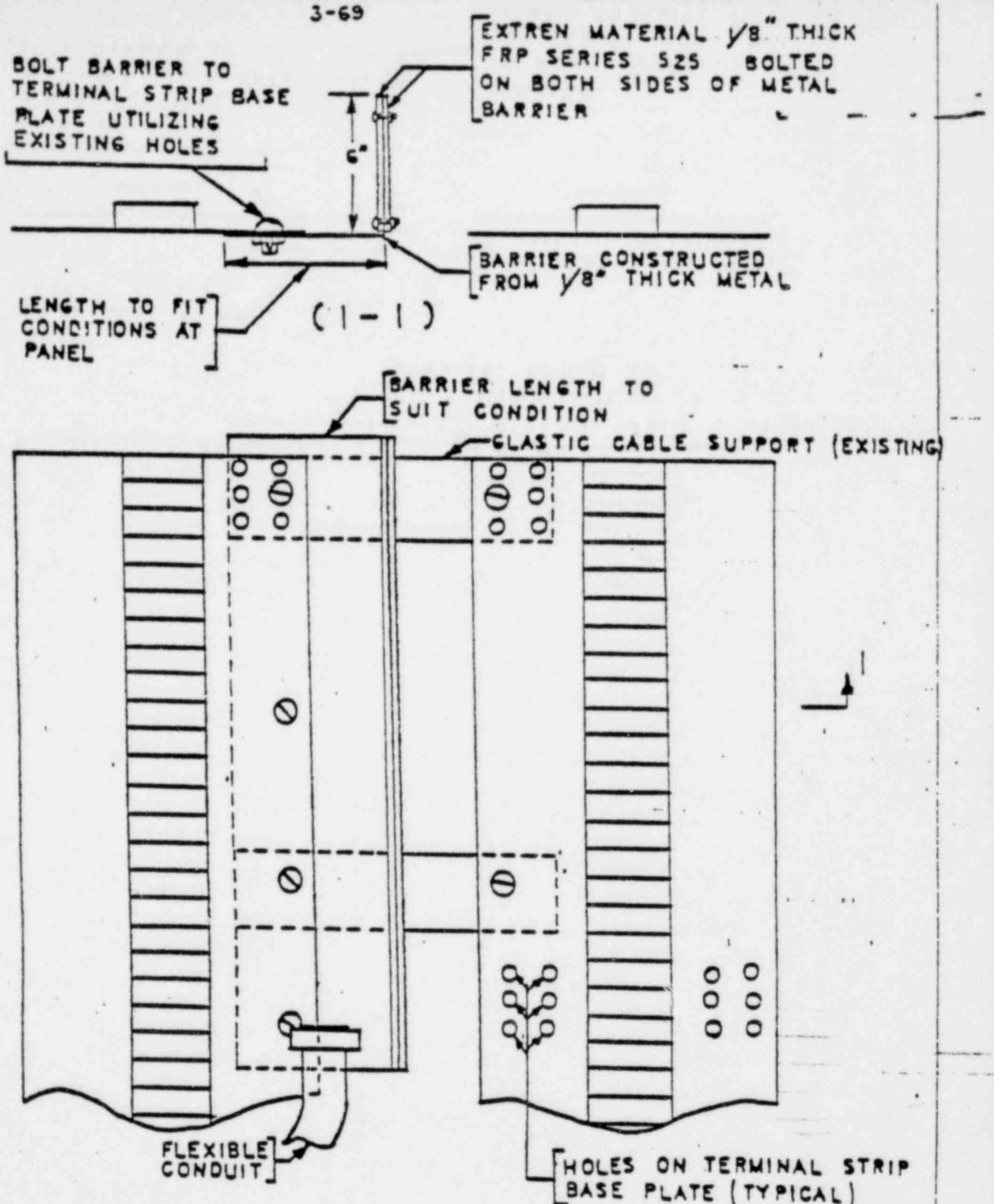
NOTES:

1. REFER TO "FIELD GUIDE-LINES FOR CAT. I RIGID CONDUIT SUPPORTS."
2. ALL TRAYS ARE LADDER TYPE WITH SOLID COVERS.
3. CONDUIT TO PANELS SHALL BE SPACED TO PERMIT SEPARATION OF FIELD INSTALLED CABLES WITHIN EQUIPMENT IN ACCORDANCE WITH SECTION VIII-5H.

CHECKED	
CORRECT	
APPROVED	
DATE	
REVISIONS	

EXAMPLES OF ACCEPTABLE SEPARATION OF CABLE AND CONDUIT IN THE CABLE SPREADING AREA
SHOREHAM NUCLEAR POWER STA. UNIT 1

FIG. 9



CHECKED	TITLE EXAMPLE OF ACCEPTABLE METAL BARRIER SEPARATION	SCALE: NONE	
CORRECT		DATE:	
APPROVED	LILCO SNPS 1		
REVISIONS (2) (3) (4) (5)		FIGURE 10	

EXHIBIT 2

SEPARATION OF ELECTRIC EQUIPMENT:

PLANT WIDE FIELD AUDIT PROCEDURE

LaSalle County Station

July 1, 1980

(pages 1 to 11)

La Salle County Station
Units 1 & 2

Separation of Electrical Equipment
Plant Wide Field Audit
Procedure

Project No. 4266-02

Commonwealth Edison Company

Prepared by:

Sargent & Lundy Engineers
Chicago

R. F. Carlton
R. H. Sadlowski

July 1, 1980

La Salle County Station
Units 1 & 2

Separation of Electrical Equipment
Plant Wide Field Audit
Procedure

Issue Summary

Rev. No.	Issue Date	Purpose of Issue
0	7-1-80	Comments

La Salle County Station
Units 1 & 2

Separation of Electrical Equipment
Plant Wide Field Audit
Procedure

Table of Contents

La Salle County Station
Units 1 & 2

Separation of Electrical Equipment
Plant Wide Field Audit
Procedure

1. Scope

1.1 Perform a detailed field audit to verify that the installed electric equipment and systems conform to the separation criteria described in the La Salle Final Safety Analysis Report (FSAR), subsections 8.3.1.3 and 8.3.1.4 as projected in Electrical Work Specification J-2559. The audit shall include a sample of not less than 10% of the installed Safety-Related equipment and cables.

2. General

2.1 The audit shall be conducted by a Separation Task Force Audit Team (Task Force) consisting of an engineer Task leader with supporting engineering and technical personnel designated by Sargent & Lundy and the Owner, who are familiar with separation criteria, standards and guides as they apply to the La Salle County Station electrical equipment and systems. No member of the Task Force shall have participated in the design and installation of any equipment and systems subject to this audit.

2.2 The existing onsite Commonwealth Edison Construction Offices shall be used by the Task Force for an audit control center. (Telephone

2.3 The Owner shall designate a participating staff (CECo) Task Force member as Safety Coordinator to perform liaison functions between Operations/Construction forces and the Task Force. The Safety Coordinator shall arrange for tags or clearances, when required, for access to energized circuits, electrical equipment, panels, enclosures, switchgear and motor control centers. In addition, he shall arrange for scaffolding, ladders or other items required to visually inspect cable trays or enclosures which are not readily accessible.

2.4 The audit shall include samples of (but not limited to) the following general categories:

a. Separation of redundant Class 1E equipment.

b. Separation of redundant Class 1E cables.

General (Cont'd)

2.4 (Cont'd)

c. Separation of associated circuits.

d. Identification (marking) of redundant Class 1E equipment and cables.

e. Identification (marking) of associated circuits to a level indicative of the Class 1E with which they are associated.

f. Separation of redundant wiring, indicators and controls at panels and control boards.

2.4.1 The audit will include a review of conduit and conduit supports, cable tray and cable tray supports, cable in conduit and trays, cable at control boards, and control board wiring for portions of those systems listed in Table 1.

2.4.2 The specific equipment and systems to be audited are shown on Separation Audit Forms and Cable Tabs which are listed in Table 2.

2.4.3 Separation violations discovered during the audit of equipment and systems which do not appear in Table 2 shall be documented on additional Separation Audit Forms. Miscellaneous items will be listed in Table 2A and will form an integral part of this audit.

3. Audit Criteria

3.1 The safety evaluation report for La Salle County Station construction permit was issued on September 10, 1973. Since Regulatory Guide (RG) 1.75 (Rev. 1) "Physical Independence of Electrical Systems" applies to plants whose safety evaluation report was issued after February 1, 1974, compliance with RG 1.75 shall be in accordance with LSCS FSAR Appendix B, Amendment 48, Page B.194.

3.2 Independence of redundant Class 1E systems and equipment shall be installed to ensure availability during any design-basis event as described in FSAR subsection 8.3.1.4 "Physical Independence of Redundant Systems," 8.3.1.4.2.2 "Cable Routing Criteria" and 8.3.1.3 "Physical Identification of Safety-Related Equipment." These criteria are transmitted to the field by the La Salle Electrical Installation Work Specification J-2559, Amendment 2, dated December 13, 1978.

3.3 Cable fire protection shall comply with FSAR subsections 8.3.3.2, 8.3.3.3, 8.3.1.4.2 and FSAR Appendix H, Fire Hazards Analysis.

Audit Criteria (Cont'd)

3.4 The criteria referred to in paragraphs 3.2 and 3.3 (above) shall be the basis for performing this audit.

4. Systems Selected for Audit

4.1 The audit shall be performed on sample portions of systems and related electric equipment as shown in Table 2. The approximate total number of Class 1E cables installed for each system and those to be audited are also included.

4.2 The cables selected represent a variety of physical locations; i.e., the AP system represents portions of various switchgear and motor control centers, DG represents cables related to each diesel generator, etc.

5. Audit Procedure

5.1 The Task Force shall review those cables, raceways and equipment listed in Table 2, to verify that the Installer has properly implemented the design referred to in paragraphs 3.2 and 3.3.

5.2 The Task Force auditor shall visually verify that cable routing, raceway separation, control panels and boards, terminations, barriers, isolation devices and equipment identification do not present deficiencies that, under single failure conditions, could result in the simultaneous loss of redundant safety-related equipment with possible subsequent loss of safety function. Any violation of the separation criteria shall be considered as a deficiency.

5.3 Field audit forms listed in Table 2, shall be used with the respective Cable Tab, for recording data.

5.4 Those criteria listed in paragraphs 3.2 and 3.3 are assigned identification numbers for use in this audit as shown in Table 3. The Task Force shall become familiar with contents and numbering system assigned to various separation criteria described.

6. Separation, Identification and Fire Barrier Requirements

6.1 Separation, identification and fire barrier requirements referred to in Table 3 shall be used by the Task Force to record deficient or acceptance items for those cables included on the Audit Forms.

Separation, Identification and Fire Barrier Requirements (Cont'd)

6.2 Missile, high energy pipe and Fire Hazard Areas shall be considered those shown on Sargent & Lundy Electrical Installation Drawings. The Task Force shall be alert to observe additional areas that may be hazardous to redundant electrical systems and equipment and shall document them in accordance with paragraph 2.4.3 of this procedure.

6.3 Segregation codes shall meet the requirements of Tables 4 and 5.

7. Audit Progress

7.1 A Task Force member shall periodically meet with a Representative designated by the Owner, to discuss audit progress and to evaluate audit findings.

7.2 The Owner shall designate a time and location for such meetings.

8. Audit Results

8.1 The audit results shall be prepared by the Task Force in a report format which is acceptable to the Owner, for transmittal to the NRC.

8.2 The results shall contain a discussion of the corrective action taken for those items found deficient during the audit.

8.3 In the event a large number of deficient items are discovered during this audit, the report to the NRC shall contain the Owner's proposal for any additional audit.

Dated 7-1-80

Table 1

Systems Selected for Audit

AP	- Auxiliary Power
DC	- Battery and DC Distribution
DG	- Diesel Generator
DO	- Diesel Fuel Oil
HG	- Primary Containment Instrument Nitrogen
HP	- HPCS
LC	- MSTV Leakage Control
LD	- Leak Detection
LP	- LPCS
NB	- Auto Depressurization
NR	- Neutron Monitoring
PC	- Primary Containment and Reactor Vessel Isolation
RH	- RHR
RI	- Reactor Core Isolation Cooling
RP	- Reactor Protection
SC	- Standby Liquid Control
VC	- Control Room - Aux. Elect. Rm. HVAC
VD	- Diesel Generator Room Vent
VE	- Auxiliary Elect. Equip. Rm. Ventilation
VG	- Standby Gas Treatment System Vent
VX	- Switchgear Heat Removal
VY	- Core Standby Cooling System Equip. Cooling (CSCS)

Table 7

Index

Separation Audit Forms and Cable Tab Page Numbers

System	Total No. of Safety-Related Cables	Total No. of Associated Cables	No. of Safety-Related Cables to be Audited	No. of Associated Cables to be Audited	Cable Tab Pg. No.	Audit Form Pg. No.
AF	66	63	8	8	AF07	AF1 of 5
					AF09	AF2 of 5
					AF17	AF3 of 5
					AF31	AF4 of 5
					AF32	AF5 of 5
DC	31	36	4	4	DC01	DC1 of 2
					DC04	DC2 of 2
DG	112	27	12	4	DG01	DG1 of 4
					DG02	DG2 of 4
					DG04	DG3 of 4
					DG13	DG4 of 4
DS	18	18	3	3	DS04	DS1 of 1
HC	35	9	6	3	HC02	HC1 of 2
					HC04	HC2 of 2
HP	162	72	17	7	HP01	HP1 of 3
					HP21	HP2 of 3
					HP25	HP3 of 3
LC	173	23	17	4	LC07	LC1 of 3
					LC08	LC2 of 3
					LC15	LC3 of 3
LD	71	145	8	15	LD02	LD1 of 3
					LD09	LD2 of 3
					LD10	LD3 of 3
LP	43	34	6	4	LP01	LP1 of 1
NB	294	219	28	21	NB01	NB1 of 7
					NB02	NB2 of 7
					NB12	NB3 of 7
					NB13	NB4 of 7
					NB18	NB5 of 7
					NB35	NB6 of 7
					NB73	NB7 of 7
NR	408	221	40	20	NR03	NR1 of 6
					NR14	NR2 of 6
					NR25	NR3 of 6
					NR38	NR4 of 6
					NR42	NR5 of 6
					NR44	NR6 of 6
PC	97	18	10	3	PC06	PC1 of 2
					PC13	PC2 of 2
RH	403	238	41	24	RH01	RH1 of 8
					RH02	RH2 of 8
					RH04	RH3 of 8
					RH14	RH4 of 8
					RH17	RH5 of 8
					RH40	RH6 of 8
					RH50	RH7 of 8
					RH51	RH8 of 8
RI	178	69	20	7	RI01	RI1 of 3
					RI02	RI2 of 3
					RI21	RI3 of 3
RP	302	42	30	4	RP03	RP1 of 7
					RP04	RP2 of 7
					RP08	RP3 of 7
					RP12	RP4 of 7
					RP23	RP5 of 7
					RP32	RP6 of 7
					RP42	RP7 of 7
SC	-	45	-	5	SC03	SC1 of 1
VC	151	12	15	2	VC02	VC1 of 3
					VC10	VC2 of 3
					VC15	VC3 of 3
VD	47	18	10	3	VD01	VD1 of 2
					VD03	VD2 of 2
VE	80	21	7	3	VE01	VE1 of 2
					VE11	VE2 of 2
VG	52	21	5	3	VG03	VG1 of 1
VX	34	15	4	2	VX03	VX1 of 2
					VX05	VX2 of 2
VY	51	29	6	3	VY01	VY1 of 2
					VY07	VY2 of 2

Table 3

Separation and Identification Requirements

Criteria Group 1
Physical Separation

Criteria	Condition	Physical Separation
1a	Cable tray within the same division	1. 1 foot vertical separation 2. 3 inch horizontal separation
1b	Cable tray or conduit of different divisions in Protected Zones (low probability of being subject to damage from missiles and/or conflagration)	1. 3 feet horizontal from side rail to adjacent tray side rail 2. 5 feet vertical from bottom of upper to top of lower tray 3. Where horizontal or vertical distance cannot be met, barriers of 1 inch transite and 6 inch air space shall be provided
1c	Cable tray or conduit of different divisions in Hazard Zones (high probability of being subject to damage from missiles and/or conflagration) Missile Areas: Turbine Bldg. (Main Floor); Reactor Feed Pump Turbines; Reactor Bldg. Operating Floor Fire (Conflagration Areas): Oil Storage Room; Turbine Oil Tanks Inside Turbine Shield Walls Beneath Main Floor; Diesel Fuel Oil Storage; Generator Hydrogen System	1. 20 feet separation or a 6 inch reinforced concrete wall
1d	Open cable trays of different divisions in General Plant Zones	1. 3 feet horizontal fire air space 2. 5 feet vertical fire air space 3. Fire resistant barrier with dimensions sufficient to maintain minimum free air spacing of 1 and 2 4. Where horizontal and vertical distances cannot be met, limitations of Criteria 1b shall be met
1e	Cable trays or conduits of different divisions that cross each other (in Protected Zones)	1. 12 inch vertical separation and tray must be covered for 5 feet each side of intersection of centerlines of trays
1f	Class 1E Control Boards and Panels of different divisions in Protected Zones (Control Room and Aux. Equip. Room)	1. Cables entering panel must have 3 foot separation between divisions 2. Where 3 foot separation cannot be met, cable of one division should be installed in conduit to a point where 3 foot separation is attained
1g	Class 1E Control Boards and Panels of different divisions in General Plant Zones	1. Not more than one division in panel 2. 1 inch air space between panels
1h	Containment Electrical Penetrations serving Class 1E Circuits (same division)	1. See Criteria 1a
1i	NSSS/PCIS, APS Systems	Routed in accordance with FSAR subsection 8.3.1.4.2.2
1j	Conduits within the same division	1 inch horizontal and vertical separation

Criteria Group 2
Identification

Criteria	Equipment	Identification
2a	Cable tray and conduit	In accordance with Table 4
2b	Cable	1. In accordance with Cable Tab 2. Cable tag with permanent material to each cable end and where it passes through a wall or an enclosure
2c	Nameplates	In accordance with Tables 4 & 5

EXHIBIT 3

LILCO LETTER TO NRC NO. SNRC-677 (3/11/82)

RESPONSE TO NRC INSPECTION 82-02

CONCERNING DEVIATION FROM FSAR COMMITMENTS

LPMS APR 15 1982

LILCO

LONG ISLAND LIGHTING COMPANY

175 EAST OLD COUNTRY ROAD • HICKSVILLE, NEW YORK 11801

DIST. LIST #
FILE #
LE / APE
T.R. FORM ☐ D.P. CARD ☐

MILLARD S POLLOCK
VICE PRESIDENT-NUCLEAR

SNRC-677

March 11, 1982

Mr. Richard W. Starostecki, Director
Division of Resident and Project Inspection
U. S. Nuclear Regulatory Commission, Region I
631 Park Avenue
King of Prussia, PA 19406

NRC Inspection No. 82-02
Shoreham Nuclear Power Station, Unit No. 1
Docket No. 50-322

Dear Mr. Starostecki:

This letter responds to your letter of February 2, 1982, which forwarded the report of the routine inspection of activities authorized by NRC License CPPR-95, conducted by Mr. Higgins of your office on January 1-31, 1982. Your letter stated that it appeared that one of our activities was not conducted in full compliance with NRC requirements, and that one other activity appeared to be a deviation from FSAR commitments. Our response to the apparent non-compliance was provided in our letter SNRC-674. The deviation and our response follow:

APPARENT DEVIATION FROM COMMITMENT MADE IN THE SHOREHAM FSAR, PARAGRAPH 4.4.6 THAT THE LOOSE PARTS MONITORING SYSTEM MEETS THE REQUIREMENTS OF REGULATORY GUIDE 1.133

1. Regulatory Guide 1.133, Paragraph C.1.c specifies that instrument channels be physically separated where inaccessible during full power operation.

   Contrary to that requirement, as of January 13, 1982, instrument cables for different channels were not physically separated inside the drywell (which is inaccessible during full power operation) in that they were run in the same conduits and they utilized the same electrical penetration.

2. Regulatory Guide 1.133, Paragraph C.1.d specifies that an audible or visual alarm should alert control room personnel when the alert level is reached.

SUPPLEMENTAL DOCUMENT

CONTROL

2. Cont'd.

Contrary to that requirement by system design, as of January 13, 1982, there was no alarm or annunciator from the loose parts monitoring panel to audibly or visually alert control room personnel that the alert level had been reached.

CORRECTIVE ACTION AND RESULTS

1. The loose parts monitoring system is not, nor is it required to be, a safety-related system. As such, Class IE criteria do not apply to the design and installation of this system. Regulatory Guide 1.133, Paragraph C.1.c, however, does recommend physical separation of the two sensors at each natural collection region from the sensor itself to a point in the plant that is always accessible for maintenance during full power operation. It should be noted that, as the purpose of having two sensors is to provide "broad coverage" of the collection region, these two sensors are not redundant.

The functional reason for separation is not explicit in the regulatory guide; however, it is stated that "it is desirable that the loose part detection system be designed to function following all seismic events that do not require plant shutdown." It is our interpretation, therefore, that the purpose of separation for this system is to protect non-accessible components of at least one of the two channels serving the same natural collection region from mechanical damage precipitated by an operating basis earthquake. In this regard we state the following:

a. The loose parts monitoring system is designed in accordance with R.G. 1.133 to operate to Operating Basis Earthquake (OBE) criteria. As such, the existing cabling in primary containment, which is installed to Design Basis Earthquake (DBE) levels plus Mark II hydrodynamic load criteria, is qualified significantly beyond the qualification of the loose parts monitoring system.

b. Although the existing cables are in the same penetration, the penetration is qualified to safety grade standards and exceeds loose parts monitoring system requirements.

c. Within the biological shield, separation is maintained up to a common junction box located at the biological shield penetration. From this junction box a common cable is run through conduit and trays to the [illegible]

c. Cont'd.

containment penetration, all of which are designed and supported to withstand DBE. The conduit and cable tray provide mechanical protection to the cabling within the primary containment. Structures and equipment within the primary containment are also designed and installed to DBE levels plus Mark II hydrodynamic load criteria; therefore, any seismic event of sufficient magnitude to damage common channel cables or the penetration would exceed the design basis of the loose parts monitoring system as recommended by Regulatory Guide 1.133.

Although we do not believe separation for fire protection is intended by the regulatory guide, we further note that Shoreham's inerted containment will prevent the outbreak of fire. Also, the cable will carry only low energy signals (50Vmax AC and DC), for which the voltage and current handling capacity of the safety grade cabling will far exceed even the short circuit output of the loose parts monitoring system electronics.

Therefore, we believe that the intent, as well as the functional requirements, of Regulatory Guide 1.133 were met by the current design and installation, although the literal interpretation was not. Paragraph 4.4.6 of the Shoreham FSAR will be revised to explicitly state the above interpretation.

2. Visual indication of a loose part "alert" is provided at the loose parts monitoring panel at the main control room; however, the lack of spare annunciator windows at the main control board resulted in an alarm not being provided. Both an audible and an external visual alarm will be added at the loose parts monitoring system panel in the main control room to alert control room personnel that an alert level has been reached or exceeded. In addition, this alarm will be designed to remain functional following an OBE event as recommended by Paragraph C.1.g.

STEPS TAKEN TO PREVENT RECURRENCE

As stated above, we believe both the intent and the functional requirements of Regulatory Guide 1.133 were achieved without incorporation of electrical separation as recommended by the Regulatory Guide, therefore we feel no corrective action is required. Regarding the loose parts alert signal, the audible and visual signals as described above will be added to the loose parts monitoring panel.

With respect to the implementation of corrective actions associated with overall management control systems as they apply to the FSAR, in a meeting held on November 12, 1981 with the Resident Inspector, Region I Management, NRC Licensing Project Management, Stone & Webster Engineering Corporation, and LILCO Management, a number of similar inspection item findings were discussed both separately and in light of how they related to the overall question of FSAR conformance. As a result of an extensive evaluation performed by our Architect Engineer, it has been our conclusion that there have been no significant or generic differences between the licensing and design documents, that would warrant substantive changes to the in-place FSAR control mechanisms. As documented in Inspection Report 81-20, the NRC in general agreed with that conclusion, but nevertheless believed that the number of discrepancies between the as-built plant and the licensing document required an additional LILCO review to compare the as-built plant to the FSAR.

As a result of this meeting, we have initiated a formal Shoreham Configuration Review Program which involves a documented detailed comparison of the as-constructed configuration of major plant safety systems to the applicable FSAR descriptions. This review compares the systems to the FSAR, formally documents any discrepancies found, and initiates corrective actions/ dispositions, as appropriate. We feel confident that the existing FSAR update and control mechanisms, coupled with the FSAR configuration review program will provide adequate and effective management controls to assure that FSAR conformance is maintained.

DATE WHEN FULL COMPLIANCE WILL BE ACHIEVED

With respect to the loose parts monitoring audible and visual signals, full compliance will be achieved by June 30, 1982. With respect to the Shoreham Configuration Review Program, we anticipate completion by fuel load.

Very truly yours,

M. S. Pollock
Vice President-Nuclear

cc: J. W. Dye, Jr.
J. Rivello
W. J. Museler
B. R. McCaffrey
E. J. Youngling
Dist.
R. E. Plaskon
D. J. Binder/H. Chau
R. A. Kubinak
Eng. File A21
SR2

STATE OF NEW YORK)
: ss.:
COUNTY OF NASSAU)

MILLARD S. POLLOCK, being duly sworn, deposes and says that I am a Vice President of Long Island Lighting Company, the owner of the facility described in the caption above. I have read the Notice of Deviation attached to NRC Inspection Report 82-02 and also the response thereto prepared under my direction dated March 11, 1982. The facts set forth in said response are based upon reports and information provided to me by the employees, agents, and representatives of Long Island Lighting Company responsible for the activities described in said Notice of Violation and in said response. I believe the facts set forth in said response are true.

Millard S. Pollock
MILLARD S. POLLOCK

Sworn to before me this
11th day of March, 1982.

Rosalee Oliveros

ROSALEE OLIVEROS
Notary Public, State of New York
Qualified in Nassau County
Commission expires Mar. 30, 1983

EXHIBIT 4

FSAR TABLE 223.12-3

CABLE TRAY SEPARATION IN NON-HAZARDOUS AREAS

TABLE 223.12-3

CABLE TRAY SEPARATION IN NONHAZARDOUS AREAS

	IEEE Std. 384 and Reg. Guide. 1.75	SNPS-1
Redundant Class 1E Trays		
Cable Spreading Area		Redundant trays never in same vertical stack
Vertical	3 ft(1)	1 ft
Horizontal	1 ft	solid(3)
Tray Covers	none required	
General Plant Areas		Same as above
Vertical	5 ft(1)	3 ft
Horizontal	3 ft	solid(3)
Tray Covers	none required	
Non-Class 1E & Class 1E Trays		
Cable Spreading Area		
Vertical	3 ft(1)	1 ft(1)
Horizontal	1 ft	1 in.
Tray Covers	none required	solid(3)
General Plant Area		
Vertical	5 ft(1)	1 ft(1)(2)
Horizontal	3 ft	1 in.
Tray Covers	None	solid(3)
Cable Specification	no requirement except for associated circuits	Same as Class 1E
Fire Protection	none required.	Auto CO_2 in Cable Spread. Area, Diesel Generator Rooms, Emergency and Normal Switchgear Rooms

NOTES:

(1) Vertical separation for SNPS-1 is measured from the bottom of the top tray to the bottom of the side rail of the bottom tray instead of the bottom of the top tray to the top of the side rail of the bottom tray as stated in IEEE Std. 384.

(2) In certain isolated cases, 9 in. separation is used in the reactor building due to limitation of available space.

(3) Tray covers for H and L trays are solid side ventilated; covers of K, C, and X trays are solid nonventilated.