12/21/82

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

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

DIRECT TESTIMONY OF
RICHARD B. HUBBARD AND DR. FRANCISCO J. SAMANIEGO
REGARDING TORREY PINES TECHNOLOGY'S INSPECTION OF
SHOREHAM NUCLEAR POWER STATION

I. INTRODUCTION

Q: Mr. Hubbard, please state your name, address, occupation and professional qualifications.

A: My name is Richard B. Hubbard, and my business address is 1723 Hamilton Avenue, San Jose, California. I am vice-president of MHB Technical Associates. My qualifications have been previously submitted to the Board in this proceeding.

Q: Dr. Samaniego, please state your name, address, and occupation.

A: My name is Dr. Francisco J. Samaniego. I am an Associate Professor of Statistics at the University of California, Davis and am currently a Visiting Associate Professor of Biostatistics at the University of Washington. My address is 3773 N.E. 153rd Street, Seattle, Washington.

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Q: Please describe your qualifications and research experience which are relevant to the matters you address in your portion of this testimony.

A: My research interests include Mathematical Statistics, Decision Theory, Reliability and Survival Analysis. My research covers a broad range of statistical theory and application. I have published research contributions in over ten refereed journals. Most of my research efforts have been directed toward signal detection, reliability and statistical applications in engineering. I have served on the editorial board of the Journal of the American Statistical Association since 1978 and am an elected Fellow of the American Statistical Association.

Over the last ten years, I have served as a statistical consultant to over one hundred researchers at the University of California, Davis. I have also served as a private consultant to the City of Davis, the State of California Employment Development Department and Arthur Young, Inc. In each of the last ten years, I have been an invited lecturer on sampling techniques at the annual Short Course on Statistical Quality Control sponsored by the College of Agriculture at the University of California, Davis. A further statement of my professional qualifications is attached to this testimony as Attachment 1.

Q: Who is sponsoring the various portions of this testimony?

A: Except when indicated otherwise, Mr. Hubbard is the author and sponsor for Parts III through VI of this testimony, and Dr. Samaniego is the author and sponsor of Part VII of this testimony.

II. PURPOSE AND CONCLUSIONS

Q: Mr. Hubbard, what is the purpose of your testimony?

A: The purpose of my testimony is to address the adequacy of the inspection conducted by Torrey Pines Technology ("TPT") of the Shoreham Nuclear Power Station ("Shoreham"). I have had only a very limited time to review the TPT "Final Report: Independent Verification -- Shoreham Nuclear Power Station" ("TPT Report") and to prepare this testimony, and I have not had access to the underlying data and inspection checklists used in preparing the TPT Report. However, I have identified a number of serious deficiencies and limitations in the TPT inspection which lead to certain conclusions.

Q: What are these conclusions and where are they discussed?

A: First, as discussed in Part III, the lack of independence of TPT, the inadequacy of the protocol by which the inspection was conducted, and the limited scope of the TPT

inspection program (including that TPT inspected "safety-related" systems, and not those which are also "important to safety") indicate that the TPT inspection was not an "independent verification" showing that there was an adequate construction QA/QC program at Shoreham. Second, TPT did not consistently properly identify discrepancies and preliminary findings; accordingly, the number and safety significance of deficiencies are understated in the TPT Report. This matter is discussed and examples are presented in Part IV of this testimony. Third, as discussed in Part V, the number of discrepancies which remained undetected until the TPT review, despite the number of layers, or "gates," in the QA/QC program at Shoreham, corroborates Suffolk County's contentions regarding deficiencies in that program. Fourth, the Corrective Action Plans ("CAPs") proposed by LILCO and accepted by TPT do not in all cases fully respond to the root causes or the extent of TPT's Findings, and no CAPs were prepared in response to TPT's Observations or Discrepancy Reports, as discussed in Part VI. Finally, I concur with Dr. Samaniego's testimony in Part VII.

Q: Dr. Samaniego, what is the purpose of your testimony?

A: The purpose of my testimony is to address the question of whether the conclusions of the TPT Report are justified, given the sampling methodology which was used.

Q: In summary, what are your conclusions?

A: The samples taken by TPT were obtained in a non-random fashion and do not lend themselves to extrapolation to the populations of items and documents under study. I therefore

conclude that the substantive findings of the TPT Report are unjustified. These matters are discussed in Part VII of this testimony.

III. INDEPENDENCE AND SCOPE OF TPT REVIEW

Q: Mr. Hubbard, was the TPT review the kind of independent inspection of the as-built plant which you have urged be conducted?

A: No. Aside from other factors discussed in my testimony, TPT was not acceptably independent from LILCO, nor did it operate under an acceptable protocol.

Q: Why wasn't TPT acceptably independent?

A: TPT was selected and retained by LILCO unilaterally. In the context of settlement negotiations with LILCO, Suffolk County's Assistant County Attorney identified TPT as one of eight consultants which the County recommended to "includ[e] in the bidding for the contract" for a QA/QC independent inspection. Had the negotiations resulted in a settlement, the County would have been involved in the selection process and in determining the scope and protocol for the inspection. Instead, when LILCO itself hired TPT, the County was excluded from these matters and prevented from participating in the inspection to ensure TPT's independence. No engineering consultant can properly be deemed "independent" when it was selected by LILCO, its job was defined by LILCO, it reported to LILCO, and its personnel

were in daily contact with LILCO personnel to perform their tasks, to the exclusion of other parties.

Q: Why wasn't the protocol under which TPT operated acceptable?

A: Because no party other than LILCO had any relationship with TPT. Not only LILCO, but Suffolk County, and indeed the other parties in the licensing proceeding, should have had the opportunity to review and comment on the scope of work, acceptance criteria, procedures, schedule, and resource allocation of TPT. Not only LILCO, but Suffolk County and the other parties, should have had the right to observe inspections and audits in progress, attend all meetings, and review all documents presented to and generated by TPT. Instead, TPT interfaced only with LILCO, received information and comments only from LILCO, reported only to LILCO, and could only be influenced by LILCO.

Q: Aside from the fact that only LILCO participated with TPT in the inspection, was the protocol adequate?

A: I have not had access to the documents underlying the TPT Report and not contained in it, such as the procedures used by TPT and inspection checklists. Examination of such documents could disclose other problems with the protocol and procedures under which TPT operated.

Q: Does the TPT inspection provide a comprehensive design review, physical inspection, and QA/QC review to verify that the design and construction of Shoreham have been implemented in accordance with FSAR commitments and regulatory requirements?

A: No. It is generally true that the work effort on a nuclear plant can be subdivided into four basic phases: design, construction, startup, and commercial operation.[1/] While overlaps between phases do occur, the subject of the TPT verification effort was the construction phase. Thus, the adequacy of the design of Shoreham and of LILCO's proposed operating procedures, including the QA/QC program for operations, are not addressed by TPT.

Q: Was the scope of the TPT review of the construction process adequate to support the conclusions of the TPT Report?

A: No. The TPT review of the construction process was improperly limited or restricted in three important areas: equipment "important to safety;" electrical equipment; and QA/QC programs.

Q: Explain how the TPT review of equipment "important to safety" was improperly limited or restricted.

A: In this proceeding there has been substantial testimony which addressed LILCO's failure to implement a systematic QA/QC program for items "important to safety," as required by GDC-1 of Appendix A to 10 C.F.R. Part 50. I believe the evidence adduced to date indicates that LILCO has largely limited its Shoreham QA/QC program to the subset of items designated as "safety-related."[2/] The TPT review suffers

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1/ TPT Report, Volume II, pp. 1-1 and 1-5, defines these phases.

2/ See definitions of "safety-related" and "important to safety" as set forth by Harold Denton of the NRC and included as Attachment 1 to the County's direct testimony on Contention 7B. The definitions will not be repeated herein for the sake of brevity. LILCO also identifies safety-related items as "Category I."

from the same deficiency, since TPT appears to limit its review and conclusions to "safety-related" features. As Mr. Johnson of TPT states in his prefiled testimony:

> (i) "TPT's conclusions are applicable to construction of all safety-related equipment. . ." (Emphasis added.)
>
> (ii) "It was obviously impractical to inspect all safety-related equipment at the plant. We therefore designed our program to provide a basis to judge the adequacy of all safety-related components." (Emphasis added.) 3/

For example, as discussed in more detail in Part IV of this testimony, valid Discrepancy Reports identified during the TPT inspection were not converted to Potential Finding Reports in a number of instances because components or equipment were not designated as safety-related.[4/] Thus, the TPT review can provide no assurance that the QA/QC requirements of GDC-1 of Appendix A have in fact been systematically implemented. This is a significant omission in the scope of the TPT review.

Q: How was the TPT review of electrical equipment improperly limited or restricted?

3/ Testimony of Louis D. Johnson, p. 26. See also, e.g., TPT Report, Volume I, pp. 1-6, 2-2, 3-1, 3-2, 3-3, 3-4, 3-5, 3-7, 4-2, 4-3, 5-1, 5-2, and 5-3 and Figures 4-1 and 4-2. A similar pattern of limitations of the TPT review to safety-related activities is set forth in Volumes II and III of the TPT Report.

4/ See, e.g., TPT Report, Volume II, Table C-1, pp. 4C-1, 4C-2, and 4C-3, as to electrical items.

A: The TPT program plan, and the manhours required for the review, are summarized below:

Task	Description	Manhours	
A	Construction QA/QC Control Program Review	500	5/
B	Construction QA/QC Program Implementation Review	1,200	6/
C	Physical Inspection, Walkdown	21,000	7/
D1	ASME Piping Weld Inspection	1,100	8/
D2	Primary Containment Concrete Test	240	9/
D3	Witnessing Primary Containment Structural Acceptance Test	200	10/
E1	ASME Piping Material Certification Review	240	11/
E2	Preoperational Test Review	450	12/
F	Potential Finding Processing)		
G	Administrative and Reporting)	7,000	13/
	TOTAL	33,000	14/

The walkdown of electrical items made up only about 8% of the total features checked by TPT.[15] Clearly, the major emphasis of the TPT inspection was devoted to an evaluation of whether the mechanical and pipe support items were installed as shown on the applicable design documents. The pipe support and mechanical walkdowns constituted about 47% and 45%, respectively, of the total features checked and resulted in 49% and 17% of the Discrepancy Reports.[16] In contrast, the electrical walkdown, constituting 8% of total features checked, resulted in about 34% of the Discrepancy Reports.[17] As a result, TPT concluded:

5/ TPT Report, Volume I, p. 3-2.
6/ Ibid., p. 3-3.
7/ Ibid., p. 3-4.
8/ Ibid., p. 3-5.
9/ Ibid., p. 3-6.
10/ Ibid., p. 3-7.
11/ Id.
12/ Ibid., p. 3-8.
13/ TPT Report, Volume II, p. 1-6.
14/ Id.
15/ Ibid., p. 7-25.
16/ Id.
17/ Id.

(i) ". . . electrical discrepancies are much more prevalent than the relative number of electrical walkdown features." 18/

(ii) ". . . relatively more discrepancies were identified on electrical than on mechanical features because of the greater complexity of electrical equipment and component identification." 19/

The alleged complexity of electrical features does not explain why the Shoreham QA/QC program failed to reveal and cure deficiencies. Moreover, if the electrical items are in fact more complex, one would have expected a more intense inspection by TPT of those items. Yet even when it became clear that discrepancies in electrical features occurred with a much higher frequency than in other systems, TPT failed to increase the scope of its inspection of electrical items. This is a serious deficiency.

Q: Explain how the TPT review of QA/QC programs was improperly limited or [illegible].

A: Tasks A and B of the TPT review included, respectively, an assessment of the Shoreham QA/QC program for construction and a review of the effectiveness of the QA/QC program implementation. As discussed above, the TPT review of QA/QC was restricted to the QA/QC measures applied to safety-related items; that review was not extended to items important to safety. The

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18/ Id.

19/ Ibid., p. 7-26.

QA/QC program assessment was further limited to a review of the Stone and Webster ("S&W") and LILCO QA/QC manuals and procedures. Other Shoreham site contractors with QA/QC program during construction, such as Courter and Reactor Controls, were in large part excluded from the TPT assessment, even though they had substantial construction responsibility. Based on the restricted number of contractors addressed in the TPT program, no valid conclusions can be drawn concerning the overall QA/QC program implementation for all site contractors.

Q: Are there other limitations in the scope of the TPT review which impact its conclusions?

A: Yes. In important cases, such as the large bore piping review (Task C), the TPT assessment was conducted against a changing construction baseline. Because of the ongoing construction activities and the QA/QC activities which had not yet occurred, TPT was not able to verify that the completed items were constructed in accordance with the design requirements. Thus, a number of items selected by TPT could not be reviewed in a completed condition. In one instance, 27 potential pipe support safety concerns were designated as invalid during the Potential Finding Review process, merely because construction of the final pipe supports was incomplete. In other cases, the required documentation requested by TPT initially was not

readily retrievable, contrary to the records requirements of Criterion XVII of 10 C.F.R. Part 50, Appendix B. Seven potential safety concerns resulting from the documentation review were determined to be invalid Potential Finding Reports when appropriate documentation was identified "post-facto" to resolve the concern.[20/]

IV. DISCREPANCY/FINDING PROCESSING

Q: Do you know how TPT prepared and processed Discrepancy Reports ("DRs") and initiated Potential Finding Reports ("PFRs")?

A: Yes. According to the TPT Report:

> "The DR was the form used to document perceived differences between an observed condition and a required condition. When a walkdown team or a document investigator perceived a difference between what was being reviewed and the requirement document, they were required by procedure to fill out a DR to document the perceived discrepancy, indicating the required condition as well as the observed condition. This document was then reviewed by the respective team leader to evaluate the validity of the DR (i.e., to assess whether there was an actual difference between the observed and required conditions) and to evaluate the potential of the observed condition for safety impact. The task leader then reviewed the completed DR, including the team leader's assessment of validity and potential safety impact. If either the team leader or the task leader perceived a potential safety impact, a PFR was initiated and the PFR number was referenced on the DR." [21/]

20/ TPT Report, Volume I, pp. 4-2 and 4-3.

21/ TPT Report, Volume II, p. 1-9.

Q: In your opinion, were all DRs invalidated by TPT properly invalidated?

A: No. Although the TPT Report required that "any difference between an observed condition (document or installed hardware) and a required condition" be documented,[22/] DRs were often invalidated in a manner inconsistent with this standard. Of the 371 DRs generated, 103 were found by TPT to be invalid.

Q: Can you give some examples of DRs which you believe were improperly invalidated?

A: Yes. DRs 010, 011, 015, 022, 048, 068 and 153 are examples of DRs that were invalidated because differences between the item and the required condition did not affect system performance. DR 25 was invalidated because a circuit was found to function properly despite the difference from the required condition. A number of secondary pipe supports were found to be different from the required condition, but their DRs (see, for example, DRs 245, 287, 324, 328, 354, and 356) were invalidated because the differences did not affect the primary line. DRs 034, 042, 047, and 168 are examples of DRs that were invalidated because the inspected items were not within the scope of the TPT walkdown. DR 199 was invalidated because LILCO considered the item to be acceptable. In some instances DRs were invalidated for reasons that also applied to DRs that remained valid (for example, compare DRs 54 and 57 and DRs 287 and 312).

Q: Could improper invalidation of DRs have resulted in fewer Observations and Findings?

22/ TPT Report, Volume I, p. 4-1. (Emphasis added.)

A: Some improperly invalidated DRs may have become PFRs and eventually Findings or Observations. There is no way to make an accurate prediction, because invalidated DRs were not subjected to the next level of inquiry and were therefore not evaluated with respect to their potential safety impact. Further, the cumulative effect of similar DRs could have a potential safety impact, or could indicate a repetitive QA/QC program deficiency, which would not be evident in a single isolated DR.

Q: Do you believe that TPT consistently and accurately determined which valid DRs should be PFRs?

A: No. TPT dismissed from further consideration DRs which related to non-Category I ("safety-related") material, components or equipment. DRs 112, 124, 130, 137, 139, 249, 259, 264, 268, 292, and 331 are examples. Accordingly, there was a wholesale exclusion from the PFR category of valid DRs for items which may have been important to safety, but which had not been classified as Category I. This decision may have resulted in a fewer number of Findings and Observations in the final TPT Report.

In addition, in some instances TPT made inaccurate determinations concerning a DR's potential safety impact, and therefore no PFR was written. For example, DR 123 examined LILCO's QA Audit Program and concluded that the program was deficient in not following LILCO QA Procedure No. 18.2, regarding corrective action for violations reported by audits. In its inspection, TPT discovered that a failure to follow Procedure 18.2 had led

to the same violation over four consecutive audits. Nevertheless, this DR was not made a PFR, because TPT concluded that there was no potential safety impact. I disagree with this conclusion because the failure to initiate prompt corrective action in response to a repetitive audit finding could have a safety impact, depending upon the nature of the audit finding. In addition, this failure is contrary to the requirements of Criteria XVI and XVIII of Appendix B to 10 C.F.R. Part 50.

Another example was TPT's questionable decision to find that DR 281 was "no longer a safety item" and therefore did not warrant being made a PFR. DR 281 disclosed that General Electric and S&W differed in their views of whether certain equipment was safety-related. General Electric had listed a number of items as Category I classification, while S&W had listed the same items as Category II. This difference resulted in certain equipment being classed as safety-related (Category I) during receipt inspection, but non-safety-related (Category II) during installation. It is not clear whether General Electric agreed to the downgrading of these items.

As a final example, TPT decided that DR 230 was "not a safety problem," and therefore no PFR was written. DR 230 determined that an uncalibrated torque wrench might have been used in the torquing of the primary containment drywell head. In my opinion, this decision ignores the fact that the use of an uncalibrated tool is prohibited by a specific QA policy (LILCO QA Manual, Section 12, paragraph 12.3.1.). Apparently, TPT did

not conduct a further investigation of the generic implications of this DR to determine whether uncalibrated tools were used in other plant procedures in violation of the QA policy.

Q: In summary, what are your conclusions in this area?

A: TPT improperly invalidated a number of DRs. Accordingly, the TPT Report understated the number of deficiencies and PFRs and possibly the number of Findings and Observations.

V. DEFICIENCIES IN SHOREHAM QA/QC PROCESS

Q: What is your understanding of LILCO's so-called "gating effect"?

A: As described on page 22 of LILCO's prefiled testimony on Suffolk County Contentions 12, 13, 14 and 15 and Shoreham Opponents Coalition Contention 12:

> "LILCO's several types of inspections, whether receipt, in-process, or final, produce what is called a 'gating effect.' The term 'gate' means a stage in the process at which functions or attributes must be verified and beyond which material or components may not pass unless the requirements have been met. Within each major gate (procurement, receiving, storage, pre-installation, installation, system turnover, and test program) there may also be several subgates that require passing an inspection before the item may continue to be processed. The effect of these multiple gates is to provide several chances to detect a nonconformance."

Q: Does the TPT inspection substantiate that LILCO's "gating effect" is adequate to ensure that materials, components or equipment that do not satisfy requirements will be detected?

A: No. The TPT inspection indicates the opposite. TPT identified a number of discrepancies and PFRs that were later classified as Findings or Observations. Based upon information available to me in the TPT Report, I believe that many of these Findings and Observations described deficiencies that were first detected by TPT, despite prior opportunities for the LILCO "gating effect" to have detected the same deficiencies. It is likely that an analysis of PFRs which did not become Findings or Observations, and of valid DRs which were not made PFRs, would disclose additional deficiencies not detected by LILCO's QA/QC program. Unfortunately, TPT did not attempt to identify failures in the LILCO QA/QC program which permitted discrepancies to occur and remain undetected.

Q: Please give some examples of Findings which you believe demonstrate that LILCO's inspection process failed to detect deficiencies in materials, components or equipment.

A: In PFR 004 (piping boss material certification), TPT found that a 6,000 pound boss had been installed on a line when the material certification provided by the manufacturer recorded a 3,000 pound boss. TPT also noted two other identical discrepancies. These discrepancies appear to have escaped at least four inspection stages in the LILCO "gating process": (1) procurement; (2) receiving; (3) pre-installation; and (4) installation.

In PFR 114 (debris inside HVAC ducting), TPT noted that QA/QC procedures required "inspection of all ducting at completion of construction to prevent the fouling/clogging of ducts by foreign material." 23/ Despite these procedures, TPT discovered that:

> ". . . garbage, consisting of fiberglass cloth and insulating material, was blocking approximately 25% of the duct flow area. This garbage would have eventually worked its way into the fan with resultant damage/ failure of the fan, and thus, preventing proper operation of the system. The impact of such a failure would have serious consequences if postulated to occur during accident conditions. . ." 24/

Notwithstanding these QA/QC procedures and the potential seriousness of these conditions, the discrepancy had gone unnoticed until detected by TPT. There were at least two opportunities for detection of the debris before that time -- at the installation and system turnover inspections.

Q: Please give some examples of Observations which you believe demonstrate failures in LILCO's "gating effect."

A: PFR 022 (installed solenoid valve different from that which was required), PFR 037 (opening in HVAC duct) and PFR 092 (temperature elements not installed as required in the steam tunnel) all confirm my concerns with the adequacy of LILCO's

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23/ TPT Report, Volume III, Book 2, p. 5 of PFR 114.

24/ Id.

inspection process. The valve addressed in PFR 022 was incorrect from the time of procurement; therefore, as many as four prior inspections may have failed to detect the discrepancy (procurement, receiving, pre-installation, and installation inspections). In PFR 037, TPT discovered that a sizable hole had been left in a QA Category I HVAC duct as a result of relocating certain instrumentation. This discrepancy should have been discovered by LILCO during inspection at the time of the removal of the instrumentation. In PFR 092, TPT detected that four temperature elements had been installed in locations which differed from the design drawings. Although the actual locations were determined to be acceptable, this discrepancy should have been detected at the time of the initial installation inspection. Moreover, although a subsequent inspection noticed the improper locations, that inspection resulted in initiating a corrective Engineering and Design Coordination Report ("E&DCR") which left the temperature elements in incorrect locations.

Q: But doesn't the relatively small number of TPT's Findings and Observations suggest that LILCO's gating system basically worked well?

A: No such conclusion is justified. If, as discussed in Part III of this testimony, the scope of the TPT review had not been so restricted, and if TPT had not improperly assessed DRs and identified PFRs, as discussed in Part IV, I believe there would be substantially more examples demonstrating the inadequacy of the QA/QC program for construction of Shoreham. Given the scope and methodology of the TPT review, the number of discrepancies not discovered until the TPT inspection provides evidence supporting Suffolk County's concerns.

VI. INADEQUATE CORRECTIVE ACTION MEASURES

Q: Did LILCO initiate corrective action measures in response to the TPT Findings?

A: Yes. Thirteen Corrective Action Plans ("CAPs") were prepared by LILCO and reviewed by TPT. A CAP was prepared for each of the 19 Findings, except that seven similar pipe support Findings were grouped into one CAP. However, no CAPs were prepared in response to the 32 Observations or the hundreds of DRs. This appears to be a significant omission in the TPT program.

Q: In your technical judgment, do all 13 CAPs fully satisfy the requirements for corrective action of Criterion XVI of 10 C.F.R. Part 50, Appendix B?

A: No. The proposed corrective action measures in a number of cases appear to address the symptom, rather than the root cause, of the inspection Finding. Of the 13 CAPs, a number had weaknesses that indicated an incomplete review of the discrepant conditions. For instance, the CAPs in some cases failed to provide for an investigation beyond the immediate discrepant condition to determine the cause, the underlying reason for the cause, why the condition had not been detected by the QA/QC program, and where else the condition could exist.

Q: Do you have examples of CAPs which exhibited the weaknesses you described?

A: Yes. CAPs 2, 5, 6, 11 and 13 all exhibited incomplete corrective action measures.

Q: Explain what you mean by incomplete corrective action measures as applied to CAP 2 (PFR 009).

A: CAP 2 was prepared in response to PFR 009 (the as-built HVAC ducting in systems T41 and T46 did not agree with flow diagrams). The CAP is judged as weak in that it merely agrees, through the means of an E&DCR, to update the flow diagrams to reflect the as-built installations. Some type of engineering evaluation or assessment should be accomplished concurrent with the updating effort to ensure that the as-built installation of the HVAC system still meets requirements and specifications. Such an engineering evaluation or assessment

may have been done, but if so, it is not evident from Mr. Novarro's prefiled testimony or the CAP.

Q: Explain what you mean by incomplete corrective action measures as applied to CAP 5 (PFR 045).

A: PFR 045 disclosed that construction temporarily removed part of a large-bore pipe support without following the appropriate procedure, FQC Procedure QC 15.4. Thus, there was no record of the temporary removal nor a request to replace the pipe support. CAP 5 did not go far enough in preventive action, in that LILCO should have done more than just issuing a verbal reminder to the offending organization. LILCO should have taken a stronger stand by going to each organization accomplishing work with a strong, written reminder of the seriousness of this type of oversight or omission. After all, the omission of a pipe support removes one of the assurances that a plant will be constructed as designed.

Q: Explain what you mean by incomplete corrective action measures as applied to CAP 6 (PFR 048).

A: In PFR 048, problems were identified in certifying that the recirculation pump motors met the Quality Classification assigned. These motors had been classified as QA Category I, then reclassified as Category II, and then parts of the motors were again reclassified as Category I. CAP 6 presented logical steps to resolve the certifying process problem; however, the attachment to this CAP described prior problems that were detected while these motors were in QA Category I storage. As

noted by TPT:

> "The reactor recirculation pump motors had been fabricated, shipped, and lying in controlled QA Category I storage on the Shoreham site for about four years when, in October of 1979, heat exchangers were removed from both motors to facilitate installation in the drywell. During this operation, a number of adverse conditions were discovered. Upon further inspection using a borascope, non-conforming conditions were observed, including: mildew on the insulation, rust on bearings, evidence of rodent occupation, large pieces of loose insulating varnish, steel cuttings, free water and high humidity." 25/

These problems indicated an apparent lapse in storage procedures. That this CAP, and the follow-up actions by TPT, did not address this apparent lapse is considered a weakness. The CAP should have at least indicated:

(i) When and where these conditions developed;

(ii) What lapses in QA/QC control permitted these conditions to develop;

(iii) Why QA/QC inspections and audits had not detected these conditions earlier;

(iv) What other Category I equipment has possibly been subjected to these lapses in control;

(v) What has been done to verify the acceptability of the equipment identified in Item iv, above.

25/ TPT Report, Volume III, Book 1, Attachment 3, p. 3 of 5, to PFI 048.

Until the above information has been provided, doubt will exist about the condition of other Category I equipment installed in the Shoreham plant that came from the same source, or that was stored in the same place at the same time, as the recirculating pump motors.

Q: Explain what you mean by incomplete corrective action measures as applied to CAP 11 (PFR 114).

A: In PFR 114, debris was found in the HVAC distribution system of the Control Room. The system had been completed, inspected, and placed in operation with the debris inside. Neither CAP 11, nor Mr. Novarro's prefiled testimony, nor TPT's actions after discovery of the debris, adequately address the potential generic problem of contamination found in a completed, inspected, and closed system. CAP 11 has several weaknesses in that:

(i) LILCO is planning to use flow rates as evidence of lack of debris in closed systems;

(ii) This incident did not appear to raise questions on effectiveness of inspection in assuring cleanliness in other closed systems, such as steam, water, pneumatic, and hydraulic systems.

Systems that are closed without assuring cleanliness can show proper flow rates even though debris is present. Such debris often collects over time at certain sensitive points, such as low points, corners, valves, restrictions, filters,

junctions, pump and fan intakes, and instrumentation parts, where it could impede flow at inopportune times. Also, the effects of some kinds of contamination may not show up as impedance to flow performance, but could show up in valve opening or closing performance or as deterioration of internal lines and components. Suitable corrective action questions should have included:

(i) How did QA/QC inspections miss the debris in the HVAC ducting?

(ii) Where else could inspections have missed debris or other forms of system contamination (objects, materials, liquids and gases)?

(iii) How does LILCO know for certain that other closed systems (ducting, piping, lines, and equipment) are not also contaminated?

Q: Explain what you mean by incomplete corrective action measures as applied to CAP 13 (PFR 120).

A: PFR 120 identified three aspects deficient in the installation of a solenoid-operated valve ("SOV") as follows:

(i) SOV not yet replaced per E&DCR with an SOV that was environmentally qualified;

(ii) SOV not oriented as per manufacturer's instructions at installation;

(iii) Installation had been "bought" by QA/QC inspection.

Corrective Action Plan 13 has several weaknesses, as follows:

(i) Despite an installation orientation arrow on the SOV body and despite the note "Installation: Valves must be mounted with solenoid vertical and upright" in the manufacturer's bulletin, LILCO has elected to accept telephonic assurance from the manufacturer that the SOV installed orientation is satisfactory for angles "up to and including 90° from the upright and vertical position." Further, LILCO plans to issue E&DCR P-3810B for installation of new, environmentally-qualified valves to this relaxed orientation criterion.

(ii) Despite the finding of TPT that this one valve was installed and verified correct by inspection, LILCO made only a limited inspection of the installation of several SOV model numbers. A reinspection verification is needed on at least all safety-related SOVs in the plant.

(iii) LILCO should verify the manufacturer's telephonic information to assure that the relaxed installation orientation requirement has been confirmed by tests and experience over long time periods, before adopting such relaxation.

(iv) LILCO should determine what caused the breakdown in QA/QC inspection that permitted acceptance of valve installation that did not conform to the

manufacturer's instructions. Neither the CAP nor Mr. Novarro's prefiled testimony addresses the range of corrective action measures described herein.

VII. STATISTICALLY VALID SAMPLING METHODOLOGY NOT UTILIZED BY TPT

Q: The TPT Report concludes that ". . . the implementation of the construction control program has resulted in adequate construction of nuclear safety systems and components in the Shoreham plant"[26/] and that the construction of Shoreham ". . . is judged to meet the construction requirements of the design documents . . . ."[27/] In your judgment, given the methodology applied by TPT, are these conclusions justified?

A: No. The determination of the status of Shoreham vis-a-vis any fixed measure of quality or safety is very definitely a statistical matter. It is clearly not feasible to inspect every component of the plant or examine every document that has been generated during Shoreham's construction phase. Thus, one must seek to answer general questions about Shoreham from an inspection of a sub-collection of components or documents. However, in order for one to make statistically valid inferences about the general character of the plant, the sample of items examined must be selected in such a way that they can appropriately be thought of

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26/ TPT Report, Volume I, p. 5-2.

27/ Ibid., p. 5-3.

as representative of the entire collection of items. It is in this crucial area that the TPT study is deficient. Instead of availing itself of widely-accepted, probability-based sampling methods and their attendant systematic methodologies for extrapolating from sample to population, TPT has selected items for inspection in a non-random, ad hoc manner.[28/] While such an inspection, especially when it is of the magnitude of TPT's, can uncover useful information (for example, some previously undetected flaws might be identified), it cannot form the basis for reaching general conclusions about Shoreham.[29/]

Q: Why wasn't it valid for TPT's engineers to use their experience and judgment in selecting a cross-section of items to be sampled?

A: TPT's approach to the formation of samples does not provide a vehicle for developing a general profile of the

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28/ See, e.g., testimony of Louis D. Johnson, p. 12.

29/ On page 26 of his prefiled testimony, Mr. Johnson of TPT states:

> "TPT thus believes it very reasonable to conclude that the hardware not inspected by TPT, which was built under the same construction controls and QA program, is also satisfactorily built to the engineering requirements."

For the reasons discussed in my testimony, I disagree that such a conclusion is justified.

population. While engineering experience and judgment play important roles in evaluation, they can introduce biases into the sampling process that preclude the possibility of drawing general conclusions. For example, when TPT engineers included welds for inspection during their implementation of Task D, two of the factors included among the selection criteria were: (1) a preference for high stress welds; and (2) weld accessibility.

A sample that is formed on the basis of judgment or convenience carries with it a high risk of being statistically biased. The direction of the bias is often unpredictable, and the magnitude of the bias can be substantial. More importantly, there is no rigorous methodology which enables one to validly extrapolate from a judgment sample to the population. In contrast with this, a randomly-chosen sample can be expected to be representative of the population from which it was drawn. Moreover, we can estimate population characteristics from such a sample, and can bound the error of our estimates in a manner that is mathematically and logically rigorous. In summary, the process of extrapolation from sample to population is justified through the unbiased and representative character of random samples. The use of engineering judgment in the selection of items to be involved in a sample can only obscure our view and obstruct our efforts to describe the population as a whole.

Q: Does the application of the science of Statistics preclude the use of engineering experience and judgment?

A: No. The design of a statistical study benefits from an engineer's experience and judgment. The engineer must decide what populations are of interest, and he must decide which questions are worth asking. Large and diverse populations can best be studied through stratification into relatively homogeneous subpopulations. Such a division into parts is again a matter of judgment. Finally, after a statistical study is complete, the engineer will often identify follow-up questions suggested by the current data. The process of studying a population statistically is interactive, and involves design phases which are subjective and testing phases which are objective and scientifically rigorous.

Q: Is it possible to design a statistically-valid program to demonstrate that Shoreham was constructed in accordance with design requirements, without an inspection of virtually every item in the plant?

A: Yes. It is neither necessary nor desirable to inspect every item in the plant. The validity of a statistical study depends on the extent to which the sample taken is representative of the population. If random samples are drawn, and the sizes of the samples are large enough to ensure the desired precision in estimating population parameters, questions concerning the general characteristics of Shoreham can be definitively resolved.

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Fellow, American Statistical Association, 1982-

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Associate Editor, Journal of the American Statistical Association, 1978-present.

Assistant Program Secretary, IMS Western Regional Meeting, Davis, CA, June 1980.

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Publications:

[1] "Estimating a Binomial Parameter with Finite Memory," IEEE Transactions on Information Theory, Vol. IT-19, September 1973, 636-43.

[2] "On Tests with Finite Memory in Finite Time," IEEE Transactions on Information Theory, Vol. IT-20, May 1974, 387-388.

[3] "On testing Simple Hypotheses in Finite Time with Hellman-Cover Automata," IEEE Transactions on Information Theory, IT-21, March 1975, 157-162.

[4] "On T-minimax Estimation," The American Statistician, 29 (1975), 168-9.

[5] "A Comment on Admissibility and Completeness," The American Statistician (Letter), 29 (1975), 173.

[6] "A Characterization of Convoluted Poisson Distributions with Applications to Estimation", Journal of the American Statistical Association, 71 (1976), 475-479.

[7] "Optimal Sampling Design for Estimating the Integral of a Process with Stationary Independent Increments," IEEE Transactions on Information Theory, Vol. IT-21, May 1976, 173.

[8] "Mode Identification with Finite Statistics," IEEE Transactions on Information Theory, Vol. IT-22, September 1976, 588-590.

[9] "Covariance Analysis in the Evaluation of an Enrichment Program," Journal of Educational Statistics, 2, Summer 1977, 121-137 (with S. T. Rickard).

[10] "Posterior Distribution of the Parameters of the Pearson Type III Distribution: An Application to Design Flood Series Analysis," Proceedings of the International Symposium on Risk and Reliability in Water Resources, (1977), (with B. Espildora and J. Amorocho).

[11] "Estimating Value in a Uniform Auction," Naval Research Logistics Quarterly, 25 (1978), 621-632 (with L. D. Kaiser).

[12] "On the Power of the χ^2 Goodness of Fit Test at Signal Plus Noise Alternatives," Communications in Statistics, B, 8 (1979), 75-90 (with L. D. Kaiser).

[13] "Two Characterizations of Pascal Signals in Additive Noise," Sankhya, Series A, 41, (1979), 219-231 (with G. Gong).

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[15] "Performance of Activated Sludge Processes and Reliability Based Design," Journal of the Water Pollution Control Federation, March 1980, 2841-57 (with S. Niku and E. D. Schroeder).

[16] "Discharge Standards Based on the Geometric Mean," Journal of the Water Pollution Control Federation, April 1981 (with S. Niku and E. D. Schroeder).

[17] "Performance of Activated Sludge Processes: Reliability, Stability and Variability," Research and Development Reports of the Environmental Protection Agency, EPA-600/52-81-227, (Dec. 1981) 1-11 (with S. Niku, E.D. Schroeder and G. Tchobanoglous).

[18] "Maximum Likelihood Estimation for a Class of Multinomial Distributions Arising in Reliability," Journal of the Royal Statistical Society, B, 43 (1981), 45-52 (with L. E. Jones).

[19] "Pseudo Maximum Likelihood Estimation: Theory and Applications," Annals of Statistics, (1981), 9, 861-69 (with G. Gong).

[20] "Moment Identities for Nonnegative Variables Via Integrated Survival Curves," IEEE Transactions on Reliability, to appear.

[21] "Evaluating Performance in Continuous Experiments with Feedback to Subjects," Psychometrika, to appear (with J. Utts).

[22] "Estimating the Sib Proportion in Seed Purity Determinations," Biometrics, to appear (with P. Arus).

[23] "On Characterizing Discrete Signals in Additive Noise--A Unified Treatment," submitted for publication, (with R. Boyles). TR #15.

[24] "Modeling and Inference for Positively Dependent Variables in Dichotomous Experiments," submitted for publication (with R. Boyles). TR #19.

[25] "Maximum likelihood Estimation for Discrete Shock Model," submitted for publication, (with R. Boyles). TR #21.

[26] "Estimating a Survival Curve when New is Better than Used," submitted for publication, (with R. Boyles). TR #22.

[27] "Estimating a Survival Curve Based on Nomination Sampling," in preparation (with R. Boyles).

*Technical Reports are available through the Division of Statistics, University of California, Davis, CA 95616.

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.)

CERTIFICATE OF SERVICE

I hereby certify that copies of the DIRECT TESTIMONY OF RICHARD B. HUBBARD AND DR. FRANCISCO J. SAMANIEGO REGARDING TORREY PINES TECHNOLOGY'S INSPECTION OF SHOREHAM NUCLEAR POWER STATION have been served to the following this 21st day of December, 1982 by U.S. Mail, first class, except as otherwise noted.

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