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-OL-4 (Low Power)
(Shoreham Nuclear Power Station, Unit 1)	)	

DIRECT TESTIMONY OF
DALE G. BRIDENBAUGH AND RICHARD B. HUBBARD
ON BEHALF OF SUFFOLK COUNTY

I. INTRODUCTION

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

A: My name is Dale G. Bridenbaugh, and my business address is 1723 Hamilton Avenue, San Jose, California. I am president of MHB Technical Associates. My qualifications are attached hereto as Attachment 1.

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 are attached hereto as Attachment 2.

II. PURPOSE OF TESTIMONY

Q: What is the purpose of your testimony?

A: LILCO has sought an exemption from NRC regulations to permit low power operation in advance of any NRC decision on the adequacy of its onsite emergency diesel generators. Under 10 CFR §50.12(a) and the NRC's May 16, 1984 decision (CLI-84-8), a relevant consideration is whether the public interest and a balance of the equities are in favor of the grant of an exemption. Further, in its May 22 Application for Exemption, LILCO has expressed the view that it is only due to problems arising during preoperational testing of the Transamerica DeLaval, Inc. ("DeLaval") diesels that the diesels have not yet been licensed. See Application for Exemption at 25.

The purpose of our testimony is to summarize the results of an investigation we have undertaken into the facts and circumstances involving LILCO's selection and procurement of the DeLaval emergency diesel generators ("diesels") and of the actions taken by LILCO in conjunction with the failures subsequently experienced with these engines.

Q: In summary, what are your conclusions?

A: We conclude that the delays and costs associated with the Shoreham diesels are the responsibility of LILCO (or of LILCO suppliers or contractors). These problems did not only arise during preoperational testing. Rather, since 1974 there have been repeated indications that there might be serious problems with the DeLaval diesels. In our opinion, LILCO knew or should have known of these problems at an early date and should have taken steps to ensure that reliable diesels were procured. LILCO failed to take such steps. Such steps would have been to (i) commence a complete design review and revalidation program far in advance of the September 1983 date when such a program actually was started, thus laying the basis for potential repair and/or qualification of the DeLaval diesels in a timely manner which would not necessitate application for an exemption; or (ii) to procure replacement diesels at a far earlier date, thus having reliable diesels on hand now instead of the Summer of 1985 when the Colt diesels are scheduled to be ready. Accordingly, it is our opinion that it would not be in the public interest and that a balance of equities would not favor the grant of an exception from applicable regulations when the primary

reason that LILCO now seeks an exemption is because of its own failure to take reasonable steps to ensure procurement of reliable diesels at an earlier time.

Q: Prior to seeking an exemption, how did LILCO propose to comply with GDC 17 during low power operation?

A: Since January 1976 when the Shoreham FSAR first came out, LILCO has always relied for onsite emergency AC power on three DeLaval diesels. These diesels, as will be discussed later in our testimony, were ordered from DeLaval in 1974 and arrived at Shoreham in 1976. They were stored for some period of time, and then installed. Turnover to the startup organization for testing occurred in August 1980 for Diesel Generator 102, and in October 1981 for Diesel Generators 101 and 103. Intensive preoperational testing began in September 1982.1/

1/ Direct Testimony of William J. Museler and Edward J. Youngling, New York PSC Case No. 27563, November 4, 1983.

Q: In a previous answer you referenced an investigation of LILCO's handling of issues related to the DeLaval diesels. Please explain.

A: We submitted written testimony on February 10, 1984 in the ongoing proceeding before the New York Public Service Commission in PSC Case No. 27563 (Phase II), a case designed to investigate the cost of Shoreham. The purpose of that testimony was to examine the reasons for the dramatic increase in the estimated cost of the Shoreham Nuclear Plant, from an estimated $65-75 million in 1966 to a January 1984 estimate of $3.877 billion or more. In preparing that testimony, we evaluated the amount of the cost increase that is attributable to LILCO's allegedly imprudent responses to regulatory, design, and technical problems. Among the issues addressed was how the cost of Shoreham was affected by LILCO's procurement, installation, and testing of the DeLaval diesels.

Our investigation concerning the costs incurred at Shoreham consisted primarily of our participation in the PSC Phase II discovery process. We reviewed documents provided to Suffolk County and the Public Service Commission Staff by LILCO. In addition, we assisted

Suffolk County in the preparation of interrogatories and reviewed LILCO's responses to them. MHB representatives also attended and participated in many of the interviews that the Public Service Commission Staff and its consultants conducted with employees of LILCO and Stone and Webster (LILCO's Contractor Architect-Engineer).

In addition to our role in the discovery and testimony phase of the Phase II proceeding, Gregory Minor and Dale Bridenbaugh of MHB also provided testimony regarding the likely cost and schedule to complete Shoreham in Phase I of that proceeding. Finally, since 1977 MHB has been consultant to Suffolk County in the Atomic Safety and Licensing Board proceeding to determine whether LILCO has met the requirements necessary to receive an Operating License, participating actively in the DeLaval diesel proceeding, among others.

III. LILCO'S EMERGENCY DIESEL GENERATOR PROBLEMS

Q: Briefly describe the major problems LILCO has encountered recently with its DeLaval diesels.

A: The three DeLaval diesels at Shoreham have experienced repeated deficiencies as set forth herein and in the

Attachments. For example, operational problems with the diesels at Shoreham occurring a relatively short time prior to the August 1983 crankshaft failure included cylinder head cracks, rocker arm assembly hold-down bolt failures, turbocharger bearing failures, and cracks in the engine block casting. Further, LILCO was fined $40,000 by the NRC during 19[illegible] for its failure to follow required procedures during the preoperational testing of the diesels.

On August 12, 1983, during the testing of replacements for cylinder heads that had cracked, one of the three diesels, 102, experienced excessive vibration and erratic load swings. On August 13, 1983, it was discovered that the crankshaft on diesel 102 was completely severed. During disassembly of the diesels, the crankshafts of the other two diesels were found to contain cracks.

In addition, following the crankshaft failure in August 1983, other problems were subsequently revealed, including cracked connecting rod bearings and pistons.2/

2/ Millard S. Pollock to Harold R. Denton, Nov. 23, 1983, SNRC-986.

Ultimately, 23 of 24 pistons in the Shoreham engines were found to be cracked.3/

In Fall, 1983, following the crankshaft failure, and in recognition of other operational deficiencies as set forth later herein which have occurred with DeLaval diesels, LILCO instituted a recovery program aimed at determining the cause of the crankshaft failure, correcting it, and attempting to ensure that other components of the Shoreham diesels would operate reliably in the future.4/ In our opinion, this recovery program came far too late in time.

Q: Were the recent DeLaval problems you just described a complete surprise or were these problems to have been expected?

3/ LILCO Diesel Generator Status Report, November 17, 1983.

4/ Brian R. McCaffrey to Harold R. Denton, January 6, 1984, Shoreham Diesel Generator Recovery Program Summary, SNRC-1003. The NRC has also recognized the need for such a recovery program. Indeed, the NRC determined that a broad pattern of deficiencies in critical engine components has become evident at Shoreham and at other nuclear and non-nuclear facilities employing DeLaval diesels. The NRC now believes that the deficiencies stem from inadequacies in design, manufacture and quality control by DeLaval. Order Requiring Diesel Generator Inspection," Grand Gulf Nuclear Station, Docket No. 50-416, May 22, 1984. (In particular, see Attachment 4 thereto.)

A: The precise problems or failures which have been experienced in the Shoreham DeLaval diesels in the last year and a half were perhaps not expected. However, given prior events related to the diesels, serious problems cannot be deemed to have been a surprise. Indeed, the reported cause of the current problems (discussed later in this testimony) can be traced directly to failures that occurred early in the design and manufacturing process.5/

Q: How do these problems relate to LILCO's Application For Exemption?

5/ For example, LILCO retained Failure Analysis Associates ("Failure Analysis") to investigate the August 1983 crankshaft failure. Failure Analysis concluded that the crankshaft failed because it was not designed to withstand the cyclic torsional stresses that would be experienced during the diesels' operation. The conclusion was reached, based on a relatively simple calculation, that DeLaval had misdesigned the crankshaft, leading to insufficient capacity to withstand anticipated loads. Emergency Diesel Generator Crankshaft Failure Investigation, Failure Analysis, October 31, 1983. LILCO attributed the crankshaft problem to a design error in the torsional stress analysis performed by DeLaval. LILCO Diesel Generator Status Report, November 17, 1983. As will be addressed later in this testimony, the LILCO and Stone and Webster audit of DeLaval in 1975 did not even address the crucial area of design control. If it had, perhaps the design deficiency in the crankshaft would have been a notice of the need for a thorough design review.

A: It is our position that LILCO was, in effect, responsible for failing to detect these deficiencies and for failing at a far earlier date (i.e., well in advance of Fall 1983) to institute necessary steps to repair (if possible) or replace the DeLaval diesels. Thus the need for LILCO now to seek an exemption is really the result of LILCO's own fault. Indeed, as set forth in the following portions of this testimony, our review indicates that from 1974 to 1983, LILCO's approach has been to treat the symptoms rather than the root cause(s) underlying the problems disclosed in the design and fabrication of the Shoreham diesels. Thus, there have been repeated problems with these diesels which put LILCO on notice far before Fall 1983 that something was fundamentally wrong with its diesels. LILCO ignored the warning signs and never sought to determine adequately why the problems existed. The need for LILCO now to seek an exemption is a direct result of LILCO's failure to detect and remedy in a timely manner the broad pattern of deficiencies in the design and manufacture of the DeLaval diesels.

Q: Does the fact that LILCO initiated a program in Fall 1983 to attempt to mitigate and correct the problems with the DeLaval diesels change your opinion that LILCO's need for

an exemption is a result of LILCO's own failure to take appropriate actions at an earlier date?

A: No. The fact that LILCO has eventually begun to attempt to deal with the difficult (perhaps insurmountable) DeLaval diesel problems does not make its prior failure to act any less the cause of the problem in the first place. Our point is that it is not in the public interest, and it is not equitable to reward a utility by waiving a compulsory safety regulation, when the reason the utility is unable to comply with that regulation is a result of its own insufficient actions.

Q: When did LILCO first become aware of the potential for serious deficiences relating to the DeLaval diesels?

A: In 1974 LILCO was on notice that heightened QA/QC audit treatment of DeLaval would be necessary to ensure that a reliable and top quality product would be designed and manufactured. In fact, however, despite obvious warning signals, LILCO and Stone and Webster failed to implement an adequate QA/QC audit program for the design and manufacture of the DeLaval diesels.

Q: Please state the basis(es) for your prior answer.

A: The diesels supplied for Shoreham were DeLaval's first ever contract for supply of a diesel for a nuclear application. To the best of our knowledge, DeLaval had never even attempted to develop or implement a 10 CFR 50 Appendix B QA program before 1974. DeLaval's newness to nuclear work and Appendix B QA matters, in our opinion, made it incumbent on LILCO or its delegate to pay close attention, from the beginning, to how well DeLaval was doing in designing and manufacturing the Shoreham diesels. Indeed, the fact that DeLaval was new to the nuclear field made it absolutely incumbent on LILCO to ensure that a stringent audit program was instituted to ensure that all nuclear requirements were met. In fact, however, LILCO did not institute such a program.6/

6/ Since the Shoreham diesels were DeLaval's first attempt to design and manufacture diesels pursuant to the regulatory requirements of Appendix A and Appendix B to 10 CFR Part 50, LILCO and Stone and Webster should have anticipated "bugs" in the DeLaval QA program. Thus, Stone and Webster should have increased its audits of DeLaval activities during the design and fabrication of the Shoreham diesels because the need to detect and correct the "bugs" in the DeLaval QA/QC process was obvious. LILCO's failure to assure that this was done is another basis for our belief that LILCO's present need for the requested exemption is its own fault.

The purchase order for the DeLaval diesels was issued by LILCO in May 1974 following a QA survey of the DeLaval shop conducted by Stone and Webster on February 26, 1974.7/ The DeLaval QA manual had been reviewed by Stone and Webster one week earlier (on February 19, 1974) and had been found not to meet several of the regulatory requirements of Appendix B to 10 CFR Part 50. The major deficiencies discovered by Stone and Webster were that design control and a number of measures for vendor corrective action, QA record retention, and audits, were not addressed in the DeLaval manual.8/ It was not until March 14, 1974, that Stone and Webster determined that the DeLaval QA manual, as revised on March 1, 1974, was in compliance with the intent of 10 CFR Part 50, Appendix B.

Based on the preceding, we conclude that the Stone and Webster shop survey should have put Stone and Webster and LILCO even more on alert (aside from DeLaval's lack of nuclear experience) in early 1974 of the need to closely watch DeLaval's QA implementation. They did not.

7/ Stone and Webster Procurement Quality Control Survey of DeLaval, G. I. Beaman, February 26, 1974.

8/ Stone and Webster Manual Checklist, DeLaval QA Manual dated May 1, 1970, Ellen O'Connor, February 19, 1974.

The fact that the February 1974 shop survey was conducted on a QA manual and program which were in transition should have led to a new survey and audits of QA implementation shortly after March 14, 1974 when the QA manual was found to be adequate or shortly after May 1974 when the purchase order was issued. This would have allowed an early judgment, during the key diesel design phase, regarding whether essential QA functions were being properly performed. LILCO failed to do any such audits in a timely manner.

Stone & Webster did, much later, conduct an audit of DeLaval. However, the audit findings, the time of the audit, its scope, and the lack of additional audits, support our view that LILCO should be deemed to be responsible for the difficulties with the DeLaval diesels. This one audit of DeLaval by Stone and Webster was not conducted until October 28 to 30, 1975, more than 18 months after the initial shop survey that found DeLaval QA to be deficient and about 18 months after the purchase order had been placed. Reaudits of the corrective action measures required of DeLaval as a result of the October 1975 audit were performed on February 23, 1976 and June 18, 1976. In both the 1975 audit report and the February

reaudit, Stone and Webster auditors concluded that DeLaval had failed to fully comply with the requirements set forth in its QA manual or with the regulations in Appendix B to 10 CFR Part 50.

The three diesels were shipped to LILCO on the following dates: diesel 101, February 27, 1976; diesel 102, March 27, 1976; diesel 103, May 14, 1976. Therefore, all three diesels were designed, fabricated, tested, and shipped prior to implementation of the required QA measures, in effect without full regard for the potential impact of the identified discrepancies on the hardware. Indeed, even at the time of the first audit in late 1975, DeLaval's design and procurement activities were nearly complete, and the fabrication of components at the DeLaval casting and manufacturing facility was well advanced. Thus, in many respects, the Stone and Webster audit largely represented an after-the-fact evaluation which resulted in little or no effect on the Shoreham diesels.

Rather prophetically, Mr. Bienduga, Stone and Webster Procurement Quality Control District Chief, observed in a January 29, 1976 memorandum which concerned the October 1975 audit:

> I feel that DeLaval's response is too little too late as the audit was conducted to verify compliance to the P.O. and approved Q/A program, not to upgrade their system for future work. We should either get a positive response as to what actions are being taken now or we should stop the job!

Furthermore, there were significant limitations in the scope of the audit conducted on behalf of LILCO by Stone and Webster. The 1975 audit, as well as the reaudits, investigated DeLaval's compliance with only 11 of the 18 criteria of Appendix B: Criteria 4, 7, 9, 10 and 12 to 18. The areas audited by Stone and Webster primarily involved procurement and fabrication. Critical areas including design control (Criterion 3),[9/] procedural control (Criterion 5), and document control (Criterion 6) were not addressed in the Stone and Webster audit or reaudits. Thus, during the entire course of DeLaval's design and manufacture of the diesels for Shoreham, critical Appendix B criteria were never audited by LILCO or its representative. Stone and Websters' failure to audit the DeLaval design activities, including the design verification program, is a significant omission. Stone and

---

9/ We note that the critical crankshaft failure of August 1983 resulted from design errors. See note 4 in this testimony.

Webster, in effect, delegated responsibility for design QA activities to DeLaval. Further, Stone and Webster failed to recognize early in the design and fabrication schedule the potential problems that DeLaval might confront in supplying its first diesels for nuclear application. Indeed, Mr. Bienduga came to this conclusion after the fact:

> My personal feelings regarding this reaudit is that too much responsibility has been given a relatively young, inexperienced, quality engineering group. There seems to be passive acceptance by the Q/C Mgr. of excuses and not enough supervisory follow up to get things done.
>
> Granted the LILCO order is their first 'nuclear' contract and there are many 'bugs' to be ironed out but that doesn't help our situation unless the Q/C Mgr. is willing to take positive steps to get the 'bugs' out of the system.10/

In light of DeLavals' failure to meet adequate QA standards in other areas, DeLaval's lack of nuclear experience, and Stone and Webster's knowledge of such failure and inexperience, this was a particularly deficient action by LILCO's contractor, which supports our belief that the problems with the DeLaval diesels could possibly have been prevented by LILCO.

10/ Stone and Webster Interoffice memorandum, W. V. Bienduga, February 25, 1976.

Q: What actions should LILCO have taken after the knowledge it gained or should have gained in the 1974-76 period?

A: The serious deficiences in the QA implementation deficiences identified in 1974-76 should have alerted LILCO to the need to carefully assess the adequacy of these diesels at an early date.

Q: Did LILCO commence such an early reassessment program?

A: No. As noted above, LILCO did not start such a program until Fall 1983.

Q: Between 1976 and the Fall of 1983 did LILCO acquire (or should it have acquired) further data to indicate the need for an early revalidation or diesel replacement program, which, if implemented, would have eliminated the need for LILCO to seek the instant exemption?

A: Yes. LILCO's experience with the DeLaval diesels commencing in 1977 should have alerted LILCO at an early date to potential QA problems, so that at an early date LILCO should have taken steps to avoid the situation which it presently confronts.

Since late 1977, LILCO has discovered and repaired or sought to remedy numerous problems with the Shoreham diesels. For example, 21 problems with the diesels that LILCO experienced prior to 1981 are set forth in a January 15, 1981 letter from D.D. Terry of LILCO Start-Up to Mr. Taylor. The letter is appended as Attachment 3 hereto. These deficiencies also necessitated a number of Engineering and Design Coordination Reports (see Attachment 4 hereto) in order to attempt to achieve engineering resolution of these problems, leading one LILCO employee to observe "we bought the low bidder."

In addition, in 1983, Energy Consultants Incorporated conducted a retrospective assessment for the NRC of selected operational problems identified in LILCO Deficiency Reports, Repair/Rework Requests, and failure reports issued by LILCO and DeLaval. Energy Consultants' report, issued prior to the DeLaval crankshaft failure, concluded:

> A large number and variety of problems that have been experienced can be attributed to vendor workmanship. These errors, in conjunction with the problems identified during audits of DeLaval's Quality Assurance Program [audits/reaudits conducted October 1975, February 1976, and June 1976], indicate a weakly implemented Quality Control Program.

(Emphasis supplied). Energy Consultants also observed that:

> During the detailed review of various Deficiency Reports, Failure Reports and Repair/Rework Requests, a significant number of problems or errors have been identified which seem to have occurred due to errors and incomplete or improperly completed work by the manufacturer.11/

Examples of specific problems with the DeLaval diesels that Energy Consultants concluded fell into this category are set forth in Attachment 1 of its report.

Other documents also reveal a broad pattern of problems with the diesels. Indeed, even LILCO now asserts that:

> Prior to the crankshaft failure, LILCO had experienced a number of occurrences attributable to defectively designed or fabricated diesel generator components, including three leaking cylinder heads, defective jacket water pumps, leaking fuel oil injection lines, inadequate turbocharger thrust bearing lubrication, inadequate piston skirt to piston crown

---

11/ Energy Consultants Incorporated, "Witness and Evaluation of Emergency Diesel Generator Testing at Shoreham Nuclear Power Station for Nuclear Regulatory Commission, Region I Staff, Final Report of NRC Contract No. 05-82-249 Parameter Purchase Order No. NRC-IE-82/83, Task 38", July 12, 1983, appended as Attachment 5.

> attachment, broken rocker arm shaft bolts and cracked subcover assemblies. While these occurrences were generally of the type experienced in the shakedown of large diesel engines, they appear, nonetheless, to be attributable to defective design or fabrication.12/

In our opinion, LILCO could and should have recognized far before Fall 1983 that the DeLaval diesels were probably not reliable, and thus, should have taken steps at an earlier time to remedy the diesel problem. However, LILCO failed to do so. Instead, it let the situation deteriorate to the point of a catastrophic failure of the machines, and now seeks special treatment from the NRC.

LILCO's failure to take timely early action to address the root causes of DeLaval failures is also reflected in LILCO's failure to take heed of the significant NRC findings of deficiences in the DeLaval QA program. For example, the NRC Staff has observed that "the number of minor problems experienced by the TDI machines in nuclear service appears to be abnormally high."13/ A summary of

---

12/ Letter, E.M. Barrett of LILCO to Robert E. Smith, counsel for DeLaval, December 2, 1983, appended as Attachment 6.

13/ Nuclear Regulatory Commission Board Notification 83-160, October 21, 1983, page 1. Enclosures 2 and 4 to the Board

(Footnote cont'd next page)

operating problems experienced with DeLaval diesels, which was compiled by the NRC Staff, is appended to this testimony as Attachment 8.14/ In addition, during its vendor inspections in 1983, the NRC inspectors identified "conditions which imply that portions of the DeLaval QA Program have not been carried out in accordance with the provisions of 10 CFR 50, Appendix B."15/

Further, the NRC vendor inspection program previously had identified problems in the implementation of the DeLaval QA program. Beginning in 1979 and continuing through 1983, the NRC conducted nine inspections at DeLaval. Sixty-two instances of regulatory violations or nonconformances were documented.16/ This number of

---

(Footnote cont'd from previous page)

Notification identify a number of problems that have occurred with DeLaval diesels over the last three years. It is appended as Attachment 7.

14/ DeLaval Diesel Generator Operation Experience, handout prepared by the Nuclear Regulatory Commission at a meeting on DeLaval diesels held by the Staff in Bethesda, Maryland on January 26, 1984. Appended as Attachment 8.

15/ Nuclear Regulatory Commission Board Notification 83-160, October 21, 1983, page 2 (attached as Attachment 7). The details of the allegations have not been revealed by the NRC to avoid compromising the ongoing investigation of DeLaval being conducted by the NRC's Office of Investigations.

16/ Nuclear Regulatory Commission Vendor Inspection Reports (October 14 to 17, 1980), issued January 22, 1981; 81-01,

(Footnote cont'd next page)

problems in the DeLaval QA program, many of which remained uncorrected over three years after the completion of the Shoreham diesels, further demonstrates that the DeLaval QA process was suspect and that LILCO, far before Fall 1983, should have recognized the unreliability of the DeLaval diesels and taken steps to institute a comprehensive revalidation program or to replace them completely.

Attached to this testimony as Attachment 9 is a summary of the DeLaval inspection history prepared by the NRC's Vendor Inspection Branch. The vendor inspection history was discussed by John Collins, Regional Administrator for Region IV of the Nuclear Regulatory Commission, at a January 26, 1984 meeting NRC Staff/DeLaval Owners' Group meeting. Mr. Collins expressed serious reservations about the adequacy of both the DeLaval and utilitys' QA/QC program, as follows:

> As we indicated at the beginning, we have summarized in these slides the findings. But, more that's of interest. If you carefully review the findings that were handed

---

(Footnote cont'd from previous page)

to 16, 1981), issued September 18, 1981; 82-01, (January 25 to 29, 1982), issued April 15, 1982; 82-02, (August 23 to 26, 1982), issued December 8, 1982; and 83-01, (July 11 to 15, 1983), issued October 3, 1983.

> to you that were documented in the handout to you, one thing it says to me, in my opinion, is that not only has there been problems at the manufacturing shop, but also, in my opinion, calls into question the adequacy of the vendor programs or surveillance programs that are being conducted by the utilities. Had some of these been identified up front by utilities on-site inspection programs, or receiving inspection programs, or procurement programs, I think they could have been identified even sooner than now. So, it really calls into question your own programs.17/

(Emphasis added). Similarly, Mr. William Foster of the NRC Staff stated recently that the number and nature of violations and nonconformance at DeLaval indicated to him that the DeLaval QA System was "ineffective."18/

Q: What is the significance in the context of this proceeding of the NRC's findings concerning DeLaval with respect to LILCO's responsibility for the diesel failures that have required it to seek an exemption?

17/ John Collins, "Transcript of Meeting on DeLaval Diesel Generators," held at the Nuclear Regulatory Commission headquarters, Bethesda, Maryland, January 26, 1984, appended as Attachment 10.

18/ Deposition of William Foster, May 22, 1984, at 16.

A: LILCO should have been aware of the NRC's DeLaval inspection findings since the reports were publicly available. LILCO should have read these NRC inspection reports and taken appropriate actions. This is especially the case regarding LILCO since the 1974-76 experience (discussed above) had given bases for concern. We have found little evidence, however, of any systematic response by LILCO management to determine the root cause(s) in the QA/QC program implementation which resulted in the numerous nonconformances found at DeLaval by the NRC. This failure by LILCO further supports our belief that LILCO's need for an exemption is the result of its own inappropriate actions or inaction.19/

19/ LILCO should also have been alerted to potential problems with the Shoreham diesels as a result of the pattern of deficiencies in DeLaval's production of other diesel engines for nuclear service, which resulted in numerous operational problems. These problems were generally reported by DeLaval in Part 21, Title 10 of the Code of Federal Regulations reports, or by the owners of the diesels in Part 50.55(e), Title 10 of the Code of Federal Regulations reports. Copies of such Part 21 reports were sent to LILCO by DeLaval.

Q: Is there any other basis for your opinion that LILCO's need for an exemption results from LILCO's own inappropriate actions?

A: Yes. DeLaval diesel owners have documented serious operational problems in non-nuclear applications similar to those experienced by nuclear users. Thus, in addition to the problems LILCO itself experienced with the DeLaval diesels prior to 1983, if LILCO had looked, it would have found much additional evidence of the unsatisfactory design and manufacture of DeLaval diesels similar to the Shoreham diesels. In our opinion, in view of the history known to LILCO of QA problems with DeLaval, LILCO, prior to 1983, should have tracked and responded to the significant problems with DeLaval diesels in non-nuclear applications. This is especially the case since the lack of operating experience of DeLaval diesels in nuclear applications should have led LILCO to inquire how DeLaval diesels were performing in non-nuclear applications.

For example, the DeLaval diesels supplied for the ship M.V. Columbia have experienced many component failures including:

- o Cylinder heads - design and manufacturing defects
- o Cylinder liner distortion and wear - due to block distortion
- o Piston ring distortion and wear - due to block distortion
- o Cylinder blocks - distortion and cracking
- o Connecting rod bearings - design of articulated connecting rod assembly
- o Main bearings - premature wear, high loading
- o Camshafts - premature wear[20/]

Based on the preceding, the authors of the M.V. Columbia evaluation concluded:

> "[M]ajor moving components of the engine failed or required an inordinate amount of corrective maintenance at a significantly higher rate as compared to either DeLaval's recommended scheduled maintenance or other

---

20/ Seaworthy Engine Systems Report No. 124-01, Evaluation Of The Operational And Maintenance History Of, And Recent Modifications To, The Main Engines In the M.V. Columbia, April, 1983. Other shipboard failures of the same nature experienced by the Pride of Texas are set forth in Attachment A to letter from C.C. Wei, Falcon Carriers, Inc. to C. Matthews, DeLaval, Re: Pride of Texas Engine Problems, July 22, 1982.

typical diesel manufacturer's TBOs. The types of failures and number of failures of some of the major components indicates design deficiencies in these components. Two critical components which have been subject to failure, which are not typically expected to routinely fail, were the articulated connecting rods and cylinder blocks.21/

Q: Why do you believe that LILCO's failure to consider non-nuclear data concerning the DeLaval diesels was inappropriate?

A: As noted above, the lack of DeLaval diesels in nuclear applications should have led LILCO to inquire regarding their performance in non-nuclear service. Indeed, LILCO itself apparently considered non-nuclear applications of the DeLaval diesels to be relevant to the use of the diesels at Shoreham. For example, LILCO relied upon DeLaval's allegedly good non-nuclear experience in other aspects of this proceeding. In his affidavit attached to LILCO's Opposition to Suffolk County's Motion to Add an Emergency Diesel Generator Contention, May 16, 1983, Mr. Youngling of LILCO testified:

21/ Seaworthy Engine Systems Report No. 124-01, Evaluation Of The Operational And Maintenance History Of, And Recent Modifications To, The Main Engines In the M.V. Columbia, April, 1983.

> The vendor has advised LILCO that the basic diesel engine in the Shoreham diesel generators has been in production since the early 1950's. There are 97 diesel engines in this country that are essentially identical or very similar to the Shoreham diesels.

(Emphasis added). Mr. Youngling later testified that:

> Some of the diesels that we have cited in our 97 are marine application diesels, others are stationary application for power production and some are nuclear applications.22/

If LILCO had carefully scrutinized available data, however, it would have found actually that very serious problems were being experienced in non-nuclear DeLaval diesels.

In our opinion, a careful and timely look by LILCO at the non-nuclear experience with DeLaval diesels would have caused LILCO to review the adequacy of the Shoreham diesels well before their catastrophic failure in 1983. However, there is no evidence prior to 1983 that LILCO management sought to conduct such reviews, despite the fact that diesel operation was critical to the startup of

---

22/ Transcript of diesel proceeding, June 10, 1983 ("Hearing Transcript"), at 21,291.

Shoreham and despite the evidence, that grew stronger through the years, and of which LILCO had both direct and indirect knowledge, that DeLaval's diesels were seriously deficient for nuclear application.

Q: Does LILCO's purchase of alternate diesel generators, as stated in the Application for Exemption (p. 25), support the requested exemption?

A: No. At the October 26, 1983 LILCO Board of Directors meeting, the LILCO Board ratified a contract with the Fairbanks Morse Engine Division of Colt Industries ("Colt") for three 4400 kilowatt diesels for Shoreham at a cost of $12.985 million. However, that action does not change our opinion about the reasons LILCO should not be granted the requested exemption. Long before 1983, LILCO could, indeed should, have recognized the extremely serious problem with the DeLaval diesels and have perhaps purchased diesels from Colt. Indeed, LILCO could have selected the Colt diesels originally, and thus have avoided altogether the problems with the DeLaval diesels and the need for an exemption.

Colt submitted a bid in 1974 for three 4,296 kilowatt units. The Colt bid exceeded the DeLaval proposal by only

$100,967 (i.e., $2,210,967 for the Colt diesels versus $2,110,000 for the DeLaval diesels), but the Colt offer was determined to be technically unacceptable by LILCO because the kilowatt rating was deemed larger than required.[23] We believe that LILCO was in error in excluding Colt on this basis. Colt's prior experience in supplying nuclear grade diesels was given insufficient weight in LILCO's technical evaluation. In our opinion LILCO should have considered whether the QA/QC and other critical processes would have gone as smoothly with DeLaval, a vendor that had no previous nuclear experience, as they might have with Colt, which had extensive experience in qualifying its diesels for nuclear application. In this sense, perhaps DeLaval was not the lowest qualified bidder.

Q: What impact have the diesel problems had on the date for the operation of Shoreham?

A: LILCO contends that it would have been able to proceed with low power operation of Shoreham shortly after the

---

23/ "Technical Evaluation, Diesel Generator Sets - SHI-89," April 5, 1974, attached to letter from J.P. Allen, Stone & Webster project engineer, to H.C. Buckley, LILCO Purchasing Agent, April 11, 1974.

Atomic Safety Licensing Board issued its Partial Initial Decision on September 21, 1983 had it not been for the problems encountered with the diesels. Therefore, it appears that the DeLaval diesel problems are responsible for the delays from September 21, 1983 until such time as Shoreham begins low power operation, and constitute the reason for LILCO's alleged need for an exemption. As noted previously, however, LILCO had ample opportunity prior to Fall 1983 to take actions to head off the diesels being in the critical path. LILCO failed to take advantage of these numerous opportunities.

IV. CONCLUSIONS

Q: What are your conclusions concerning the selection, procurement, and installation of Shoreham's diesel generators?

A: Our investigation of these problems reveals that LILCO, directly or through its contractor, Stone and Webster, failed to act appropriately to assure that it acquired and installed emergency diesel generators suited for use at Shoreham.

- o LILCO and Stone and Webster failed to properly or promptly obtain, review, and follow up on available information that demonstrated deficiencies in the DeLaval QA program as well as numerous flaws in the product resulting from that program;

- o LILCO improperly excluded full consideration of the other potential diesel generator suppliers, specifically the Colt bid, and failed to properly evaluate Colt's nuclear experience;

- o LILCO relied too heavily upon DeLaval to design and manufacture the diesels, and thus failed to assure that DeLaval and Stone and Webster carried out their delegated QA tasks;

- o LILCO failed to conduct a suitable design verification of the DeLaval diesels at an early date, and thus failed to detect that the diesels may have significant deficiencies that prevent their approval for nuclear application.

- o LILCO failed to adhere to the NRC's QA/QC requirements and thus failed to take the planned and systematic actions necessary to provide adequate confidence

with this position. Rather, it is because of LILCO's insufficient actions since 1974 in the total diesel generator procurement and installation process described above that this delay has occurred. The problems arose far in advance of LILCO's late 1982 preoperational testing program and with prompt action could have been addressed at a far earlier date, thus eliminating any possible need for the exemption application. Thus, we conclude that the exceptional circumstances claimed by LILCO do not exist, particularly since LILCO itself is largely responsible for the problems which have occurred, and thus no exemption is warranted.

ATTACHMENT 1

PROFESSIONAL QUALIFICATIONS OF DALE G. BRIDENBAUGH

DALE G. BRIDENBAUGH
1723 Hamilton Avenue
Suite K
San Jose, CA 95125
(408) 266-2716

EXPERIENCE:

1976 - PRESENT

President - MHB Technical Associates, San Jose, California

Co-founder and partner of technical consulting firm. Specialists in energy consulting to governmental and other groups interested in evaluation of nuclear plant safety and licensing. Consultant in this capacity to state agencies in California, New York, Illinois, New Jersey, Pennsylvania, Oklahoma and Minnesota and to the Norwegian Nuclear Power Committee, Swedish Nuclear Inspectorate, and various other organizations and environmental groups. Performed extensive safety analysis for Swedish Energy Commission and contributed to the Union of Concerned Scientist's Review of WASH-1400. Consultant to the U.S. NRC - LWR Safety Improvement Program, performed Cost Analysis of Spent Fuel Disposal for the Natural Resources Defense Council, and contributed to the Department of Energy LWR Safety Improvement Program for Sandia Laboratories. Served as expert witness in NRC and state utility commission hearings.

1976 - (FEBRUARY - AUGUST)

Consultant, Project Survival, Palo Alto, California

Volunteer work on Nuclear Safeguards Initiative campaigns in California, Oregon, Washington, Arizona, and Colorado. Numerous presentations on nuclear power and alternative energy options to civic, government, and college groups. Also resource person for public service presentations on radio and television.

1973 - 1976

Manager, Performance Evaluation and Improvement, General Electric Company - Nuclear Energy Division, San Jose, California

Managed seventeen technical and seven clerical personnel with responsibility for establishment and management of systems to monitor and

measure Boiling Water Reactor equipment and system operational performance. Integrated General Electric resources in customer plant modifications, coordinated correction of causes of forced outages and of efforts to improve reliability and performance of BWR systems. Also responsible for development of Division Master Performance Improvement Plan as well as for numerous Staff special assignments on long-range studies. Was on special assignment for the management of two different ad hoc projects formed to resolve unique technical problems.

1972 - 1973

Manager, Product Service, General Electric Company - Nuclear Energy Division, San Jose, California

Managed group of twenty-one technical and four clerical personnel. Prime responsibility was to direct interface and liaison personnel involved in corrective actions required under contract warranties. Also in charge of refueling and service planning, performance analysis, and service communication functions supporting all completed commercial nuclear power reactors supplied by General Electric, both domestic and overseas (Spain, Germany, Italy, Japan, India, and Switzerland).

1968 - 1972

Manager, Product Service, General Electric Company - Nuclear Energy Division, San Jose, California

Managed sixteen technical and six clerical personnel with the responsibility for all customer contact, planning and execution of work required after the customer acceptance of department-supplied plants and/or equipment. This included quotation, sale and delivery of spare and renewal parts. Sales volume of parts increased from $1,000,000 in 1968 to over $3,000,000 in 1972.

1966 - 1968

Manager, Complaint and Warranty Service, General Electric Company - Nuclear Energy Division, San Jose, California

Managed group of six persons with the responsibility for customer contacts, planning and execution of work required after customer acceptance of department-supplied plants and/or equipment--both domestic and overseas.

1963 - 1966

Field Engineering Supervisor, General Electric Company, Installation and Service Engineering Department, Los Angeles, California

Supervised approximately eight field representatives with responsibility for General Electric steam and gas turbine installation and maintenance

work in Southern California, Arizona, and Southern Nevada. During this period was responsible for the installation of eight different central station steam turbine-generator units, plus much maintenance activity. Work included customer contact, preparation of quotations, and contract negotiations.

1956 - 1963

Field Engineer, General Electric Company, Installation and Service Engineering Department, Chicago, Illinois

Supervised installation and maintenance of steam turbines of all sizes. Supervised crews of from ten to more than one hundred men, depending on the job. Worked primarily with large utilities but had significant work with steel, petroleum and other process industries. Had four years of experience at construction, startup, trouble-shooting and refueling of the first large-scale commercial nuclear power unit.

1955 - 1956

Engineering Training Program, General Electric Company, Erie, Pennsylvania, and Schenectady, New York

Training assignments in plant facilities design and in steam turbine testing at two General Electric factory locations.

1953 - 1955

United States Army - Ordnance School, Aberdeen, Maryland

Instructor - Heavy Artillery Repair. Taught classroom and shop disassembly of artillery pieces.

1953

Engineering Training Program, General Electric Company, Evendale, Ohio

Training assignment with Aircraft Gas Turbine Department.

EDUCATION & AFFILIATIONS:

BSME - 1953, South Dakota School of Mines and Technology, Rapid City, South Dakota, Upper 1/4 of class.

Professional Nuclear Engineer - California. Certificate No. 0973.

Member - American Nuclear Society

Various Company Training Courses during career including Professional Business Management, Kepner Tregoe Decision Making, Effective Presentation, and numerous technical seminars.

HONORS & AWARDS:

Sigma Tau - Honorary Engineering Fraternity.

General Managers Award, General Electric Company.

PERSONAL DATA:

Born November 20, 1931, Miller, South Dakota.
Married, three children
6'2", 190 lbs., health - excellent
Honorable discharge from United States Army
Hobbies: Skiing, hiking, work with Boy Scout Groups

PUBLICATIONS & TESTIMONY:

1. Operating and Maintenance Experience, presented at Twelfth Annual Seminar for Electric Utility Executives, Pebble Beach, California, October 1972, published in General Electric NEDC-10697, December 1972.

2. Maintenance and In-Service Inspection, presented at IAEA Symposium on Experience From Operating and Fueling of Nuclear Power Plants; Bridenbaugh, Lloyd & Turner, Vienna, Austria, October, 1973.

3. Operating and Maintenance Experience, presented at Thirteenth Annual Seminar for Electric Utility Executives, Pebble Beach, California, November 1973, published in General Electric NEDO-20222, January, 1974.

4. Improving Plant Availability, presented at Thirteenth Annual Seminar for Electric Utility Executives, Pebble Beach, California, November 1973, published in General Electric NEDO-20222, January, 1974.

5. Application of Plant Outage Experience to Improve Plant Performance, Bridenbaugh and Burdsall, American Power Conference, Chicago, Illinois, April 14, 1974.

6. Nuclear Valve Testing Cuts Cost, Time, Electrical World, October 15, 1974.

7. Testimony of D. G. Bridenbaugh, R. B. Hubbard, and G. C. Minor before the United States Congress, Joint Committee on Atomic Energy, February 18, 1976, Washington, D.C. (Published by the Union of Concerned Scientists, Cambridge, Massachusetts.)

8. Testimony of D. G. Bridenbaugh, R. B. Hubbard, G. C. Minor to the California State Assembly Committee on Resources, Land Use, and Energy, March 8, 1976.

9. Testimony by D. G. Bridenbaugh before the California Energy Commission, entitled, Initiation of Catastrophic Accidents at Diablo Canyon, Hearings on Emergency Planning, Avila Beach, California, November 4, 1976.

10. Testimony by D. G. Bridenbaugh before the U. S. Nuclear Regulatory Commission, subject: Diablo Canyon Nuclear Plant Performance, Atomic Safety and Licensing Board Hearings, December, 1976.

11. Testimony by D. G. Bridenbaugh before the California Energy Commission, subject: Interim Spent Fuel Storage Considerations, March 10, 1977.

12. Testimony of D. G. Bridenbaugh before the New York State Public Service Commission Siting Board Hearings concerning the Jamesport Nuclear Power Station, subject: Effect of Technical and Safety Deficiencies on Nuclear Plant Cost and Reliability, April, 1977.

13. Testimony by D. G. Bridenbaugh before the California State Energy Commission, subject: Decommissioning of Pressurized Water Reactors, Sundesert Nuclear Plant . arings, June 9, 1977.

14. Testimony by D. G. Bridenbaugh before the California State Energy Commission, subject: Economic Relationships of Decommissioning, Sundesert Nuclear Plant, for the Natural Resources Defense Council, July 15, 1977.

15. The Risks of Nuclear Power Reactors: A Review of the NRC Reactor Safety Study WASH-1400, Kendall, Hubbard, Minor & Bridenbaugh, et al, for the Union of Concerned Scientists, August, 1977.

16. Testimony by D. G. Bridenbaugh before the Vermont State Board of Health, subject: Operation of Vermont Yankee Nuclear Plant and Its Impact on Public Health and Safety, October 6, 1977.

17. Testimony by D. G. Bridenbaugh before the U.S. Nuclear Regulatory Commission, Atomic Safety and Licensing Board, subject: Deficiencies in Safety Evaluation of Non-Seismic Issues, Lack of a Definitive Finding of Safety, Diablo Canyon Nuclear Units, October 18, 1977, Avila Beach, California.

18. Testimony by D. G. Bridenbaugh before the Norwegian Commission on Nuclear Power, subject: Reactor Safety/Risk, October 26, 1977.

19. Swedish Reactor Safety Study: Barseback Risk Assessment, MHB Technical Associates, January, 1978. (Published by the Swedish Department of Industry as Document DsI 1978:1)

20. Testimony by D. G. Bridenbaugh before the Louisiana State Legislature Committee on Natural Resources, subject: Nuclear Power Plant Deficiencies Impacting on Safety & Reliability, Baton Rouge, Louisiana, February 13, 1978.

21. Spent Fuel Disposal Costs, report prepared by D. G. Bridenbaugh for the Natural Resources Defense Council (NRDC), August 31, 1978.

22. Testimony of D. G. Bridenbaugh, G. C. Minor, and R. B. Hubbard before the Atomic Safety and Licensing Board, in the matter of the Black Fox Nuclear Power Station Construction Permit Hearings, September 25, 1978, Tulsa, Oklahoma.

23. Testimony of D. G. Bridenbaugh and R. B. Hubbard before the Louisiana Public Service Commission, Nuclear Plant and Power Generation Costs, November 19, 1978, Baton Rouge, Louisiana.

24. Testimony by D. G. Bridenbaugh before the City Council and Electric Utility Commission of Austin, Texas, Design, Construction, and Operating Experience of Nuclear Generating Facilities, December 5, 1978, Austin, Texas.

25. Testimony by D. G. Bridenbaugh for the Commonwealth of Massachusetts, Department of Public Utilities, Impact of Unresolved Safety Issues, Generic Deficiencies, and Three Mile Island-Initiated Modifications on Power Generation Cost at the Proposed Pilgrim-2 Nuclear Plant, June 8, 1979.

26. Improving the Safety of LWR Power Plants, MHB Technical Associates, prepared for U.S. Dept. of Energy, Sandia Laboratories, September 28, 1979.

27. BWR Pipe and Nozzle Cracks, MHB Technical Associates, for the Swedish Nuclear Power Inspectorate (SKI), October, 1979.

28. Uncertainty in Nuclear Risk Assessment Methodology. MHB Technical Associates, for the Swedish Nuclear Power Inspectorate (SKI), January 1980.

29. Testimony of D. G. Bridenbaugh and G. C. Minor before the Atomic Safety and Licensing Board, in the matter of Sacramento Municipal Utility District, Rancho Seco Nuclear Generating Station following TMI-2 accident, subject: Operator Training and Human Factors Engineering, for the California Energy Commission, February 11, 1980.

30. Italian Reactor Safety Study: Caorso Risk Assessment, MHB Technical Associates, for Friends of the Earth, Italy, March, 1980.

31. Decontamination of Krypton-85 from Three Mile Island Nuclear Plant, H. Kendall, R. Pollard, & D. G. Bridenbaugh, et al, The Union of Concerned Scientists, delivered to the Governor of Pennsylvania, May 15, 1980.

32. Testimony by D. G. Bridenbaugh before the New Jersey Board of Public Utilities, on behalf of New Jersey Public Advocate's Office, Division of Rate Counsel, Analysis of 1979 Salem-1 Refueling Outage, August, 1980.

33. Minnesota Nuclear Plants Gaseous Emissions Study, MHB Technical Associates, for Minnesota Pollution Control Agency, September, 1980.

34. Position Statement, Proposed Rulemaking on the Storage and Disposal of Nuclear Waste, Joint Cross-Statement of Position of the New England Coalition on Nuclear Pollution and the Natural Resources Defense Council, September, 1980.

35. Testimony by D. G. Bridenbaugh and G. C. Minor, before the New York State Public Service Commission, In the Matter of Long Island Lighting Company Temporary Rate Case, prepared for the Shoreham Opponents Coalition, September 22, 1980, Shoreham Nuclear Plant Construction Schedule.

36. Supplemental Testimony by D. G. Bridenbaugh before the New Jersey Board of Public Utilities, on behalf of New Jersey Department of the Public Advocate, Division of Rate Counsel, Analysis of 1979 Salem-1 Refueling Outage, December, 1980.

37. Testimony by D. G. Bridenbaugh and G. C. Minor, before the New Jersey Board of Public Utilities, on behalf of New Jersey Department of the Public Advocate, Division of Rate Counsel, Oyster Creek 1980 Refueling Outage Investigation, February 1981.

38. Economic Assessment: Ownership Interest in Palo Verde Nuclear Station, MHB Technical Associates, for the City of Riverside, September 11, 1981.

39. Testimony of D. G. Bridenbaugh before the Public Utilities Commission of Ohio, in the Matter of the Regulation of the Electric Fuel Component Contained Within the Rate Schedules of the Toledo Edison Company and Related Matters, subject: Davis-Besse Nuclear Power Station 1980-81 Outage Review, November, 1981.

40. Supplemental Testimony of D. G. Bridenbaugh before the Public Utilities Commission of Ohio, in the matter of the Regulation of the Electric Fuel Component Contained within the Rate Schedules of the Toledo Edison Company and Related Matters, subject: Davis-Besse Nuclear Power Station 1980-81 Outage Review, November 1981.

41. Systems Interaction and Single Failure Criterion, Phase 2 Report, MHB Technical Associates for the Swedish Nuclear Power Inspectorate (SKI), January, 1982.

42. Testimony of D. G. Bridenbaugh and G. C. Minor on behalf of Governor Edmund G. Brown Jr., before the Atomic Safety and Licensing Board, regarding Contention 10, Pressurizer Heaters, January 11, 1982.

43. Testimony of D. G. Bridenbaugh and G. C. Minor on behalf of Governor Edmund G. Brown Jr., before the Atomic Safety and Licensing Board, regarding Contention 12, Block and Pilot Operated Relief Valves, January 11, 1982.

44. Testimony of D. G. Bridenbaugh before the Commonwealth of Massachusetts, Department of Public Utilities, on behalf of the Massachusetts Attorney General, Pilgrim Nuclear Power Station, 1981-82 Outage Investigation, March 11, 1982.

45. Testimony of D. G. Bridenbaugh before the Pennsylvania Public Utility Commission, on behalf of the Pennsylvania Office of Consumer Advocate, Beaver Valley Outage, March, 1982.

46. Interim testimony of D. G. Bridenbaugh before the Illinois Commerce Commission, on behalf of the Illinois Attorney General's Office, Expected Lifetimes and Performance of Nuclear Power Plants, March, 1982.

47. Testimony of D. G. Bridenbaugh and G. C. Minor before the Atomic Safety and Licensing Board, on behalf of Suffolk County, in the matter of Long Island Lighting Company, Shoreham Nuclear Power Station, Unit 1, regarding Suffolk County Contention 11, Passive Mechanical Valve Failures, April 13, 1982.

48. Testimony of D. G. Bridenbaugh and R. B. Hubbard, in the Matter of Jersey Central Power and Light Company For an Increase in Rates for Electrical Service, on behalf of New Jersey Department of the Public Advocate, Division of Rate Counsel, Three Mile Island Units 1 & 2, Cleanup and Modification Programs, May, 1982.

49. Testimony of D. G. Bridenbaugh and G. C. Minor on behalf of Suffolk County, before the Atomic Safety and Licensing Board, in the matter of Long Island Lighting Company, Shoreham Nuclear Power Station, Unit 1, regarding Suffolk County Contention 22, SRV Test Program, May 25, 1982.

50. Testimony of D. G. Bridenbaugh and G. C. Minor on behalf of Suffolk County, before the Atomic Safety and Licensing Board, in the matter of Long Island Lighting Company, Shoreham Nuclear Power Station, Unit 1, regarding Suffolk County Contention 28(a)(vi) and SOC Contention 7A(6), Reduction of SRV Challenges, June 14, 1982.

51. Testimony of D. G. Bridenbaugh before the Illinois Commerce Commission, on behalf of the Illinois Attorney General's Office, Expected Lifetimes and Performance of Nuclear Power Plants, June 18, 1982.

52. Testimony of D. G. Bridenbaugh and R. B. Hubbard on behalf of the Ohio Consumers Counsel, before the Public Utilities Commission of Ohio, regarding Construction of Perry Nuclear Generating Unit No. 1, October 7, 1982.

53. Issues Affecting the Viabiling and Acceptability of Nuclear Power Usage in the United States, prepared by MHB Technical Associates for Congress of the United States, Office of Technology Assessment for use in conjunction with Workshop on Technological and Regulatory Changes in Nuclear Power, December 8 & 9, 1982.

54. Testimony of D. G. Bridenbaugh on behalf of Rockford League of Women Voters, before the Atomic Safety and Licensing Board, in the matter of Commonwealth Edison Company, Byron Station, Units 1 and 2, regarding Contention 22, Steam Generators, March 1, 1983.

55. Testimony of G. C. Minor and D. G. Bridenbaugh before the Pennsylvania Public Utility Commission, on behalf of the Office of Consumer Advocate, Regarding the Cost of Constructing the Susquehanna Steam Electric Station, Unit I, Re: Pennsylvania Power and Light, March 18, 1983.

56. Surrebuttal Testimony of D. G. Bridenbaugh before the Pennsylvania Public Utility Commission, on behalf of the Office of Consumer Advocate, Regarding the Cost of Constructing the Susquehanna Steam Electric Station, Unit I, Re: Pennsylvania Power and Light, April 20, 1983.

57. Testimony of D. G. Bridenbaugh In the Matter of Public Service Gas & Electric, Base Rate Case, Nuclear Construction Expenditures, on behalf of New Jersey Department of the Public Advocate, Division of Rate Counsel, October 13, 1983

58. Affidavit of D. G. Bridenbaugh, in the Matter of Jersey Central Power and Light, on behalf of New Jersey Department of the Public Advocate, Division of Rate Counsel, TMI Fault Investigation, November 23, 1983.

59. Testimony of D. G. Bridenbaugh, in the Matter of Public Service Electric & Gas, on behalf of New Jersey Department of the Public Advocate, Division of Rate Counsel, LEAC Investigation, Salem-1 Outages, December 1, 1983.

60. Rebuttal Testimony of D. G. Bridenbaugh, in the Matter of public Service Electric & Gas, on behalf of New Jersey Department of the Public Advocate, Division of Rate Counsel, LEAC Investigation, Salem-1 Outages, January 18, 1984.

61. Testimony of D. G. Bridenbaugh, L. M. Danielson, R. B. Hubbard and G. C. Minor before the State of New York Public Service Commission, PSC Case No. 27563, in the matter of Long Island Lighting Company Proceeding to Investigate the Cost of the Shoreham Nuclear Generating Facility -- Phase II, on behalf of County of Suffolk, February 10, 1984.

62. Status Report, WJ Zimmer Plant, Assessment of Options, MHB Technical Associates, prepared for The Ohio Office of the Consumer's Counsel, February 23, 1984.

ATTACHMENT 2

PROFESSIONAL QUALIFICATIONS OF RICHARD B. HUBBARD

RICHARD B. HUBBARD
MHB Technical Associates
1723 Hamilton Avenue
Suite K
San Jose, California 95125

EXPERIENCE:

9/76 - PRESENT

Vice-President - MHB Technical Associates, San Jose, California.
Founder, and Vice-President of technical consulting firm. Specialists in independent energy assessments for government agencies, particularly technical and economic evaluation of nuclear power facilities. Consultant in this capacity to California, Massachusetts, Oklahoma and Illinois Attorney Generals, Minnesota Pollution Control Agency, German Ministry for Research and Technology, Governor of California, Swedish Energy Commission, Swedish Nuclear Inspectorate, Suffolk County, Ohio Consumer's Counsel, New Jersey Public Advocate, and the U. S. Department of Energy. Also provided studies and testimony for various public interest groups including the Center for Law in the Public Interest, Los Angeles; Public Law Utility Group, Baton Rouge, Louisiana; Friends of the Earth (FOE), Italy; and the Union of Concerned Scientists, Cambridge, Massachusetts. Provided testimony to the U.S. Senate/House Joint Committee on Atomic Energy, the U.S. House Committee on Interior and Insular Affairs, the California Assembly, Land Use, and Energy Committee, the Advisory Committee on Reactor Safeguards, and the Atomic Safety and Licensing Board. Performed comprehensive risk analysis of the accident probabilities and consequences at the Barseback Nuclear Plant for the Swedish Energy Commission and edited, as well as contributed to, the Union of Concerned Scientist's technical review of the NRC's Reactor Safety Study (WASH-1400).

2/76 - 9/76

Consultant, Project Survival, Palo Alto, California.
Volunteer work on Nuclear Safeguards Initiative campaigns in California, Oregon, Washington, Arizona, and Colorado. Numerous presentations on nuclear power and alternative energy options to civic, government, and college groups. Also resource person for public service presentations on radio and television.

5/75 - 1/76

Manager - Quality Assurance Section, Nuclear Energy Control and Instrumentation Department, General Electric Company, San Jose, California.
Report to the Department General Manager. Develop and implement quality plans, programs, methods, and equipment which assure that products produced by the Department meet quality requirements as defined in NRC regulation 10 CFR 50, Appendix B, ASME Boiler and Pressure Vessel Code, customer contracts, and GE Corporate policies and procedures. Product areas include radiation sensors, reactor vessel internals, fuel handling and servicing tools, nuclear plant control and protection instrumentation systems, and nuclear steam supply and Balance of Plant control room panels. Responsible for approximately 45 exempt personnel, 22 non-exempt personnel, and 129 hourly personnel with an expense budget of nearly 4 million dollars and equipment investment budget of approximately 1.2 million dollars.

11/71 - 5/75

Manager - Quality Assurance Subsection, Manufacturing Section of Atomic Power Equipment Department, General Electric Company, San Jose, California.
Report to the Manager of Manufacturing. Same functional and product responsibilities as in Engagement #1, except at a lower organizational report level. Developed a quality system which received NRC certification in 1975. The system was also successfully surveyed for ASME "N" and "NPT" symbol authorization in 1972 and 1975, plus ASME "U" and "S" symbol authorizations in 1975. Responsible for from 23 to 39 exempt personnel, 7 to 14 non-exempt personnel, and 53 to 97 hourly personnel.

3/70 - 11/71

Manager - Application Engineering Subsection, Nuclear Instrumentation Department, General Electric Company, San Jose, California.
Responsible for the post order technical interface with architect engineers and power plant owners to define and schedule the instrumentation and control systems for the Nuclear Steam Supply and Balance of Plant portion of nuclear power generating stations. Responsibilities included preparation of the plant instrument list with approximate location, review of interface drawings to define functional design requirements, and release of functional requirements for detailed equipment designs. Personnel supervised included 17 engineers and 5 non-exempt personnel.

12/69 - 3/70

Chairman - Equipment Room Task Force, Nuclear Instrumentation Department, General Electric Company, San Jose, California.
Responsible for a special task force reporting to the Department General Manager to define methods to improve the quality and reduce the

installation time and cost of nuclear power plant control rooms. Study resulted in the conception of a factory-fabricated control room consisting of signal conditioning and operator control panels mounted on modular floor sections which are completely assembled in the factory and thoroughly tested for proper operation of interacting devices. Personnel supervised included 10 exempt personnel.

12/65 - 12/69

Manager - Proposal Engineering Subsection, Nuclear Instrumentation Department, General Electric Company, San Jose, California.
Responsible for the application of instrumentation systems for nuclear power reactors during the proposal and pre-order period. Responsible for technical review of bid specifications, preparation of technical bid clarifications and exceptions, definition of material list for cost estimating, and the "as sold" review of contracts prior to turnover to Application Engineering. Personnel supervised varied from 2 to 9 engineers.

8/64 - 12/65

Sales Engineer, Nuclear Electronics Business Section of Atomic Power Equipment Department, General Electric Company, San Jose, California.
Responsible for the bid review, contract negotation, and sale of instrumentation systems and components for nuclear power plants, test reactors, and radiation hot cells. Also responsible for industrial sales of radiation sensing systems for measurement of chemical properties, level, and density.

10/61 - 8/64

Application Engineer, Low Voltage Switchgear Department, General Electric Company, Philadelphia, Pennsylvania
Responsible for the application and design of advanced diode and silicon-controlled rectifier (SCR) constant voltage DC power systems and variable voltage DC power systems for industrial applications. Designed, followed manufacturing and personally tested an advanced SCR power supply for product introduction at the Iron and Steel Show. Project Engineer for a DC power system for an aluminum pot line provided to Anaconda beginning at the 161KV switchyard and encompassing all the equipment to convert the power to 700 volts DC at 160,000 amperes.

9/60 - 10/61

GE Rotational Training Program

Four 3-month assignments on the GE Rotational Training Program for college technical graduates as follows:

a. Installation and Service Eng. - Detroit, Michigan
Installation and startup testing of the world's largest automated hot strip steel mill.

b. Tester - Industry Control - Roanoke, Virginia
Factory testing of control panels for control of steel, paper, pulp, and utility mills and power plants.

c. Engineer - Light Military Electronics - Johnson City, New York
Design of ground support equipment for testing the auto pilots on the F-105.

d. Sales Engineer - Morrison, Illinois
Sales of appliance controls including range timers and refrigerator cold controls.

EDUCATION:

Bachelor of Science Electrical Engineering, University of Arizona, 1960.

Master of Business Administration, University of Santa Clara, 1969.

PROFESSIONAL AFFILIATION:

Registered Quality Engineer, License No. QU805, State of California.

Member of Subcommittee 8 of the Nuclear Power Engineering Committee of the IEEE Power Engineering Society responsible for the preparation and revision of the following national Q.A. Standards:

a. IEEE 498 (ANSI N45.2.16): Requirements for the Calibration and Control of Measuring and Test Equipment used in the Construction and Maintenance of Nuclear Power Generating Stations.

b. IEEE 336 (ANSI N45.2.4): Installation, Inspection, and Testing Requirements for Class 1E Instrumentation and Electric Equipment at Nuclear Power Generating Stations.

c. IEEE 467 : Quality Assurance Program Requirements for the Design and Manufacture of Class 1E Instrumentation and Electric Equipment for Nuclear Power Generating Stations.

I am currently a member of the IEEE Committee which is preparing a standard relating to the selection and utilization of replacement parts for Class 1E equipment during the construction and operation phase.

PUBLICATIONS AND TESTIMONY:

1. In-Core System Provides Continuous Flux Map of Reactor Cores, R. B. Hubbard and C. E. Foreman, Power, November, 1967.

2. Quality Assurance: Providing It, Proving It, R. B. Hubbard, Power, May, 1972.

3. Testimony of R. B. Hubbard, D. G. Bridenbaugh, and G. C. Minor before the United States Congress, Joint Committee on Automic Energy, February 18, 1976, Washington, D.C. (Published by the Union of Concerned Scientists, Cambridge, Massachusetts.) Excerpts from testimony published in Quote Without Comment, Chemtech, May, 1976.

4. Testimony of R. B. Hubbard, D. G. Bridenbaugh, and G. C. Minor to the California State Assembly Committee on Resources, Land Use, and Energy, Sacramento, California, March 8, 1976.

5. Testimony of R. B. Hubbard and G. C. Minor before California State Senate Committee on Public Utilities, Transit, and Energy, Sacramento, California, March 23, 1976.

6. Testimony of R. B. Hubbard and G. C. Minor, Judicial Hearings Regarding Grafenrheinfeld Nuclear Plant, March 16 & 17, 1977, Wurzburg, Germany.

7. Testimony of R. B. Hubbard to United States House of Representatives, Subcommittee on Energy and the Environment, June 30, 1977, Washington, D.C., entitled, Effectiveness of NRC Regulations - Modifications to Diablo Canyon Nuclear Units.

8. Testimony of R. B. Hubbard to the Advisory Committee on Reactor Safeguards, August 12, 1977, Washington, D.C., Risk Uncertainty Due to Deficiencies in Diablo Canyon Quality Assurance Program and Failure to Implement Current NRC Practices.

9. The Risks of Nuclear Power Reactors: A Review of the NRC Reactor Safety Study WASH-1400, Kendall, et. al., edited by R. B. Hubbard and G. C. Minor for the Union of Concerned Scientists, August, 1977.

10. Swedish Reactor Safety Study: Barseback Risk Assessment, MHB Technical Associates, January 1978 (Published by Swedish Department of Industry as Document DSI (1978:1).

11. Testimony of R. B. Hubbard before the Energy Facility Siting Counsil, March 31, 1978, in the matter of Pebble Springs Nuclear Power Plant, Risk Assessment: Pebble Springs Nuclear Plant, Portland, Oregon.

12. Presentation by R. B. Hubbard before the Federal Ministry for Research and Technology (BMFT), August 31 and September 1, 1978, Meeting on Reactor Safety Research, Risk Analysis. Bonn, Germany.

13. Testimony by R. B. Hubbard, D. G. Bridenbaugh, and G. C. Minor before the Atomic Safety and Licensing Board, September 25, 1978, in the matter of the Black Fox Nuclear Power Station Construction Permit hearings, Tulsa, Oklahoma.

14. Testimony of R. B. Hubbard before the Atomic Safety and Licensing Board, November 17, 1978, in the matter of Diablo Canyon Nuclear Power Plant Operating License Hearings, Operating Basis Earthquake and Seismic Reanalysis of Structures, Systems, and Components, Avila Beach, California.

15. Testimony of R. B. Hubbard and D. G. Bridenbaugh before the Louisiana Public Service Commission, November 19, 1978, Nuclear Plant and Power Generation Costs, Baton Rouge, Louisiana.

16. Testimony of R. B. Hubbard before the California Legislature, Subcommittee on Energy, Los Angeles, April 12, 1979.

17. Testimony of R. B. Hubbard and G. C. Minor before the Federal Trade Commission, on behalf of the Union of Concerned Scientists, Standards and Certification Proposed Rule 16 CFR Part 457, May 18, 1979.

18. ALO-62, Improving the Safety of LWR Power Plants, MHB Technical Associates, prepared for U.S. Department of Energy, Sandia National Laboratories, September, 1979, available from NTIS.

19. Testimony by R. B. Hubbard before the Arizona State Legislature, Special Interim House Committee on Atomic Energy, Overview of Nuclear Safety, Phoenix, AZ, September 20, 1979.

20. "The Role of the Technical Consultant", Practising Law Institute program on "Nuclear Litigation", New York City and Chicago, November, 1979. Available from PLI, New York City.

21. Uncertainty in Nuclear Risk Assessment Methodology, MHB Technical Associates, March, 1980, prepared for and available from Swedish Nuclear Power Inspectorate, Stockholm, Sweden.

22. Italian Reactor Safety Study: Caorso Risk Assessment, MHB Technical Associates, March, 1980, prepared for and available from Friends of the Earth, Rome, Italy.

23. Development of Study Plans: Safety Assessment of Monticello and Prairie Island Nuclear Stations, MHB Technical Associates, August, 1980, prepared for and available from the Minnesota Pollution Control Agency.

24. Affidavit of Richard B. Hubbard and Gregory C. Minor before the Illinois Commerce Commission, In the Matter of an Investigation of the Plant Construction Program of the Commonwealth Edison Company, prepared for the League of Women Voters of Rockford, Illinois, November 12, 1980, ICC Case No. 78-0646.

25. Systems Interaction and Single Failure Criterion, MHB Technical Associates, January, 1981, prepared for and available from the Swedish Nuclear Power Inspectorate, Stockholm, Sweden.

26. Summary of Emergency Response Planning Criteria for Regional and Local Authorities Near Nuclear Electric Generating Stations, MHB Technical Associates, June, 1981, prepared for and available from Friends of the Earth, Rome, Italy.

27. Economic Assessment: Ownership Interest In Palo Verde Nuclear Station, September 11, 1981, prepared for and available from the City of Riverside, California.

28. Systems Interaction and Single Failure Criterion: Phase II report, MHB Technical Associates, December, 1981, prepared for and available from the Swedish Nuclear Power Inspectorate, Stockholm, Sweden.

29. Testimony of Richard Hubbard and Gregory Minor on Emergency Response Planning, Diablo Canyon Operating License hearings before ASLB, January 11, 1982.

30. Statement of Richard Hubbard before the U.S. House Subcommittee on Energy and Environment concerning QA program breakdowns, November 19, 1981.

31. Testimony of Richard Hubbard on Quality Assurance, South Texas Operating License hearing before ASLB, prefiled June, 1981.

32. Presentation of Richard Hubbard for Governor Edmund G. Brown, jr. concerning PG&E's Proposed Seismic Design Reverification Program, Diablo Canyon Nuclear Power Plant, February 1982.

33. Testimony of R. B. Hubbard, G. C. Minor, M. W. Goldsmith, S. J. Harwood on behalf of Suffolk County, before the Atomic Safety and Licensing Board, in the matter of Long Island Lighting Company, Shoreham Nuclear Power Station, Unit 1, regarding Contention 7B, Safety Classification and Systems Interaction, April 13, 1982.

34. Testimony of R. B. Hubbard and D. G. Bridenbaugh, in the matter of Jersey Central Power and Light Company For an Increase in Rates for Electrical Service, on behalf of New Jersey Department of the Public Advocate, Division of Rate Counsel, Three Mile Island Units 1 & 2, Cleanup and Modification Programs, May, 1982.

35. Testimony of R. B. Hubbard and G. C. Minor on behalf of Suffolk County, before the Atomic Safety and Licensing Board, in the matter of Long Island Lighting Company, Shoreham Nuclear Power Station, Unit 1, regarding Suffolk County Contention 27 and SOC Contention 3, Post-Accident Monitoring, May 25, 1982.

36. Presentation of R. B. Hubbard for Governor Edmund G. Brown, Jr. concerning Diablo Canyon Reverification Program, Diablo Canyon Nuclear Power Plant, September, 1982.

37. Testimony of R. B. Hubbard on behalf of Suffolk County, before the Atomic Safety and Licensing Board, in the matter of Long Island Lighting Company, Shoreham Nuclear Power Station, Unit 1, regarding Suffolk County Contentions 12, 13, 14, and 15, Quality Assurance/Quality Control, June 29, 1982.

38. Presentation of Richard B. Hubbard on Behalf of the State of California, Before the NRC Commissioners, Proposed Phase II Diablo Canyon Reverification Program (IDVP), November 10, 1982.

39. Testimony of R. B. Hubbard and Dr. Francisco J. Samaniego on behalf of Suffolk County, Before the Atomic Safety and Licensing Board, in the matter of Long Island Lighting Company, Shoreham Nuclear Power Station, Unit 1, regarding Torrey Pines Technology's Inspection of Shoreham Nuclear Power Station, December 21, 1982.

40. Supplemental testimony of G. C. Minor, R. B. Hubbard, and M. W. Goldsmith on behalf of Suffolk County, before the Atomic Safety and Licensing Board, in the matter of Long Island Lighting Company, Shoreham Nuclear Power Station, Unit 1, regarding Suffolk County Contention 7B, Safety Classification and Systems Interaction, March 23, 1983.

41. Supplemental Affidavit of R. B. Hubbard before the Atomic Safety and Licensing Appeal Board Concerning Breakdowns in the Diablo Canyon Quality Assurance Program, March 29, 1983.

42. Declaration of R. B. Hubbard before the Atomic Safety and Licensing Appeal Board, Concerning Breakdowns in Construction Quality Assurance at Diablo Canyon, May 6, 1983.

43. Presentation by R. B. Hubbard on behalf of Suffolk County to Cuomo Commission regarding Quality Assurance/Quality Control (QA/QC).

44. Testimony of R. B. Hubbard on Behalf of the State of California, Before the Atomic Safety and Licensing Appeal Board, in the matter of Pacific Gas and Electric Co., Regarding Design Quality Assurance, October, 1983.

45. Testimony of D. G. Bridenbaugh, L. M. Danielson, R. B. Hubbard and G. C. Miror before the State of New York Public Service Commission, PSC Case No. 27563, in the matter of Long Island Lighting Company Proceeding to Investigate the Cost of the Shoreham Nuclear Generating Facility — Phase II, on behalf of County of Suffolk, February 10, 1984.

46. Status Report, WJ Zimmer Plant, Assessment of Options, MHB Technical Associates, prepared for The Ohio Office of the Consumer's Counsel, February 23, 1984.

ATTACHMENT 3

LI-3068

SR2-R43.010

January 15, 1981

J.H. Taylor

Emergency Diesel Generator 102 Problems Encountered To Date
Shoreham Nuclear Power Station - Unit No. 1
W.O. 44430/48923

The attached report, prepared by T. Brown, J. Higgins and W. Cook accurately state the problems we have had to date.

An attempt to resolve many of the items was tried on December 18, 1980 when Startup arranged a meeting between ourselves, S&W and Delaval. Regretfully, Delaval could not attend and no real progress on problem solutions were made.

Another meeting is scheduled for January 20, 1981 at Shoreham and hopefully resolution to many problems will be achieved.

Many of the problems encountered by Startup to date have been the result of the "Skid Mounted Equipment", as with this type, the Construction organization has very minimal involvement other than "hooking up" to it. Along these lines, alignment deficiencies have been identified, storage problems have been corrected etc., all of which adds to Startup's scope of work as related to placing the equipment into service.

A rescheduling effort of the Diesel generators must be conducted due to the recent Proposed Site policy to primarily support the Integrated Flush. At the present time, we can not project a preop start date due to many unresolved problems and no projected turnover date for Engines 101 and 103.

D.D. Terry
Lead Startup Engineer

DDT:bc

cc: T. Brown
J. Higgins
W. Cook
L.W. Lewin
W.M. Matejek
SR2-R43.010

FLAG C SYS 1R43
COMP SYS
FILE 010 DOC —

PROBLEM REPORT

R43- EMERGENCY DIESEL GENERATORS

1- Procedure that had been JTG approved for subsystem flushes were not adequate. Specifically, the lube oil flush did not provide sufficient flow to clean the system. (this test procedure used B&A pump (40GPM.) which has a normal flow of about 250GPM. Also, the JW system flush procedure uses the J.W. heater circulating pump (50GPM) for a system with a normal flow of 800 GPM. This procedure will be revised to incorporate a temporary flush pump.

2- Excessive amounts of time were required to review component lists since (a) initial list missed many items (b) isometrics are continually changing resulting in added and/or deleted sections, and (c) hanger listings change as isos are revised and the designation changes (E&DCR F 29376). Changes in component lists are no longer to be reviewed - only marked noted by test engineer.

3- Excessive amounts of time was required to review punchlist items. This was compounded by (a) reorganization of lists by renumbering all items, (b) excessive number of items, (c) failure to perform verification of completion by turnover and (d) non-informative responsiblity assignment.

Responsibility is not discussed with the individual resulting frequently in the wrong discipline being assigned, the individual being unaware of his responsibility, and the wrong completion code being assigned. The issuing of the complete list each month instead of a list of changes results in an impossible review task.

4- Excessive amounts of time are required for review of preliminaries. New preliminary release packages are submitted for review with little or no change in the punchlists. Meetings are called to discuss package updates with the only change being requests for further concessions on number of items required for turnover. R43A has had six preliminaries and the punchlist is still some 46 pages long.

5- Construction status for release was poor--we received a minimum of requested storage history information. Final engine alignment was not performed. There was no record of foundation bolt torquing. Megger readings of generator stator were not up to date. Megger reading of generator field and bearing pillow block were non-existant.

6- Numerous design and construction errors necessitated initiation of E&DCR's (65 to date. This has resulted in an exorbitant amount of time being expended reviewing drawings and documents. Many of the original problem solutions were incorrect which resulted in rewriting the E&DCR or calling SEO to request the next issue. We have attempted to get the drawings updated to reflect the system as it was designed and to get the drawings that the diesels were built to, but usually we are requested to mark up prints reflecting as built conditions. Problem solutions are at a standstill at present, only one has been answered since the end of October - nineteen are unanswered.

7- Numerous repair-reworks (38) have been written because of many incomplete or defective items. Some of these are a result of E&DCR's, some are a result of poor factory assembly practices, some are a result of a forced turnover with incomplete/deficient components, and some are a result of poor construction practices. A great amount of time was expended in obtaining documentations for rework of factory wiring. This has also been expended on attempts to expedite parts and tools for reworks.

8- Extra time has been expended because of numerous technician changes with no overlap. This has resulted in some rework, additional time locating equipment, and additional time locating documents.

9- Many hours have been expended attempting to get information for C&IO work (especially the tach-relay, the fuel oil Booster Pump D.C. motor loss of field relay) with incomplete results. Many hours have been expended attempting to set up for testing D.C. Circuit breakers since there is no regulated DC power supply of 30 amp capacity on site.

10- Poor storage conditions and work area controls during construction phases had to be compensated by cleaning of the 102 generator by Startup support.

11- Poor design of panel cable support and poor housekeeping during construction resulted in a prolonged cleaning effort to achieve error free operation of relays.

12- Original schedules did not allow time for rewritting procedures, reperforming C&IO work because of design changes, performing design and construction review.

13- Original C&IO schedule by previous test engineer allowed six weeks. A recalculation including all equipment with the same allowed time for devices, indicates that fifteen weeks should be allowed.

14- Modification of diesel generators to upgrade design are being incorporated. This was not allowed for this in the assigned schedule.

15- Additional time and manpower was required to clean crank cases of diesel since preservative of wrong type was suspected to have been used on engine during storage.

16- Additional Test Engineer time was expended clearing construction red tags after system release.

17- Failure to be able to control access to the Diesel room because construction activities were in progress slowed Startup activities. Construction work on rewiring MCC, installing scaffolds (for X60 actuators, service water line walk, and conduit resupport), and reworks assigned to construction. Temporary doors were unlocked, knocked down and holes were cut in them.

18- Power feed (120VAC) Repair/Rework (R35-6) prevented complete testing of accessories.

19- ASME piping was not turned over at original "B" release. There has been confusion in this area concerning who owns which components. We are still unable to use Startup Support to break flanges on these systems - this results in poor control of activities by Startup.

20- Lack of personnel continuity has impacted progress - three turnover engineers have been responsible for R43 since May 1980.

21- Many hours have been spent listing problems with design, drawings, construction, and documentation. Many hours have been spent attending meetings - the only result thus far has been requests for more paperwork, (lists & copies of specific E&DCR's) and more meetings. We need to have the diesel generators Placed on a higher priority if we are to meet a date required to support other plant activities.

ATTACHMENT 4

Diesel Generator

Many E&DCRs have been written for the R43 System, diesel generators, with most of these E&DCRs being initiated by LILCO Start-Up.

The diesel generator specification SH1-089 is mainly a performance specification, i.e. design output parameters, with detailed design of the system to be supplied by DeLaval. The specification, however, does require certain specific details such as alarms and shutdown initiation signals. With a performance specification as a basis S&W must rely on the manufacturer's ability to provide a design that accomplishes the desired performance. Construction forces have completed the 102 diesel; however, Start-up is encountering problems a majority of which are details required to check out instruments and subsystems because the installation and maintenance manual furnished by DeLaval doesn't provide enough information on set points and design parameters to check various instrumentation.

There are also cases where additional details on S&W drawings would have helped to eliminate construction and start-up problems.

Start-up is also reviewing things in general with a different perspective, sometimes reviewing the maintainability to a much greater extent than S&W has.

In looking back through some of the E&DCRs we see many requests for additional information, sometimes not the appropriate vehicle for requesting the information, but a means by which a documented answer is required.

There are cases where vendors' drawings did not match the equipment thus resulting in inconsistencies between vendor and S&W drawings. Inspection could have uncovered this.

We do not anticipate similar problems with security, except probably with Viconics.

P.S. We bought the low bidder.

ATTACHMENT 5

Energy Consultants, Inc.
121 SEVENTH STREET · PITTSBURGH, PA 15222-3487 · 412/434-5200

JAK-ENG-83-181
July 12, 1983

Mr. E. B. McCabe
U. S. Nuclear Regulatory Commission
631 Park Avenue
King of Prussia, PA 19406

SUBJECT: WITNESS AND EVALUATION OF EMERGENCY DIESEL GENERATOR TESTING AT SHOREHAM NUCLEAR POWER STATION FOR NUCLEAR REGULATORY COMMISSION, REGION I STAFF, FINAL REPORT OF NRC CONTRACT NO. 05-82-249 PARAMETER PURCHASE ORDER NO. NRC-IE-82/83, TASK 38

Dear Mr. McCabe:

Enclosed are five (5) copies of the final report of the Evaluation and Witnessing of Emergency Diesel Generator Testing Problems at Shoreham Nuclear Power Station which was performed at Shoreham, New York by Mr. Gailard Kunkle and the Energy Consultants, Inc. staff in accordance with the reference contract. The final report incorporates the NRC comments on the preliminary report provided to Mr. G. Kunkle at the meeting in Region I on June 29, 1983. The preliminary report was submitted to you previously by JAK-ENG-83-161 dated June 17, 1983.

If you should have any questions or comments, please contact me.

Sincerely,

ENERGY CONSULTANTS, INC.

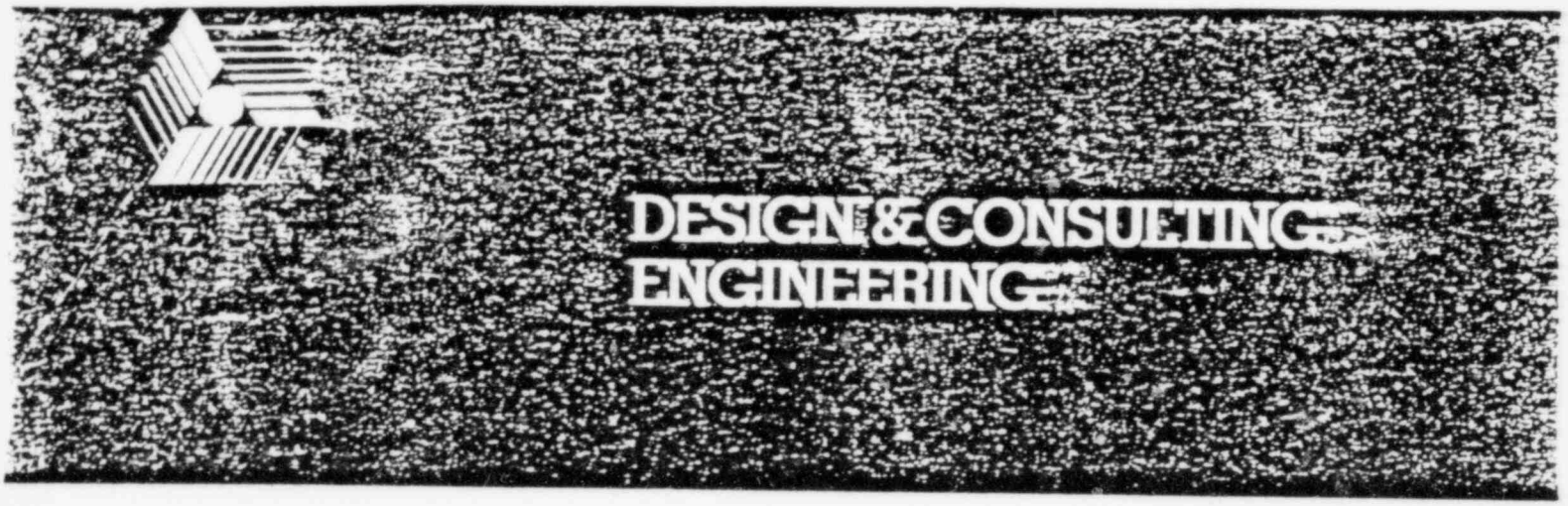
Richard J. Allerio for

John A. Kaye
Manager
Design and Consulting
Engineering Department

RJA/cw

Enclosures

cc: Jim Higgins - U. S. Nuclear Regulatory Commission
Richard A. Lofy - Parameter Incorporated



FINAL REPORT TO
U. S. NUCLEAR REGULATORY COMMISSION
REGION I

FOR
TEST REVIEW, DATA ANALYSIS AND REVIEW OF
EMERGENCY DIESEL GENERATOR OPERATIONAL/RELIABILITY
PROBLEMS AT SHOREHAM NUCLEAR POWER STATION, UNIT I,
SHOREHAM, NEW YORK
NRC CONTRACT NO. 05-82-249
PARAMETER CONTRACT NO. NRC-IE-82/83, TASK 38
FROM APRIL 25, 1983 TO MAY 19, 1983

PRESENTED ON JULY 12, 1983

BY
DESIGN AND CONSULTING ENGINEERING DEPARTMENT
ENERGY CONSULTANTS, INC.
121 SEVENTH STREET
PITTSBURGH, PENNSYLVANIA 15222-3487
(412) 434-5230

PREPARED BY G. L. Kunkle/RJA

REVIEWED BY A. B. Bennett/RJA

R. J. Addison

TABLE OF CONTENTS

EVALUATION OF DIESEL ENGINE PROBLEMS AND TESTING AT SHOREHAM, NEW YORK

I. INTRODUCTION

A. Summary:

An in depth assessment of selected operational problems was conducted which included areas such as corrective maintenance, preventive maintenance and component failure. This assessment included detailed reviews of selected problems identified in Long Island Lighting Company (LILCO) Deficiency Reports, Repair/Rework Requests issued by the Start-up Group and failure reports issued by LILCO, Delaval and other vendors. In addition, observation of maintenance activities as well as a physical inspection of each emergency diesel generator unit was conducted during both standby and, when possible, running conditions.

During the review of each item, an attempt was made to determine the following:

(a) Was the work accomplished in accordance with approved procedures?

(b) Were properly calibrated tools (if applicable) used during maintenance?

(c) Were measurements, adjustments, torquing, etc. values within prescribed ranges?

(d) Were any trends detectable in readings or component failures?

(e) Were problems/failures caused by design, engine vibration, incomplete or improper workmanship?

A review of selected preoperational diesel testing was also conducted. This review included observations of in-process testing, reviews of test procedures, reviews of completed test procedures and evaluation of completed test data.

During these reviews and evaluations of the diesel generators, a number of problem areas were found to exist and are identified in the following report. In addition to specific problems/comments, which are identified, a number of recommendations and observations are also included which should be considered for corrective actions.

Although some problems are still occurring during operation/testing, the frequency at which they occur seems to be decreasing. Additional testing and corrective action is needed to provide a high level of confidence that the engines will start and operate reliably. Specific comments and recommendations are provided in various sections of this report. Section VI provides the specific recommendations for additional testing. Once these recommendations have been adopted (in conjunction with the recommendations of the LILCO Task Force), and the testing completed with no problems, this should provide the necessary assurance that the emergency diesel can accomplish their design functions.

As identified in the recommendations of NUREG/CR-0660, the training and performance of personnel (including Q/A) involved with maintenance and operation of emergency diesels contributed significantly to the reliability of the various emergency engines. This same area appears to be a problem at Shoreham. The Repair/Rework program including records was felt to need improvement.

Additional review and evaluation is also needed of various test results as identified in Section II. In addition, Section V.B provides recommendations for further investigation as a result of the turbocharger failure.

ENERGY CONSULTANTS, INC.

FOR U. S. NUCLEAR REGULATORY COMMISSION REGION I

Contract No. NRC Contract No. 05-82-249 Parameter Purchase Order No. NRC-IE-82/83, Task 38

Docket No. 50-322

License No. CPPR-95

Licensee: Long Island Lighting Company
175 East Old Country Road
Hicksville, NY

Facility Name: Shoreham Nuclear Power Station

Inspection Location: Shoreham, New York

Inspection Conducted: April 25, 1983 - May 19, 1983

Inspector: G. L. Kunkle /RJA

Gailard L. Kunkle, Senior Consultant, Energy Consultants, Inc.

B. Equipment Identification:

Manufacturer: Engine - Transamerica Delaval Company
Generator - Portec Electric Products Division

Model: DSR-48

Serial Numbers: 74010, 74011 and 74012

Ratings: 4,889 horsepower
3,500 kilowatts (continuous)
3,900 kilowatts (2 hour rating)
0.8 power factor
4,375 kilovolt amps
4,160 kilovolts
607.2 amperage

C. Background:

The three emergency diesel generators at the Shoreham Nuclear Power Station, Unit I, have experienced repeated problems during preoperational full load and endurance tests. The operational problems have included cylinder head

problems (5 heads replaced), rocker arm assembly hold-down bolt failures, turbocharger bearing failure and linear indications in engine block casting.

D. Inspection Objectives:

Provide an independent review and assessment of emergency diesel generator operability and the ability of the diesels to perform their design function, based on a comparison of design capabilities/performance ratings (as described in the Shoreham Final Safety Analysis Report, design specifications and vendor technical manuals) with actual operational data (as described in licensee preoperational test records). Witness ongoing emergency diesel generator testing, if applicable, and assess test results.

Perform an assessment of past preoperational problems, including material failures, and determine the appropriateness of corrective actions to provide assurance of future diesel operability. Review, as appropriate, licensee records of emergency diesel generator preventive and corrective maintenance actions since January 1, 1981 and the licensee's written analysis of diesel failures and corrective actions. Assess the need for independent NRC/contractor material testing and for additional licensee material testing, as may be required.

E. Persons contacted:

Long Island Lighting Company

E. Youngling
J. Rivello

Stone & Webster Engineering Corporation

R. Purcell
T. Paulantonio
R. Lawrance
T. Brown
W. Cook
N. Rudikoff
A. Stakutis
W. Dick
J. Kamayer
T. Gray

Transamerica Delaval, Inc.

L. McHugh

R. D. Jacobs and Associates

R. Jacobs

U.S. Nuclear Regulatory Commission

J. Higgins
H. Nicholas
E. McCabe
L. Bettenhausen

II. TESTING

Background:

To verify the ability of the diesels to perform their design function, the operational data in the preoperational test records were compared to the design capabilities/performance ratings described in the Shoreham Final Safety Analysis Report, design specifications and vendor technical manuals. Actual testing was witnessed where possible.

Summary:

Portions of testing on diesel engines 102 and 103 were observed over a period of two weeks. This testing was being performed in accordance with preoperational test procedures PT. 307.003 B-1 and PT. 307.005C TCN-1. In addition, the results of a completed test procedure PT. 307.005A were reviewed. (It should be noted that the results of this completed procedure have not been reviewed nor accepted by the LILCO Joint Test Group.) The comments resulting from these reviews are as follows:

Comment #1: The Nuclear Regulatory Commission Regulatory Guide 1.108 (Revision 1, August 1977) Section C.2(3) requires the emergency diesel generators to be tested at a load equivalent to the continuous rating for 22 hours and for 2 hours at the 2 hour rating. The continuous full load rating of each emergency diesel generator set is shown in Table I. Typical values of data recorded in PT. 307.005A for the full load run are shown in the last column of Table I.

TABLE I

	Continuous Full Load Rating	Test Load Values
Kilowatts (KW)	3,500	3,510
Volts (V)	4,160	4,225
Amps (A)	607.2	480
Power Factor (PF)	0.8	1.0*
Kilovolt-Amps (KVA)	4,375	3,513*

*Calculated

The low amperage (480 vs. 607.2) and calculated KVA (3,513 vs. 4,375) shows the diesel generator was not tested at its continuous full load rating considering current, power factor and KVA ratings. (Note: the higher voltage of 4,225 would only account for a 10 amp lower reading.)

Typical data for the 2 hour load run also shows the engine was not fully loaded to its 2 hour load rating on a current/power factor basis. Note: During the 2-hour full load run at the 530 amp load, the engine fuel racks were very near their full travel stops. If the amperage load were increased, the fuel racks may have reached full travel before the 110% amperage load was achieved.

Note: The lower than rated current obtained during the test did not simulate normal bus load conditions (actual bus load would probably have a lower power factor). The lower current would not result in the maximum generator I^2R heat loss. The effects that are caused by heating, therefore, were not effectively simulated.

To ensure the emergency diesels are capable of carrying their design emergency loads, additional testing should be conducted at the emergency limits (voltage, amperage & KVA) while operating at a 0.8 power factor.

Comment #2: Step 8.3.7 of PT. 307.005A states load diesel generator to full load then defines full load as 3500 ± 70 KW and 1500 ± 100 KVAR. Table I of the test procedure records KW but does not record KVAR so the data cannot be verified. In addition, Step 8.4.1 performs the 22 hour full load run, however, this step only specifies a load of 3500 + 70, - 0 KW and does not address KVAR load.

If step 8.3.7 definition of full load is correct, then the generator may not have been at full load in step 8.4.1 since only about 500 KVAR's were maintained throughout the test. This inconsistency should be investigated and resolved.

Comment #3: In evaluating the recorded data, it was found that the calculated KW (using the recorded voltage and amperage) did not always

meet the acceptance criteria unless a power factor of almost one (1) was assumed. Some examples were observed where the voltage dropped and amperage decreased by about 10% and the recorded KW went up slightly (KVAR would remain constant). These inconsistencies need further evaluation to determine if test requirements were actually met.

Comment #4: On April 27, observed that the official copy of PT. 307.005C in use for diesel testing did not contain TCN #1. (The step in progress had been changed by TCN #1. This TCN had been issued about two weeks earlier.)

Comment #5: The data sheets in test procedure PT. 307.005C were not signed by and therefore did not indicate who the data takers were.

Comment #6: Some instrumentation on the diesels being tested were not marked to indicate their calibration status as required by ANSI N45.2 and N18.7. For example, engine tachometer, cooling water thermometers, turbocharger air pressure, voltage, amperage and lube oil filter inlet and outlet pressure gages.

Comment #7: Some data had been changed/corrected by write overs making it difficult to read.

Comment #8: In test procedure PT. 307.005A&C precaution 4.7 states diesel room temperature and humidity should be frequently monitored. There was no objective evidence that this was being done.

Comment #9: Initial condition 5.5 in procedure PT. 307.005C was signed off (with no exception indicated) indicating the HVAC was in operation. However, the ventilation was not in normal operation as the ventilation damper was temporarily bypassed and failed open.

Comment #10: Step 8.4.1 of PT. 307.005A states "ensure total KVA of generator does not exceed 4375 KVA". Since there is no method provided to measure or requirement to calculate this value, it is not clear how this requirement was met.

Comment #11: The diesel generator load values in Table II of PT. 307.005A are not recorded in the correct units. The table specifies KW while values are actually recorded in MW.

Comment #12: Various steps in PT. 307.005A were designated to be witnessed by Operations Q/A. The following steps have been completed but were not signed by Operations Q/A to indicate they witnessed the steps: 8.3.9, 8.3.11, 8.5.3 and 8.6.1.

Recommendation #1: The readability of some of the test instrumentation does not seem to be accurate enough to meet the test requirements. For example, the minimum subdivision for KW on the recorder was 200 KW while the tolerance band specified in the procedure was +40 and -19 KW. Similar problems existed for amperage and voltage. Test instruments should be accurate enough to be compatible with the tolerance of the acceptance criteria in the procedure, e.g., the readability of most analog instruments is one-half the smallest scale subdivision. The high speed recorder and charts should be analyzed to verify that their accuracy will actually permit reading (interpolating) these charts to one-quarter or one-eighth of the smallest scale subdivision as necessary to assure compliance with the test requirements.

III. CORRECTIVE/PREVENTIVE MAINTENANCE AND MAINTENANCE RECORDS

Background:

Approximately eight percent of the maintenance records (including Repair/Rework Requests, Rework Supervisor Work Summaries and Quality Assurance Verification Reports) were reviewed to determine if the work was accomplished in accordance with all vendor technical requirements. This review also determined if the maintenance and maintenance records properly implemented both local and NRC requirements. In addition, problems were reviewed to determine (where possible) if the "root cause" had actually been identified and corrected.

Summary:

In many cases it was not possible to verify, based on the maintenance records identified below, that the work had been properly conducted in accordance with both technical and administrative requirements. These problems fell into the following categories:

1. Torquing - The Delaval Technical Manual, Volume I, Appendix IV provides a table of torque values to be used for various threaded fasteners. This table also stated that all torque values are based on the use of a thread lubricant consisting of a 50/50 mixture of graphite and engine oil.

   Comment A: Some maintenance records indicate incorrect torque values may have been used. For example, Repair/Rework 408 indicates the rocker arm assembly was only torqued to 120 ft lbs instead of the required 365 ft lbs; Repair/Rework 417 indicates the rocker arm assembly and sub cover were torqued to 365 ft lbs, (i.e., overtorqued) although the sub cover is only required to be torqued to 120 ft lbs. The consequences of over or under torquing should be evaluated.

Comment B: A number of maintenance records do not provide any documentation or assurance that threaded fasteners were properly torqued since no torque values are recorded in the space provided (Start-up Instruction No. 6) and since the records do not provide any reference to the use of calibrated torque wrenches (i.e., there were no Measuring and Test Equipment (M&TE) numbers and calibratic due dates recorded in the space provided). The following Repair/Rework Packages are typical of this type of problem:

(1) 751 - no torque value and no M&TE number

(2) 577 - no torque value and no M&TE number

(3) 596 - no torque value and no M&TE numbers (similar work on 805 & 808 had required information)

(4) 554 - states "no torque value, vendor specs"

(5) 637 - no torque values recorded

(6) 712 - no M&TE number for torque wrench used on head studs

(7) 394 - no torque values and no M&TE numbers

(8) 423 - no torque values and no M&TE numbers

Comment C: A number of maintenance records do not provide any assurance that the required thread lubricant was used during reassembly and torquing. Some records specifically indicate "none" or "NA" in the space provided on the form. Other packages did not include a copy of this completed form to show a lubricant had been used. Start-up Instruction No. 6 provides a place for recording type of thread lubricant. Typical examples are found in the following Repair/Rework Packages:

(1) 612 and 744 - indicate lubricant was used on head studs, other studs and bolts were not addressed

(2) 712 - states "none"

(3) 670 - states "NA"

(4) There is no reference of any lubricant in packages 596, 360, 359, 511, 636, 637, 714 and 820.

Comment D: In many of the maintenance records, the Quality Assurance verification report is so brief or general it is not possible to determine what was witnessed and verified. Typical examples are found in the following Repair/Rework Packages: 612, 349, 351, 360, 670, 712, 423 and 577.

Comment E: Some maintenance records indicated repairs and/or inspections were performed but the acceptance criteria is not clear. Typical examples can be found in the following Repair/Rework Packages:

(1) 751 - A jacket water pump was disassembled and the pump impeller was "inspected and found to be satisfactory". It is not clear what this acceptance was based on since no measurements were recorded and instructions do not specify what kind of inspection to perform (i.e., visual, measurement, dye penetrant).

(2) 546 - During repairs to a jacket water pump, this package states "started lapping and blue checking bore to shaft. Attained 85% contact on blue check." No reference is made to any acceptance criteria for the required percentage of contact.

2. Maintenance Procedures - Several Repair/Rework Packages were found which indicated the repair work had been performed in accordance

with verbal directions from the Delaval service representative. The specific directions or adjustments were not normally recorded making it impossible to verify that the work was completed in accordance with the technical specifications in the Delaval service manual. One example was found where a thrust reading outside the specified tolerance was apparently accepted based on verbal direction of the vendor. Typical examples of these problems are found in the following Repair/Rework Packages:

Comment A: 590 - The work summary in this package "checked total thrust of rotor assembly - 0.007* (okay from Al Scott Delaval representative)". A Delaval letter of December 6, 1982 (attached to LDR-926) states the Elliott specifications call for a thrust of 0.008 to 0.018.

Comment B: 374 - The work summary in this package states "adjusted rocker arms accordingly as per Delaval representative".

Comment C: 546 - The work summary in this package states "installed water pump with new gasket, tighten down bolts to representative approval".

Comment D: 554 - This package documented disassembly a jacket water pump for inspection and replaced the impeller nut. The work summary states "no torque value, vendor specs".

IV. VISUAL INSPECTION OF DIESEL GENERATORS

Background:

Visual inspections of each diesel generator unit was performed. When possible, inspections were also performed while the engines were running. These inspections were performed to determine the general condition of each engine and detect possible abnormal conditions.

Summary:

While no major problems were observed on any of the engines, some conditions were noted which should be corrected to ensure future problems do not occur. Several other conditions were observed which should be evaluated to determine the need for further corrective actions. Comments resulting from these inspections are as follows:

Comment #1: Many instrumentation, control and gage lines (1/4 inch to 3/4 inch size) are inadequately braced and vibrate excessively during operation. Some lines appear to need additional brackets while others have been removed from the brackets provided and were never reinstalled. For example, the lube oil supply line to the turbocharger failed due to vibration while in its design brackets.

Comment #2: A label plate on each diesel specified required torque values. These values do not all agree with the torque values currently in the technical manual.

Comment #3: Some bolts on the air inlet elbows to the head were loose and partially unthreaded apparently due to vibration during operation. Some bolts had washers, some lock washers and others no washers. The application of washers and/or lock washers should be specified.

V. REVIEW OF COMPONENT PROBLEMS/FAILURES

A. Engine Head Cracks

Background:

LILCO Deficiency Reports 1040, 1065, 1056 and 1141, various Repair/Rework Requests and correspondence with Delaval documents the identification of cracks in three cylinder heads. The Delaval Failure Analysis Reports indicate the cracks found in the three cylinder heads occurred as a result of manufacturing defects (hot tears resulting from sand inclusions in the casting and uneven cooling). The small amount of leakage that might occur would be blown out with the exhaust. Since these cracks were self-relieving and non-propogating, Delaval stated they would not affect operability or availability in stand-by service. The Delaval reports also indicate improved casting, manufacturing and testing techniques would preclude cracks in the latest head design.

LILCO letter SNRC-873 indicates that a leak detection procedure recommended by Delaval will be implemented until the permanent corrective action can be accomplished. This permanent corrective action will install cylinder heads of the latest available design.

Summary:

LILCO's corrective action of installing the latest design heads should eliminate this problem once the work is completed. This work is currently scheduled to be completed on a non-controlling basis. The leak detection procedure recommended by Delaval would identify any future cracks should they occur.

Based on a review of the actions being taken by LILCO, additional independent NRC/contractor material testing is not recommended.

Recommendations:

(a) Since water leakage/build up into a cylinder during long idle periods could have drastic consequences in an emergency start, it is recommended that if an engine does not have the new design heads installed, then it should be barred over with the indicator cocks open on a weekly basis after reactor critical testing has started. This barring procedure, in conjunction with the barring procedures recommended by Transamerica Delaval, should assure the engines will operate satisfactorily with the existing heads.

(b) Since Delaval has indicated stricter manufacturing controls assures the new heads are a high quality product, consideration should be given to either auditing or monitoring the production of some of these new heads or performing detailed receipt inspection and testing of one or two of these new heads.

B. Turbocharger Failure

Background:

LILCO Deficiency Report #926 documents the failure of a turbocharger thrust bearing. The initial evaluation by Delaval indicated the failure occurred due to a missing guide vane on the nozzle ring. A subsequent report from the turbocharger manufacturer (United Technologies Elliott) concluded the missing blade (vane) had failed in service apparently due to mechanical fatigue. In addition, Elliott indicated that additional analysis was being conducted on the nozzle ring and that pressure and temperature readings just upstream of the turbine inlet casing during a rapid start-up cycle would be helpful.

Summary:

Based on the type of failure (mechanical fatigue), it is recommended that this not be considered an isolated occurrence until it has been determined exactly what conditions caused the fatigue failure.

Recommendation:

Consideration should be given to:

(a) Checking the other turbochargers for possible cracking

(b) Evaluating the possibility of the missing blade having been knocked back into the exhaust manifold as postulated by Elliott.

C. Engine Block Casting Indications

Background:

LILCO Deficiency Report #1224 and Repair/Rework Request numbers 867, 868, 869, 870, 871 and 880 provide the details of Stone & Webster Engineering Corporation's (S&W's) investigation and engineering evaluation of linear indications which were found in the cam galley area of the engine block casting. The investigation required the indications on each engine to be checked and mapped using non-destructive examination. A similar design engine with a substantial number of operating hours was checked by S&W engineers using nondestructive examination. Indications were found of the same approximate size with no evidence of any propagation. S&W engineers found similar indication on a new engine block casting at the factory. This shows the indications occur during manufacture and are not a result of operations. Calculations by Delaval showed the regions where the indications are located are subject to compressive stresses which would not cause the indications to propagate. Discussions with S&W lead engineers indicated Delaval is conducting tests on an operating engine in order to verify their calculations and will issue a report when this testing is completed. Based on their evaluation of these indications, S&W has concluded that this indication will present no problems to the operation and reliability of the emergency diesel generators.

Summary:

After a review of the actions taken by S&W and Delaval and discussions with the S&W engineers, who conducted the evaluation, it is felt that their actions were adequate and the conclusions correct. However, the test results should be reviewed to ensure they verify the calculations.

D. General Review of Problems

Background:

During the detailed review of various Deficiency Reports, Failure Reports and Repair/Rework Requests, a significant number of problems or errors have been identified which seem to have occurred due to errors and incomplete or improperly completed work by the manufacturer. Attachment I to this section provides examples of specific problems that fall into this category.

Summary:

A large number and variety of problems that have been experienced can be attributed to vendor workmanship. These errors, in conjunction with the problems identified during audits of Delaval's Quality Assurance Program (audits/reaudits conducted October 1975, February 1976 and June 1976), indicate a weakly implemented Quality Control Program.

Recommendation:

Although the number of problems is decreasing significantly, they have not been completely eliminated and, therefore, reliability has not been demonstrated. Based on this, strong consideration should be given to continued operation or testing until problems have been eliminated and the engines run reliably. Once the required testing has been completed and all problems corrected, at least one engine should be started and run for the design seven days at a nominal load of 3,500 KW.

The actions taken by Delaval to eliminate these quality-related problems should also be determined and evaluated. This would ensure problems with future spare parts will not occur.

To provide the confidence factor that the emergency diesel engines will operate reliably, the periodic surveillance testing should be increased to perform a four hour load test each month. If at the end of six months no failures have occurred, return to the surveillance testing specified in the technical specifications.

GENERAL REVIEW OF PROBLEMS

394 - A memo in this package from a Delaval representative indicates the casing discharge on a jacket water pump was found partially blocked by excess casting material.

442 - E&DCR-F41289 - attached to this package indicates Delaval supplied a jacket water pump with the wrong impeller.

551 - (See LDR-0832) - A memo attached to this package indicates a jacket water pump had been assembled with an extra washer behind the impeller castle nut and that the impeller had been machined to the wrong drawing which had been provided by Delaval. A second pump failed and investigation showed the impeller had been improperly installed at the factory.

577 - A Delaval Failure Analysis Report (attached to E&DCR-F43525) indicates the jacket water pump shaft failure was induced by an improperly tightened impeller hub nut. (There were no records to indicate this pump had been disassembled since it left the factory.)

LDR-816 - This deficiency report indicates incorrect springs were installed on the internal relief valves of the engine driven fuel oil pumps.

359 and 360 - (See LDR-654) - During a pre-start inspection of the gear cases, it was found that two of the engines were missing some fitted bolts required on the cam gear. Delaval drawings require drilling holes and installing and torquing these bolts after final engine timing.

701 & 702 - (See LDRs 1006 and 1024) - During inspection of the Governor Drive assembly, the following problems were found:

(a) Coupling grid was broken due to misalignment of the governor

(b) A key of the wrong size was found installed on one engine

(c) A coupling half was found pinned to the coupling adapter although this pin was not shown on the Delaval Drawing.

712, 744, 408, 636, 661, 663, 670, 714, 715 and 717 - (See LDRs 1040, 1065, 1056 and 1141) - Part of the problems with the cracked cylinder heads was attributed to manufacturing defects and thin castings. The factory inspections and testing had failed to identify these deficiencies.

046 - (See LDR-0503) - Lube oil cooler tubes leaked due to improper rolling of tubes into the tube sheet which were not identified by vendor quality control.

236 - (See LDR-0560) - The lube oil pump suction line on one engine was found without a drilled passageway for the relief valve. This problem was attributed to an oversight at the factory.

351 - During a routine gear inspection, an extra loose bolt was found in the gear train. The bolt was badly beaten and chipped.

VI. GENERAL RECOMMENDATIONS

Background:

During the review of the Diesel Generator operations, testing and maintenance, a number of conditions were observed which did not specifically violate or deviate from requirements but which did, in the opinion of the inspector, indicate weakness or areas which could be improved. Other conditions in this category are those for which insufficient information was available to make a judgement and should be considered for further evaluation.

Summary:

The following list of observations and recommendations should be considered for further evaluation and/or possible corrective action:

Recommendation #1: Repair/Rework Requests do not reference specific repair procedures. They normally only reference the Diesel Construction specification SHI-089. This makes it difficult or impossible for either Q/A inspectors or other reviewer/auditors to determine what instructions were actually to be followed. A system that requires identifying the specific repair procedures would be a major improvement. This would allow Q/A personnel to review the specific procedure and establish hold/witness points as necessary. This could be similar to the procedure for Maintenance Work Requests.

Recommendation #2: Based on the problems identified in the 1975 audit of Delaval of the failure to have calibrated torque wrenches plus the lack of adequate documentation in maintenance records for torque value makes it impossible to ensure all components have been properly torqued. Based on the work completed to date, it is recommended that all components/ parts should have their torque values verified by analysis or tests.

Recommendation #3: As stated in other sections of this report, some problems or failures are still being experienced when an engine is run for testing. Some problems result in the engine being shutdown for

convenience to correct the problem. Other problems such as lube oil line failure and jacket water temperature pneumatic switch failure resulted in immediate engine shutdown. Testing/operation should continue until the engines all operate reliably. After all work and testing is completed, it is recommended that at least one emergency diesel generator should be started and run for seven days at about 3,500 KW. If a failure occurs, testing should continue until all three engines have demonstrated their ability to operate reliably under load for the seven-day period.

Recommendation #4: Obtain the results of audits performed on Delaval by other utilities and evaluate their findings and corrective actions (i.e., Texas Utilities, Gulf States Utilities and San Diego Gas & Electric). Based on this information, determine the need for further additional audits of Delaval.

Recommendation #5: The engine exhaust inlet and outlet elbow from the turbocharger are uninsulated and could present a fire hazard from a fuel oil or lube oil line failure. The need for insulating this area should be reconsidered or some other assurance provided that shows such a fire could not occur.

Recommendation #6: There is a substantial opening (about four (4) inches wide and several feet long) between the flywheel and the protective cage around the generator. Since this opening is on the top of the generator adjacent to the baring device, it presents a possibility of items falling into the generator causing damage or short circuits. Consideration should be given to install a protective cover over this opening.

Recommendation #7: In several of the problems/failures which Long Island Lighting Company has experienced, Delaval already had an improved/ upgraded replacement part which effectively eliminated the problem. S&W and LILCO should make a strong effort to have Delaval supply them with a list of modifications, design changes, product upgrade, etc. which have been made to this type of engine since the LILCO engines were manufactured. LILCO and S&W could then review this list and decide which of the modifications they want to implement.

Recommendation #8: During operation, a significant number of fuel oil and lube oil leaks are apparent. These leaks keep one individual busy cleaning up. During an emergency, personnel may not be available to keep these leaks cleaned up. This could result in substantial accumulations presenting a fire hazard. Action should be taken to eliminate as much of this leakage as practical.

Observation #1: Some of the LILCO Maintenance Support Division personnel have completed a diesel maintenance training program a few months ago. There was insufficient time available to determine the diesel experience or training for maintenance personnel from the construction groups who have also performed repair work on the diesels.

Observation #2: As noted in other portions of this report, there are examples that vendor field representatives operate somewhat informally at times in directing repairs. While he is assigned in the field, the Delaval representative is not clearly under the umbrella of the Delaval factory quality assurance plan. The utility (LILCO) personnel tend to accept his comments/actions since he is the "vendor expert". When a Delaval representative is performing or directing work at the site, his actions should comply with the LILCO Q/A Program just the same as any other plant worker.

Observation #3: The jacket water pumps do not have unique serial numbers making it very difficult or impossible to maintain traceability especially during multiple pump changeouts or maintenance.

Observation #4: The FSAR response to NRC question (request) 223.85 states, "As shown on Figure 9.5.7-1, a check valve prevents lubricating oil from being circulated through the turbocharger" when shutdown. However, a subsequent modification (E&DCR F-34540) has now added a small lube oil supply to the turbocharger in the shutdown condition. This response and figure should be reviewed and revised as necessary.

Observation #5: In general, it was felt that the quality assurance, engineering and testing administrative procedures that applied to

start-up activities were weakly implemented. A specific concern is the fact that most of the problems identified in this report have existed for over a year and were not identified and corrected by supervisory reviews or the audit program.

ATTACHMENT 6

LILCO
LONG ISLAND LIGHTING COMPANY

EXECUTIVE OFFICES: 250 OLD COUNTRY ROAD · MINEOLA, NEW YORK 11501

(516) 228-2244

EDWARD M. BARRETT
GENERAL COUNSEL

File 2
74010

December 2, 1983

Robert E. Smith, Esq.
Guggenheimer & Untermyer
80 Pine Street
New York, New York 10005

Dear Mr. Smith:

This letter is sent to you in your capacity as counsel to Transamerica Delaval Incorporated (Delaval).

As you know, on August 12, 1983, the crankshaft in emergency diesel generator 102 at our Shoreham Nuclear Power Station failed in the course of performance tests of the engine. LILCO retained Failure Analysis Associates (FaAA) to conduct a thorough investigation of this failure. In the course of this investigation, cracks were found in the crankshafts of diesel generators 101 and 103 as well.

FaAA's final report on the cause or causes of the crankshaft failure demonstrates that the crankshaft failure occurred as a result of inadequate or defective design. FaAA also investigated cracked connecting rod bearings and cracked pistons discovered on the engines. FaAA's interim report on the cracked bearings indicates those failures occurred as a result of a combination of causes, including inadequate or defective design and manufacture. FaAA's investigation of the cracked pistons and other matters observed in the inspection of the engines is continuing, but preliminary indications are that these, too, occurred as a result of defective or inadequate design.

Prior to the crankshaft failure, LILCO had experienced a number of occurrences attributable to defectively designed or fabricated diesel generator components, including three leaking cylinder heads, defective jacket water pumps, leaking fuel oil injection lines, inadequate turbocharger thrust bearing lubrication, inadequate piston skirt to piston crown attachment, broken rocker arm shaft bolts and cracked subcover assemblies. While these occurrences were generally of the type experienced in the shakedown of large diesel engines, they appear, nonetheless, to be attributable to defective design or fabrication.

Based on LILCO's currently available information, LILCO believes the defects in the diesel generator sets provided us by Delaval constitute a breach of the contract between LILCO and Delaval for the purchase and sale of those diesel generator sets, including but not limited to a breach of warranties contained in and arising out of that contract. This letter is solely for the purpose of providing notice of the breach. Nothing contained herein should be construed as a release of any other claims that LILCO may have against Delaval or as a waiver of any rights and remedies LILCO may have in this matter.

Although LILCO is now giving Delaval notice of claims, we believe it is in LILCO's and Delaval's best interests to pursue aggressively the prompt repair and licensing of the Shoreham diesel generators. We believe substantial progress has been made toward this goal and hope that Delaval and LILCO can work together in the future to complete this important project.

Sincerely,

Edward M. Barrett

EMB:lbs

ATTACHMENT 7

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

October 21, 1983

Docket No. 50-416

MEMORANDUM FOR: Chairman Palladino
Commissioner Gilinsky
Commissioner Roberts
Commissioner Asselstine
Commissioner Bernthal

FROM: Darrell G. Eisenhut, Director
Division of Licensing

SUBJECT: NEW INFORMATION CONCERNING TRANSAMERICA DELAVAL (TDI) EMERGENCY DIESEL GENERATORS, BOARD NOTIFICATION 83-160

In accordance with NRC procedures for board notifications, the following information is being provided directly to the Commission. The appropriate boards and parties are being provided with a copy of this memorandum. The information is applicable to Grand Gulf (an uncontested case), which will be before the Commission for full power authorization in November, 1983.

On August 12, 1983, during post-modification testing, the main crankshaft on one of the three emergency diesel generators (EDG) at the Shoreham Nuclear Power Station failed and broke into two pieces. The applicant subsequently inspected the remaining two diesel generators at Shoreham and identified additional flaws in the crankshafts of those machines in locations similar to the failure of the first machine. A more detailed description of the failure is contained in Enclosure 1 (IE Information Notice No. 83-58).

The EDGs at Shoreham were manufactured by Transamerica DeLaval Incorporated (TDI). TDI has also provided EDGs to several other nuclear power plants (see Enclosure 1). The only currently operating reactor with TDI diesels is Grand Gulf. The TDI diesel at San Onofre is used by Unit 1, which is shutdown for seismic modifications, and the diesels at Rancho Seco are not yet installed.

Besides the failure of the crankshaft at Shoreham, the staff has noted the occurrence of many minor problems with TDI EDGs, which are summarized in Enclosure 2. The staff would expect minor problems to occur during the startup testing of any large piece of machinery, such as a diesel generator, but the number of minor problems experienced by the TDI machines in nuclear service appears to be abnormally high (also See Enclosure 4).

Additionally, during vendor inspections of TDI which were performed recently by Region IV, in response to allegations, the staff identified conditions which imply that portions of the TDI Quality Assurance (QA) Program have not been carried out in accordance with the provisions of 10 CFR 50, Appendix B. Region IV has referred the QA problems to the Office of Investigations, which has requested that details not be revealed to avoid compromising the investigation. As a result of an inspection performed in July 1983, the staff identified a potential violation and several potential nonconformances which are described in IE Inspection Report No. 99900334/83-01, dated October 3, 1983 (Enclosure 5).

The Shoreham applicant is investigating the crankshaft failure, but does not expect to publish a report until later in October. The staff has asked the applicant to address a series of questions concerning the Shoreham EDG design, fabrication, operation, and maintenance in its failure report (see Enclosure 3). A similar list of questions is being developed for other applicants.

The identification of QA problems at TDI, taken together with the number of operational problems and the Shoreham crankshaft failure, has reduced the staff's level of confidence in the reliability of all TDI diesel generators. The staff will require, on a case by case basis, a demonstration that these concerns are not applicable to specific diesel generators because of subsequent inspections or testing performed specifically to address the above matters. Further developments and additional information on this subject will be reported to the appropriate Boards.

Darrell G. Eisenhut, Director
Division of Licensing

Enclosures:
(1) IE Information Notice 83-58
(2) Summary of DeLaval DG Problems (12/80-8/83)
(3) Summary of September 2, 1983 EDG Meeting on Shoreham
(4) IE Information Notice 83-51
(5) IE Inspection Report No. 99900334/83-01 With October 3, 1983 Transmittal Letter to TransAmerica DeLaval, Inc.

cc: See next page

cc: SECY
OPE
OGC
EDO

ASLB FOR:
Shorenam 50-322 (Brenner, Ferguson, Morris, Laurenson, Kline, Shon)
Perry 50-440/441 (Bloch, Bright, Kline)
Comanche Peak 50-445/446 (Bloch, Jordan, McCollan)
Midland 50-329/330 (Bechhoefer, Cowan, Harbour)
Catawba 50-413/414 (Kelley, Callihan, Foster)
Clinch River 50-537 (Miller, Hand, Linenberger)

ASLAB FOR:
Shorenam 50-322 (Rosenthal, Edles, Wilber)
Clinch River 50-537 (Edles, Johnson, Wilber)

ENCLOSURE 1

SSINS No. 6835
IN 83-58

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D.C. 20555

August 30, 1983

IE INFORMATION NOTICE NO. 83-58: TRANSAMERICA DELAVAL DIESEL GENERATOR CRANKSHAFT FAILURE

Addressees:

All nuclear power facilities holding an operating license (OL) or a construction permit (CP).

Purpose:

This information notice is provided to bring to the attention of licensees and construction permit holders a recent event at the Shoreham Nuclear Station in which a diesel generator crankshaft failed during post-modification full load testing. The Nuclear Regulatory Commission staff is reviewing the problem and its effects. If the evaluation so indicates, the NRC may request explicit licensee or CP holder action. In the interim, we expect the addressees of this information notice to review the information herein for applicability to their facilities. No specific action or response is required at this time.

Description of Circumstances:

After installation of eight new cylinder heads, emergency diesel generator (EDG) No. 102 failed during post-modification testing when its crankshaft assembly fractured at the crankpin and crankarm (web) on the generator side of the Cylinder No. 7 crank. This failure occurred during the last 15 minutes of testing at the two-hour overload rating. EDG-102 had a total of 12 hours and 25 minutes of two-hour overload testing when failure occurred. Its installed crankshaft assembly has a crankshaft diameter of 13" and a crankpin diameter of 11". Replacement crankshaft assemblies with 12" diameter crankpins are being procured.

Subsequent to this failure of EDG-102, the licensee examined the crankshafts of the two other diesel generator units at the Shoreham site, EDG-101 and EDG-103, by opening the crankshaft area. The examination of the EDG-101 crankshaft assembly showed cracking on the Cylinder No. 7 crankweb (generator side) and dye penetrant indications on the cranks at Cylinder Nos. 3 and 5. Examination of the EDG-103 crankshaft assembly identified a crack about 2" long and 3/8" deep on the Cylinder No. 6 crankweb (governor side) and a connecting rod to crankpin bearing failure on Cylinder No. 5. The bearing failure involved breaking off of approximately a 1" x 3" piece and overheating of

the surrounding area for about 2". Most of the other cracks found are similar in location and orientation to the one which resulted in EDG-102 crankshaft assembly fracture.

Transamerica Delaval reported that the following nuclear sites have Transamerica Delaval diesel generators:

Shoreham	Perry	Midland
Grand Gulf	Bellefonte	Hartsville
Catawba	WPPS	Phipps Bend
San Onofre	Comanche Peak	River Bend
Vogtle	Rancho Seco	Shearon Harris
Clinch River		

The preliminary information from the manufacturer is that the diesels at Shoreham, River Bend, and Rancho Seco* are eight cylinder in-line engines. However, the crankpin diameter is 11" in the Shoreham units and 12" in the units at the other two sites. The diesel engines at the remainder of the sites listed above are of a "V" design and have 12, 16, or 20 cylinders. The shaft material for all the engines is the same, with the possible exception of the 20 cylinder engines. All the engines are designed to have approximately the same brake mean effective pressure. The torsional systems of the engines differ. At this time it is not clear to what extent other diesel generators manufactured by Transamerica Delaval are vulnerable to the same or similar failures as these experienced by the Shoreham engines.

If you have any questions regarding this matter, please contact the Regional Administrator of the appropriate NRC Regional Office, or this office.

Edward L. Jordan, Director
Division of Emergency Preparedness
and Engineering Response
Office of Inspection and Enforcement

Technical Contact: W. Laudan, IE
(301) 492-9759

Attachment:
List of Recently Issued IE Information Notices

*The Rancho Seco units are not installed; they will be used to replace the existing diesel generators.

ENCLOSURE 2

OVERALL EMERGENCY DIESEL GENERATOR MODEL B- TRANSAMERICA DELAVAL INC. TDI

SELECTED PROBLEMS IN LAST 3 YEARS

08/12/83	• Crankshaft failure • Cause unknown, as yet • Shoreham EDG-102	• Being investigated
03/30/83	• holddown capscrews, rocker arm assy. • Shoreham EDG-103	• replaced with new design • TDI says isolated failure
03/08/83	• cracked cylinder heads • water in cylinders • Shoreham EDG-101,-102,-103	• replaced with new TDI design • TDI says no effect on operability
03/03/83	• hi-press fuel line • manufacturing defects • Shoreham EDG-102,-103 • Also failed at Grand Gulf on 8/2/83	• replaced with new design fuel line w/steel shroud
12/13/82	• unqualified control cables • failed IEEE flame test	• reported by Grand Gulf only
09/17/82	• jacket water pump shaft failures • fatigue cracking at shaft keyway • Shoreham EDG-102 (50 hours), -103 (170 hours)	• new design after foreign failure • new design failed • 3rd design includes: new impeller mat'l., removing shaft key, size of hub washer, new assembly instructions
07/22/82	• hi water jacket temp. trip • closed cooling outlet valve • incorrect valve pos. indication • Grand Gulf Div. 2	• design deficiency
06/23/82	• governor flex. drive coupling • misapplication of materials • isoprene intended for atmospheric application • being used at hi-temp. oil environment inside gear case • Grand Gulf	• replaced w/neoprene

05/11/81	• capscrews, starting air valve assy. • too long, bottom out • Grand Gulf	• re- design - starter
02/18/82	• loss of starting air (6 minutes) • sensing line not seismically qualified	• TDI recommends restricting orifice to slow bleed down time to 53 minutes and operator action to isolate line
03/15/82	• sheared bolts, rear crankshaft cover • Grand Gulf, 24-hr. test run	• TDI said vibration due to firing of rear cylinder • Independent tests showed no inordinate vibration • switched to higher strength (80,000 psi) carbon steel bolts • failure of 80,000 psi bolts now expected • MP&L now using 150,000 psi alloy steel bolts, with proper heat treatment records
12/09/81	• governor lube oil cooler assy. • air trapped in lines • improper mounting location	• TDI recommends lower mounting location
11/05/81	• piston crown separated from shirt • failure of attachment stud bolts • improperly mfgd. spherical washers	• TDI design changed to Belleville washers (Service Info. Memo No. 324)
	• cylinder liner grooving	• TDI says debris during assembly or initial startup
	• grooving of crankshaft bearing crank pin discolored	• TDI says "transient mat'l." in lube oil
	• cylinder link rod wrist pin grooved and pitted; wrist pin discolored • Grand Gulf	• TDI says blockage of lube oil, foreign matter in lube oil
07/14/81	• fire-lube oil spray • cracked instr. line • vibration • SOMGS-1	

11/21/8[illegible]	• use of non-qualified motors • aux. lube oil pump, aux. jacket water pump • TDI supplied commerical grade motors with "equivalency" vs. Class 1E motors • Equivalency data retracted	• motors at Grand Gulf being replaced by A-E
12/16/80	• Turbocharger lube oil sys. • lube drains out of thrust bearings during standby operation • causes excessive wear • SOW35-1	• design modification to permit pre-lube for test starts • occassional "fast starts" acceptable

ENCLOSURE 3

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SEP 2 1 1983

Docket No.: 50-322

APPLICANT: Long Island Lighting Company

FACILITY: Shoreham Nuclear Power Station

SUBJECT: SUMMARY OF SEPTEMBER 2, 1983 EMERGENCY DIESEL GENERATOR MEETING

On September 2, 1983, a team composed of NRC staff members from the Office of Nuclear Reactor Regulation and from the Region I office, and NRC contractors, met with representatives of the Long Island Lighting Company (LILCO) to discuss LILCO's plans to investigate the cause of the failure of the #102 Emergency Diesel Generator at Shoreham. A list of attendees is enclosed (Enclosure 1).

On August 12, 1983, durin a load test, the main crankshaft of the #102 EDG failed. Subsequent inspection of the #101 and #103 EDG crankshafts revealed cracks in locations similar to that of the break in the #102 crankshaft.

An investigation of the cause of causes of the failure is underway and will be conducted in accordance with a master plan (Enclosure 2) which generally describes the steps to be taken. LILCO intends to use the resources of appropriate LILCO organizations, Transamerica Delaval (TDI), Stone & Webster Engineering Corporation, and appropriate contractors to carry out the steps outlined in the master plan. Failure Analysis Associates (FAA) will conduct the investigation to determine the cause of the crankshaft failure and the cracks.

Mr. Youngling described the various phases of the program, which include an independent review of the crankshaft torsional design by FAA, an overall design review of the entire EDG, and a review of other crankshaft failures. He reported that FAA's torsional analysis results, to date, agreed very closely with both the TDI torsional analysis and with the values measured by TDI in a torsional test run on the #101 EDG at the TDI factory. LILCO has decided to use the #101 EDG as a test-bed to gather additional torsional test information and was in the process of instrumenting the machine at the time of this meeting. The test data will be used to verify analytical models and to try to correlate the observed problems with the effects of previous EDG qualification testing.

Members of the NRC staff discussed some of the philosophy behind the EDG test requirements contained in the Regulatory Guides, and explained the need to understood the potential generic implications of these failures. The staff is concerned that the failures may indicate a deficiency in the TDI design process which may show up in other TDI diesel generators in other nuclear power plants. The staff then presented LILCO with a list of questions and concerns which must be addressed before the staff can have confidence in the ability of the diesel generators (Enclosure 3). LILCO was requested to respond to these items as quickly as possible, as the necessary information becomes available, and Mr. Youngling and Mr. Museler assured that that could be done.

Mr. Museler reported that TDI had committed to provide LILCO with all the support necessary to solve this problem. He also explained that FAA would be the team leader and that it had been instructed to consider all possible failure mechanisims and root causes, and not arbitrarily dismiss unlikely causes.

Mr. Dynner and Mr. Christensen, representing Suffolk County, asked several questions concerning the design of the machine which LILCO promised to answer, and were assured that they would be promptly notified of the results of the inspections. The staff concluded that LILCO's plan appeared to be basically sound and proceeding in the right direction.

Ralph Caruso

Ralph Caruso, Project Manager
Licensing Branch No. 2
Division of Licensing

Enclosures:
As stated

cc: See next page

Shoreham

Mr. M. S. Pollock
Vice President - Nuclear
Long Island Lighting Company
175 East Old Country Road
Hicksville, New York 11801

cc. Howard L. Blau, Esquire
Blau and Cohn, PC.
217 Newbridge Road
Hicksville, New York 11801

Mr. Jay Dunkleberger
New York State Energy Office
Agency Building 2
Empire State Plaza
Albany, New York 12223

Energy Research Group, Inc.
400-1 Totten Pond Road
Waltham, Massachusetts 02154

Mr. Jeff Smith
Shoreham Nuclear Power Station
Post Office Box 618
Wading River, New York 11792

W. Taylor Reveley, III, Esquire
Hunton & Williams
Post Office Box 1535
Richmond, Virginia 23212

Ralph Shapiro, Esquire
Cammer & Shapiro
9 East 40th Street
New York, New York 10016

Mr. Brian McCaffrey
Long Island Lighting Company
175 E. Old Country Road
Hicksville, New York 11801

Honorable Peter Cohalan
Suffolk County Executive
County Executive/Legislative Bldg.
Veteran's Memorial Highway
Hauppauge, New York 11788

David Gilmartin, Esquire
Suffolk County Attorney
County Executive/Legislative Bldg.
Veteran's Memorial Highway
Hauppauge, New York 11788

MHB Technical Associates
1723 Hamilton Avenue, Suite K
San Jose, California 95125

Stephen Latham, Esquire
Twomey, Latham & Shea
Post Office Box 398
33 West Second Street
Riverhead, New York 11901

Jonathan D. Feinberg, Esquire
New York State
Dept. of Public Service
Three Empire State Plaza
Albany, New York 12223

Ezra I. Bialik, Esquire
Assistant Attorney General
Environmental Protection Bureau
New York State Department of Law
2 World Trade Center
New York, New York 10047

Resident Inspector
Shoreham NPS, U.S. NRC
Post Office Box B
Rocky Point, New York 11778

Herbert H. Brown, Esquire
Kirkpatrick, Lockhart, Hill,
Christopher & Phillips
1900 M Street, N.W.
Washington, D.C. 20036

Lawrence Coe Lanpher, Esquire
Kirkpatrick, Lockhart, Hill,
Christopher & Phillips
1900 M Street, N.W.
Washington, D.C. 20036

Karla J. Letsche, Esquire
Kirkpatrick, Lockhart, Hill,
Christopher & Phillips
1900 M Street, N.W.
Washington, D.C. 20036

James B. Dougherty, Esq.
3045 Porter Street
Washington, D. C. 20008

Mr. James Rivello
Plant Manager
Shoreham Nuclear Power Station
P. O. Box 628
Wading River, New York 11792

Lawrence Brenner, Esq.
Administrative Judge
Atomic Safety & Licensing Board
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dr. George A. Ferguson
School of Engineering
Howard University
2300 - 6th Street, NW
Washington, D. C. 20059

Dr. Peter A. Morris
Administrative Judge
Atomic Safety & Licensing Board
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

ATTENDANCE LIST

September 2, 1983

NRC

T. Caruso
Robert J. Giardina
Charles Petrone
J. C. Higgins
J. T. Beard
D. J. Vito

LILCO

Ivan Ostrowski
E. J. Youngling
W. J. Museler
Kenneth Simes

Franklin Research Center

R. Clyde Herrick
Harry W. Raines
Shalid Ahmed

Newsday

Stuart Diamond

KLHCP - Counsel for Suffok County

Alan Roy Dynner
Stanley Christensen

Hunton & Williams

Anthony F. Earley

Enclosure 2

Shoreham Nuclear Power Station

Emergency Diesel Generator 103

Crankshaft Failure Analysis/Recovery

Master Plan

Approvals:

Project Engineer

Operational Quality Assurance Engineer

Startup Manager

Chairman Joint Test Group

Plant Manager

Vice President Nuclear

Dated: August 11, 1983

SHOREHAM NUCLEAR POWER STATION EMERGENCY DIESEL GENERATOR 102 CRANKSHAFT FAILURE ANALYSIS MASTER PLAN

I. PURPOSE:

The purpose of this master plan is to describe the organization and organizational responsibilities for implementing the investigation into and recovery from the crankshaft failure on the Emergency Diesel Generator 102 at the Shoreham Nuclear Power Station. This master plan includes a description of those activities associated with the failure analysis; the disassembly of the Emergency Diesel Generator to allow for the investigation of the failed components; the review of the implications of this failure on the reliability of the other two diesel generators #101 and #103; and the identification of required retesting to ensure reliable diesel generator operation following repairs.

It must be emphasized that the master plan is necessarily preliminary in nature. Revisions to the approach will be made, if necessary, as information is obtained during the actions set out in this plan.

This master plan has been put in place by the organization described herein, has been reviewed by representatives of LILCO Project Engineering, LILCO Startup, the Shoreham Joint Test Group, Operational Quality Assurance and the Vice-President of Nuclear. In addition, this plan has been developed with the assistance of TransAmerica DeLaval Inc. of Oakland, California and Failure Analysis Associates of Palo Alto, California.

II. ORGANIZATION:

As a result of the failure of the crankshaft on Emergency Diesel Generator 102, an organization has been put in place consisting of the necessary expertise to assess the cause or causes of the crankshaft failure; to recover from that failure and perform suitable retesting following recovery and to determine the implications of this failure on diesel generators 101 and 103. The essential areas of expertise are shown in Attachment No. 1 Organizational Interface Diagram and consist of the following:

a. Startup Personnel
b. Engineering Personnel
c. Scheduling Personnel
d. Vendor Representatives (TDI)

e. Plant Staff Maintenance Support Personnel
f. Failure Analysis Consultants
g. Operational Quality Assurance and TDI QA Personnel

In addition to the organization shown on the attachment, support from the LILCO Office of Nuclear as well as the entire Long Island Lighting Company are available, such as the Purchasing, Engineering, Maintenance Services and Quality Assurance Departments.

A. LILCO Startup

LILCO Startup under the direction of the Startup Manager has the primary line responsibility for implementing and scheduling the entire effort on the three diesel engines since the Emergency Diesel Generators are still under Startup jurisdiction.

Repair Rework Requests initiated by Test Engineers will be the base document for the rework with Maintenance Work Requests (MWR's) being used to support administrative requirements of the maintenance contractor, Catalytic Inc. and other maintenance support organizations. Implementing maintenance and test procedures will be generated by Project Engineering, Startup and TDI and will be provided to the field via the above base documents.

B. MAINTENANCE

Catalytic Inc., a supplemental maintenance contractor to the LILCO Plant Staff maintenance section, will prepare the equipment for removal of diesel generator 102 from the Diesel Generator Room by disconnecting the piping, electrical and other appropriate connections to the engine and generator in accordance with Diesel Generator 102 Disconnection Checklist and implementing work request documents.

Gerosa Inc., a rigging and hauling contractor, will jack and skid the diesel engine out of the room and transport the equipment to the Turbine Building turbine deck, Elevation 61'.

TransAmerica DeLaval Inc. (TDI), the diesel engine manufacturer, will perform the disassembly and rebuilding of the engine. Additionally, the generator will be inspected under the cognizance of its manufacturer (Ptrtec) to determine if it sustained any damage.

TDI representatives will observe all activities associated with this investigation and will provide technical direction. TDI will provide required replacement parts.

C. LILCO Project Engineering

LILCO Project Engineering (LPO) assisted by the Stone & Webster Site Engineering Office (SEO) will provide engineering support and is responsible for the failure analysis. To accomplish these tasks LPO will use its own resources supplemented by Stone & Webster Engineering Corporation, TDI, Failure Analysis Associates and other consultants as required. Failure Analysis Associates has been charged to take whatever steps are necessary to determine the cause or causes of the failure.

D. Quality Assurance

Operational Quality Assurance will provide the required Quality Assurance coverage in accordance with the LILCO Quality Assurance Program. TDI QA representatives will be present during the period of engine disassembly and reassembly by the TDI work force. The LILCO Quality Assurance Department will provide support to the OQA organization for quality assurance matters.

E. Shift Compliment

During this investigation and the subsequent recovery the on shift compliment will consist of the following:

Startup Test Engineer
Engineering Representative
TDI Representative
Failure Analysis Associates Representative
OQA Representative
Maintenance Support Supervisor

The Test Engineer will be the Shift Director and is responsible for implementing the activities designated to be accomplished during that shift. A pre shift meeting will be held to insure proper coverage is available and to review those activities with the shift compliment.

F. Stop Work Authority

OQA has the authority to "STOP WORK" based on the QA manual.

Pursuant to the memorands from the Startup Manager, Attachment #3 and #4 the on shift QAA representative and TDI representative have been authorized to stop work through the Test Engineer.

C. Review and Audit

The overall work effort will be under the review and audit of the Joint Test Group as described in the Shoreham Startup Manual.

III. DIESEL GENERATOR 102 CRANKSHAFT FAILURE ANALYSIS AND CRANKSHAFT DESIGN ADEQUACY ASSESSMENT

A. Failure Analysis

Conduct an investigation of, and develop a detailed failure analysis for the Diesel Generator 102 crankshaft to determine causes for failure. This effort consists of the following.

1) Attendance, inspection and documentation of Diesel Generator 102 during teardown and reassembly.
2) Appropriate analysis of the failed crankshaft.
3) Review maintenance and operational history.

B. Crankshaft Design

Conduct an inspection and assessment of the adequacy of the existing (13" x 11") and replacement (13" x 12") TransAmerica DeLaval Crank Shafts for Diesel Generators 101, 102 and 103. This effort consists of the following:

1) Review of the TDI design calculations.
2) Performance of independent calculations, as required.
3) Performance of operational torsional vibration tests at various speeds and engine loads on the existing 13" x 11" crankshafts in diesel-generators 101 and 103 and on the replacement 13" x 12" crankshaft for diesel-generator 102.

IV. DIESEL GENERATOR REWORK & INSPECTION

A. Inspections & Tests - Diesel Generator 102

The inspections and tests on diesel generator 102 include but may not be limited to the following:

1.) The connecting rod for cylinder no. 7 will be pulled to allow for inspection/examination for cylinder liner damage.
2.) Main bearings #8, 9, 10 & 11 adjacent to the failure will be pulled to inspect for damage to the bearing, bearing shell and bedplate. This will be performed as soon as possible to allow evaluation of damage.
3.) Analysis of engine oil, jacket water and bearing metal will be performed.
4.) An overall engine inspection during detailed disassembly for crankshaft removal will be performed.

5.) A generator inspection will be performed.
NOTE: Item 1 and 2 above to be accomplished prior to removing the diesel generator from the room.

B. Inspection and Tests - Diesel Generator 101 and 103

The inspections and tests on diesel generator 101 and 103 include but may not be limited to the following:

1.) 100% visual inspection of crankshaft webs and dye penetrant tests where appropriate.

2.) The connecting rods on cylinder 6 ~~7 & 8~~ will be pulled to perform 100% LP and UT of the connecting rod journal.

3.) Torsional vibration testing of the crankshaft in the 101 & ~~103~~ will be performed following the above inspections per procedure provided by TDI.

C. Diesel Generator 102 Rework

LILCO has overall responsibility for the Diesel Generator 102 rework effort. The Startup Test Engineer on shift will supervise the various aspects of the work described below.

Catalytic personnel will remove pipe, tubing and electrical connections, disconnect the turbocharger; and disconnect the generator in preparation for jacking and skidding the engine out of the room.

Gerosa personnel will rig and jack the engine, skid it out of the room and move it around via flat bed to the turbine building truck bay. The entire engine will be lifted via the turbine building crane and set inside an existing caged-in area on the turbine building deck. A clean room will be set up and access control will be established.

TDI personnel will perform the disassembly allowing the appropriate inspections to take place. The TDI Service Representative will be the responsible supervisor for the TDI workman. The generator will also be inspected for damage while on the turbine deck. LILCO and FAA inspections will be performed during this work.

Once removed, the damaged shaft will be sent off site for failure analysis.

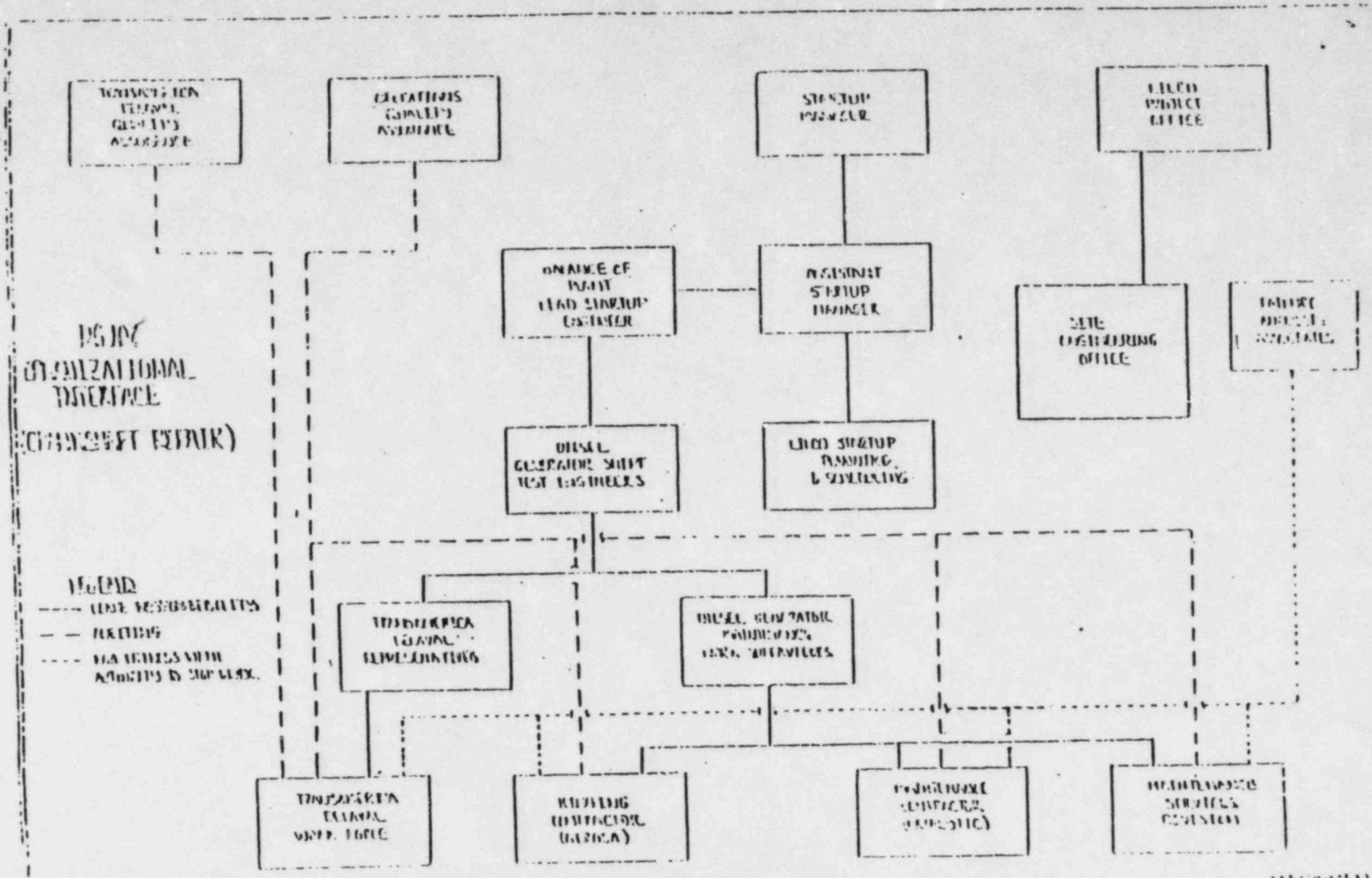
TDI personnel will rebuild the engine under the supervision of a TDI Service Representative and following reassembly, the engine will be transported back into the diesel generator room by Gerosa personnel.

Catalytic personnel will reconnect all apertenances. At this point retesting will begin.

V. RETESTING DIESEL GENERATOR 101

Upon completion of the Emergency Diesel Generator 102 rework and reinstallation, the Preop test program for this engine will be reperformed as follows.

a. All components disturbed by the rework will be subjected to appropriate C&IO, including calibrations, electrical wire checks, and pneumatic tubing connection reverifications.
b. The Lube Oil, Jacket Water, Fuel Oil and Air Start system will be reflushed as required.
c. Initial engine run-in per TDI direction.
d. The Mechanical Preop test will be reperformed in its entirety.
e. The two Electrical Preop tests will be reperformed.
f. Following completion of the above and review and concurrence by the JTG, the Qualification Preop test will be reperformed.



ATTACHMENT #2

August 18, 1983

R. T. Purcell
M. Milligan
J. Notaro

STOP WORK AUTHORIZATION - DIESEL ENGINE 102 FAILURE
Shoreham Nuclear Power Station Unit 1
W. O. No. 44430/48923

During the investigation of the Diesel Generator 102 failure the duly authorized Failure Analysis Associate Representative on shift has the authority to stop work as long as the stop work order does not cause a personnel safety concern.

This stop work authorization is being given to ensure that the Failure Analysis Associates people are in a position to ensure that they get the maximum information from the failure investigation.

Upon issuing a stop work order the Failure Analysis Associate Representative shall notify the undersigned of this action immediately.

E. J. Youngling
Startup Manager

EJY:ecm

cc: M. S. Pollock
J. Rivello
W. Museler
W. Steiger
A. Muller
G. Rogers - FAA
J. Hammeyer-SEC

ATTACHMENT #1

August 11, 1983

R. T. Purcell
M. Milligan
T. Notaro

STOP WORK AUTHORIZATION FOR TRANSAMERICA DELAVAL INC.
DIESEL ENGINE 102 FAILURE
Shoreham Nuclear Power Station - Unit 1
P. O. No. 44430/48922

During the investigation of the Diesel Generator 102 failure, the duly authorized Transamerica Delaval Inc. Representative on shift has the authority to stop work, as long as the stop work order does not cause a personnel safety concern.

This stop work authorization is being given to ensure that Delaval personnel are in a position to ensure that they obtain the maximum information from the failure investigation.

Upon issuing a stop work order, the Transamerica Delaval Representative shall notify the undersigned of this action immediately.

E. J. Youngling
Startup Manager

EJY:acm

cc: M. S. Pollock
J. Rivello
W. Museler
W. E. Steiger
A. Muller
G. Rogers - TAA
J. Kammeyer - SEO
L. McHugh - TDI

Enclosure 3

Information Requests on Diesel Generators (D/Gs)

I. General

1. Provide a written summary of the approach to be used on the Failure analysis for DG 102 on an expedited basis.

2. Provide the preoperational NDE records of the three DG crankshafts.

3. Provide the number of crankshaft failures and population size for all Delaval D/Gs, all nuclear service Delaval D/Gs, and all R-4 D/Gs.

4. Provide the failure analysis, if any, for the above crankshaft failures.

5. Provide the total number of operating hours on each D/G and the total number of hours at 3900 KW or greater.

6. Provide copies of all LILCO/S&W audits of Delaval and responses.

7.1 What is the maximum load to which these D/Gs could be upgraded?

7.2 What modifications would be required to make the upgrade?

7.3 What are the limiting components?

7.4 Provide an early reply as to whether these three questions can be answered and an estimate as to when.

8. Provide an explanation of the claim in the June 10, 1983 letter of Delaval to LILCO that the LILCO DGs are "state of the art" with no other product improvements which could positively affect reliability in light of the subcover cracks and crankshaft failure and the fact that modified parts were available but not identified. Also provide a commitment to review all product improvements available for the Shoreham D/Gs, if these D/Gs are to be repaired and used.

9. Does Delaval have a program where parts/components etc. are modified (such as design margins reduced) in order to improve ~~probability~~ profitability? Does this apply to any D/G parts for Shoreham?

10. Provide responses to all NRC open items on D/Gs.

11. Provide responses to all items in NRC consultants's report.

12. Provide all vendor documentation on crankshafts, certifications of conformance, specs, NDE records, etc. Include statements of how and where from each crank shaft originated.

13. Provide justification for grinding cracks out of 101 DG crankshaft w/o failure analysis - before any grinding is done.

14. Provide a committment for testing to demonstrate adequate vibration after reinstallation.

15. Response to 5/13/82 Delaval Part 21 report on starting air valve assembly.

II. Procurement

1. Provide procurement specifications to which the diesel generators were ordered. In addition, provide the performance specification, and the inspections performed upon receiving the diesels to show that the procurement specifications were met.

2. Discuss all tests performed on the DG's that were observed by LILCo at the manufacturing facilities. Describe all the tests performed at the manufacturing facilities that were not observed by LILCo. The description should include test procedures, pertinent instrumentation diagrams, and test data and results.

3. In addition to the qualification tests performed in accordance with the guidelines RG's 1.9 and 1.108 and IEEE Standard 387, describe all onsite tests that were performed on the DGs. Provide test procedures for these tests and also the data and tests results.

4. In addition to the deficiency reports already provided to the NRC, describe any installation problems encountered during the installation and operation of the DGs. Provide complete operating histories of the DGs.

5. Provide a description of the original design basis of the straight eight DGs used at Shoreham and a complete and detailed list of all product improvements made in this product line of DGs. Include in the description the recommended continuous and maximum loads and the operating hours for each rating for each modification.

6. Provide a latest copy of the technical instruction manual for these DGs.

III. Conditions of the Failure Occurance

1. Provice the test procecures that were being used at the time of the failure.

2. Describe the conditions in the test area prior to, during, and after the failure. The description should include all pertinent test information, vital signs, and test conditions such as test grid condition, all instrument reading prior to failure and post-failure, dither, all traces, vibrations noticed and recorded, and noises.

IV. Failure Investigation

1. Provice a copy of the Failure Analysis Associates (FAA) charter.

2. Provide the manufacturer's design calculations for the torsional analysis of the DGs. In addition, provide the models used, methods of arriving at the lumped parameters, justifications of any correlating factors used, calculations of all the natural frequencies, their mode shapes including the mode locations.

3. Describe all the torsional testin that was performed by the manufacturers on the straight-eight DGs. The description should include the test procedure, test data, test results, configurations and components of the DGs and loading devices during the test, and the instrumentation used and their locations.

4. Compare the DGs presently at Shoreham with all either TDI emergency DGs models now in use or to be used in other nuclear generating stations to show that the conditions and/or failure modes present at Shoreham will not occur at these other nuclear plants.

5. Describe the analytical investigations that FAA is or will be performing on the DGs. The description shall include the torsional vibration analysis, the stress analysis and the evaluation of the TDI torsional vibration and stress analysis.

6. Describe all the testing that will be performed by FAA on the emergency DGs at Shoreham. The description shall include test procedures and objectives, instrumentation and location, test data, test results, test loadings, test configuration, power factors, and methods of evaluation load interaction.

7. Based on the results of the analytical investigations and the test results, describe the effects, if any, that fast starts had on the failure.

8. Describe all the metallurgical and failure analysis of the crankshaft that will be performed by FAA.

V New Crankshaft/Refurbishing of EDG's

1. Describe any new or additional problems or design deficiencies that may occur as a result of the installation of the 16x12 crankshaft.

2. Describe and justify the requalification testing program that will be performed on the modified DGs. The description shall include torsional vibration and stress testing, any testing in addition to the testing required in RGs 1.9 and 1.108 and IEEE Standard 387.

3. Describe the impact of the previous multiplicity of failures on the modified DGs.

VI Root-Cause Analysis

1. Provide a root-cause analysis which shows that the various failures documented in various deficiency reports and other documentations are not causally linked; for example, could cooling water leakage contribute to crankshaft failure?

ENCLOSURE 4

SSINS No.: 6835
IN 83-51

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D.C. 20555

August 5, 1983

IE INFORMATION NOTICE NO. 83-51: DIESEL GENERATOR EVENTS

Addressees:

All nuclear power facilities holding an operating license (OL) or a construction permit (CP).

Purpose:

This information notice is provided to bring to the attention of licensees and construction permit holders some events and experience of generic diesel generator problems and corrective action taken. It is expected that recipients will review the information for applicability to their facilities. No other action or response is required.

Description of Circumstances:

In its continuing review of licensee event reports (LERs), NRC has identified during the past five months more than 100 LERs pertaining to diesel generator problems. Most of these appear to be material, equipment, or component failures. No single common trend can be identified.

NRC is concerned about the large number of diesel generator events. During discussions with diesel manufacturers and licensees, it appears that many of these events could have been eliminated or prevented by implementation of a conscientious maintenance and inspection program as well as monitoring equipment through a plant's trend program. Some licensees have instituted such a program to determine the underlying cause of the failures (see IE Information Notice 82-10) and to prevent their recurrence. Components or materials that have experienced failures are monitored or inspected more frequently. Many affected items are repaired or replaced before actual breakdown. For example, cooling water heat exchangers that were found to be ineffective after a certain period of time because of tube fouling were replaced. Cooling jacket circulating water pump bearings are inspected for wear and replaced in certain intervals. Pressure switches and timers have been found with drifting setpoints and were recalibrated or replaced frequently.

Because of the large number of diesel generator events it is not feasible to describe all the events reported. However, Attachment 1 to this information notice gives several representative examples and corrective actions taken.

If there are any questions regarding this matter, please contact the Regional Administrator of the appropriate NRC Regional Office, or this office.

Edward L. Jordan, Director
Division of Emergency Preparedness
and Engineering Response
Office of Inspection and Enforcement

Technical Contact: Wolfgang Laudan, IE
301-492-9759

Attachments:
1. Selected Examples of Licensee Event Reports Related to Emergency Diesel Generators
2. List of Recently Issued IE Information Notices

SELECTED EXAMPLES OF LICENSEE EVENT REPORTS AND VENDOR REPORTS RELATED TO EMERGENCY DIESEL GENERATORS

QUAD-CITIES 2, OCTOBER 6, 1982

During the monthly preventive maintenance testing of Unit 2 diesel generator, the diesel tripped on high temperature 10 minutes after loading. The cause was determined to be fouling in the cooling water heat exchanger. The heat exchanger was replaced and the diesel testing was satisfactorily completed. The licensee placed the heat exchanger on a preventive maintenance schedule for cleaning.

SEQUOYAH 2, OCTOBER 20, 1982

During a performance test of diesel generator 2B-B, the cooling jacket circulating water pump on the diesel generator was found to be inoperable as a result of a ball bearing failure in the pump. The bearing was replaced and the diesel generator was returned to service.

SUSQUEHANNA, OCTOBER 27, 1982

During a performance test of a diesel generator, the diesel generator tripped on high vibration. It was postulated that a vibration switch and a pressure regulator were both involved in the trip. Both were repaired and the diesel generator was returned to service. The equipment will be monitored through the plant's trend program.

BRUNSWICK 1, NOVEMBER 5, 1982

During a quick start testing program of diesel generator No. 4, the diesel generator tripped on "low lube oil pressure." The same problem occurred 2 days later on the same unit. Both events resulted from intermittent failures of the "low lube oil pressure start time relay" (STR). The relay timed out before actual pressure was above the low trip setpoint. The relay was replaced and the diesel testing was satisfactorily completed.

DRESDEN 3, NOVEMBER 9, 1982

During a Unit 3 diesel generator surveillance test, the diesel generator tripped on low cooling water pressure. A defective low cooling water pressure switch caused this event. The switch was replaced and the testing was satisfactorily completed.

RANCHO SECO, MAY 25, 1983

During startup testing, the diesel generator would not reach full operating speed. The Woodward governor speed adjustment on the unit stopped at about 650 rpm. It was found that the pointer disk was hanging up behind the dial plate. The manufacturer recommended filing about 1/16-inch off the pointer disk to allow free movement. After that the diesel achieved proper speed.

CALVERT CLIFFS, APRIL 7, 1983

During a routine inspection of the intake air check valve of No. 11 diesel generator, the licensee found a check valve holding pin sheared and the check valve loose. The same valve on two other diesel generators at Calvert Cliffs had been found to be cracked when inspected during 1982. The disk of one of these valves was found broken in two pieces. The engines in question are Fairbanks Morse Model 38TD81/8.

Because these failures did not render the diesel generators inoperable, as evidenced by successful completion of weekly operational tests, no LER was issued. The licensee pointed out that there were internal baffles between the check valves and the diesel turbocharger which made it unlikely to have a piece of the check valve enter the diesel's turbocharger. The check valve in question diverts air between the diesel turbocharger and integral air-blower. Failure of the check valve would result in air being available through the turbocharger at low loads and would affect the load control.

SHOREHAM, OCTOBER 15, 1982; APRIL 15, 1983; APRIL 20, 1983; MAY 4, 1983

During preoperational testing of Shoreham's three Transamerica Delaval, Inc. emergency diesel generators, the following mechanical problems were identified in the past 9 months and reported by the licensee under 10 CFR 50.55 (e):

October 15, 1982 - The jacket waterpump shaft failed.
April 15, 1983 - The engine head cracked.
April 20, 1983 - The fuel injection line failed.
May 4, 1983 - The rocker arm bolt failed.

Approximately 2 years before these problems occurred, the licensee discovered the following:

1. Loose hardware in cam gears during initial onsite inspection.
2. Multiple broken cylinder head exhaust bolts resulting from insufficient pipe guide clearances in the exhaust manifold.
3. Cracks in the fuel oil ejector that connects to the fuel oil drip line.
4. Absence of a drilled passageway for the relief valve on one lube oil pump line as required by design.
5. Leaky lube oil cooler tubes resulting from improper rolling in the tube sheet.
6. Cracks in rocker arm push rod socket (or cup).
7. Cam gear fitted bolts not installed at the factory as required.

The problems were corrected under the surveillance of vendor representatives. Nuclear sites with Transamerica Delaval diesel generators are listed on page 4 of this attachment.

LOUIS ALLIS REPORTED TWO DIFFERENT POTENTIAL PROBLEMS. MAY 20, 1983

(Louis Allis is the successor to Belouit Power Systems, Inc., and to Colt-Fairbanks Engine Division)

1. At the diesel generator in the Clinton Nuclear Plant, a three-phase rectifier assembly in the exciter was not connected in parallel, which could cause field winding insulation to deteriorate. Louis Allis field service took corrective action by making the necessary connections.

2. Detroit Edison experienced high vibration on its diesel generator. The cause was loose pole wedges. Louis Allis performed a detailed engineering evaluation of this problem and found that in 1975 a material change from HRS 1020 steel to 1045 steel was made. This means that diesel generators manufactured before this change may experience the same loose pole wedge problem. The affected plants are Fermi, Millstone Unit 2, and Hatch. These plants were notified by copy of the Part 21 report dated May 20, 1983.

TRANSAMERICA DELAVAL - 1981 TO 1983

The manufacturer reported the following turbocharger thrust bearing lubrication problem:

The design of the lubricating oil system permits the oil flow to the turbocharger bearing only when the diesel generator is running. When the diesel generator is in the standby mode, the turbocharger bearing lube oil system is bypassed to prevent a possible fire hazard should pressurized oil leak around the bearing seals onto hot impellers. Therefore, during startup, a sufficient amount of oil would not be available to adequately lubricate the turbocharger bearing. Because diesels are started once a month and run for a short length of time, premature bearing wear was experienced because of insufficient lubrication.

At San Onofre, the wear rate for this condition after 100 hours of operation was equivalent to 15,000 to 20,000 hours of continuous operation.

To ensure proper lubrication during startup, a design modification in the form of a lubrication oil drip system causing the lubricating oil to drip on the bearings through an orifice at a given rate was proposed, installed, and tested. An alternate method to this design modification is a change in the operating procedure. Before a monthly start, an operator would manually run the auxiliary lube oil pump for 30 to 60 seconds and confirm lube oil pressure. In the event of an emergency start, the bearings will function until oil pressure is developed.

Transamerica Delaval reported that the following nuclear sites were affected:

Shoreham	Perry	WPPSS 4
Grand Gulf	Bellefonte	Midland 1 & 2
Catawba	WPPSS 1	Hartsville
San Onofre	Comanche Peak 1 & 2	Phipps Bend

The licensees of the above plants were notified by copy of Transamerica Delaval Part 21 report dated September 19, 1980.

LIST OF RECENTLY ISSUED IE INFORMATION NOTICES

Information Notice No.	Subject	Date of Issue	Issued to
83-50	Failure of Class 1E Safety-Related Switchgear Circuit Breakers to Close on Demand	8/1/83	All power reactor facilities holding an OL or CP
83-49	Sampling and Prevention of Intrusion of Organic Chemicals Into Reactor Coolant Systems	07/25/83	All power reactor facilities holding an OL or CP
83-48	Gaseous Effluent Releases of Radioactive Iodine-125 and Iodine-131 in Excess of NRC Limits	07/14/83	NRC licensed byproduct material licensees, including medical and academic institutions, radiopharmaceutical suppliers, and industrial research
83-47	Failure of Hydraulic Snubbers as a Result of Contaminated Hydraulic Fluid	07/12/83	All power reactor facilities holding an OL or CP
83-46	Common-Mode Valve Failures Degrade Surry's Recirculation Spray Subsystem	07/11/83	All power reactor facilities holding an OL or CP
83-45	Environmental Qualification Test Of General Electric Company "CR-2940" Position Selector Control Switch	07/01/83	All power reactor facilities holding an OL or CP
83-44	Potential Damage to Redundant Safety Equipment as a Result of Backflow Through the Equipment	07/01/83	All power reactor facilities holding an OL or CP
83-43	Improper Settings of Intermediate Range (IR) High Flux Trip Setpoints	06/24/83	All power reactor facilities holding an OL or CP
83-42	Reactor Mode Switch Modifications	06/23/83	All BWR facilities holding an OL or CP

OL = Operating License
CP = Construction Permit

ENCLOSURE 5

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 1000
ARLINGTON, TEXAS 76011

OCT 03 1983

Docket No. 99900334/83-01

Transamerica Delaval, Incorporated
Engine and Compressor Division
ATTN: Mr. C. Mathews
General Manager
550 85th Avenue
Oakland, California 94251

Gentlemen:

This refers to the inspection conducted by Mr. J. W. Sutton of this office on July 11-15, 1983, of your facility at Oakland, California, associated with the manufacture of emergency diesel generators and to the discussions of our findings with you and members of your staff at the conclusion of the inspection

This inspection was made as a result of the issuance of several 10 CFR Parts 21 and 50.55(e) reports. The reports pertained to: (1) incorrectly identified bolt material, (2) failure of high pressure fuel oil injection lines, (3) failure of jacket water pump shafts, (3) failure of a crankcase cover bolt, (4) unqualified isoprene material, and (5) deficient piston skirts. These conditions were observed singly or in combination at one or more nuclear generating stations.

Areas examined and our findings are discussed in the enclosed report. Within these areas, the inspection consisted of an examination of procedures and representative records, interviews with personnel, and observations by the inspector.

During the inspection it was found that the implementation of your QA program failed to meet certain NRC requirements. The specific findings and references to the pertinent requirements are identified in the enclosures to this letter.

This Notice of Violation is sent to you pursuant to the provisions of Section 206 of the Energy Reorganization Act of 1974. You are required to submit to this office within 30 days from the date of this letter, a written statement containing: (1) a description of steps that have been or will be taken to correct these items; (2) a description of steps that have been or will be taken to prevent recurrence; and (3) the dates your corrective actions and preventive measures were or will be completed. Consideration may be given to extending your response time for good cause shown.

You are also requested to submit a similar written statement for each item which appears in the enclosed Notice of Nonconformance.

The responses requested by this letter are not subject to the clearance procedures of the Office of Management and Budget as required by the Paperwork Reduction Act of 1980, PL 96-511.

In accordance with 10 CFR 2.790 of the Commission's regulations, a copy of this letter and the enclosed inspection report will be placed in the NRC's Public Document Room. If this report contains any information that you believe to be exempt from disclosure under 10 CFR 9.5(a)(4), it is necessary that you (a) notify this office by telephone within 10 days from the date of this letter of your intention to file a request for withholding; and (b) submit within 25 days from the date of this letter a written application to this office to withhold such information. If your receipt of this letter has been delayed such that less than 7 days are available for your review, please notify this office promptly so that a new due date may be established. Consistent with Section 2.790(b)(1), any such application must be accompanied by an affidavit executed by the owner of the information which identifies the document or part sought to be withheld, and which contains a full statement of the reasons on the basis which it is claimed that the information should be withheld from public disclosure. This section further requires the statement to address with specificity the considerations listed in 10 CFR 2.790(b)(4). The information sought to be withheld shall be incorporated as far as possible into a separate part of the affidavit. If we do not hear from you in this regard within the specified periods noted above, the report will be placed in the Public Document Room.

Should you have any questions concerning this inspection, we will be pleased to discuss them with you.

Sincerely,

Uldis Potapovs, Chief
Vendor Program Branch

Enclosures:
1. Appendix A - Notice of Violation
2. Appendix B - Notice of Nonconformance
3. Appendix C - Inspection Report No. 99900334/83-01
4. Appendix D - Inspection Data Sheets (11 pages)

APPENDIX A

Transamerica Delaval, Incorporated
Engine and Compressor Division
Docket No. 99900334/83-01

NOTICE OF VIOLATION

As a result of the inspection conducted on July 11-15, 1983, and in accordance with Section 206 of the Energy Reorganization Act of 1974 and its implementing regulation 10 CFR Part 21, the following violation was identified and has been categorized in accordance with the NRC Enforcement Policy (10 CFR Part 2, Appendix C), 47 FR 9987 (March 9, 1982):

Section 21.21(b)(1) of 10 CFR Part 21, dated December 30, 1982, states, in part:

> A director or responsible officer subject to the regulations of this part or a designated person shall notify the Commission when he obtains information reasonably indicating a failure to comply or a defect affecting . . . a basic component that is within his organization's responsibility and is supplied for a facility or activity within the United States that is subject to the licensing requirements under Parts 30, 40, 50, 60, 61, 70, 71, or 72 of this chapter. The above notification is not required if such individual has actual knowledge that the Commission has been adequately informed of such defect or such failure to comply.

Contrary to the above, a director, responsible officer, or designated person had not notified the Commission in regard to:

1. Jacket water pump shaft failures on the emergency diesel generators (EDG) that had been furnished to the Shoreham Nuclear Power Station.

2. A potential defect in the fuel injection line tubing that was used on EDGs furnished to Grand Gulf and San Onofre.

This is a Severity Level IV violation (Supplement VII).

APPENDIX B

Transamerica Delaval, Incorporated
Engine and Compressor Division
Docket No. 99900334/83-01

NOTICE OF NONCONFORMANCE

Based on the results of an NRC inspection conducted on July 11-15, 1983, it appears that certain of your activities were not conducted in accordance with NRC requirements as indicated below:

Criterion V of Appendix B to 10 CFR Part 50 states: "Activities affecting quality shall be prescribed by documented instructions, procedures, or drawings, of a type appropriate to the circumstances and shall be accomplished in accordance with these instructions, procedures, or drawings. Instructions, procedures, or drawings shall include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished."

Nonconformances with these requirements are as follows:

A. Paragraph 4.6.2 of Section 4 of the Quality Assurance Manual (QAM) dated April 30, 1981, states, in part, "when required by Purchase Order material received destined to become a part of the manufactured item must be accompanied by a Certificate of Vendor inspection. The material is then inspected to all applicable specifications utilizing Vendor Certifications . . . ." In addition, paragraph 4.1.1 of Quality Control Procedure I.P.200, states, in part, "when it is determined that product deviates from specification, an Inspection Report, Form P-249, will be initiated by the Receiving Inspector describing the nature of the defect."

Contrary to the above, the Transamerica Delaval Incorporated (TDI) receiving inspector accepted material on Purchase Order No. 45333, for which required mill test reports had not been received, without issuing a nonconformance form P-249.

B. Subparagraphs of II.A and II.B dated January 29, 1976, and November 10, 1969, respectively, of the Drafting Room Practice (DRP) requires: (1) drawing of layouts on tracing paper; and (2) a special title block on layout drawings with ample space for signatures in full of the designer and witnesses along with dates.

Contrary to the above, the following layout drawings for the late 1982 redesign of the emergency diesel generator (EDG) jacket water pump had not been (1) drawn on tracing paper and (2) signed and dated: (a) 101973, (b) 03-426-09-AA, and (c) 03-425-10-AE (lined through).

C. Paragraphs 2.2 and 2.3 of the Engineering Operating Procedure (EOP) 4, dated April 19, 1979, states, respectively, "The designer shall perform the necessary calculations, if required, and prepare the required design layouts.

"The designer shall sign, date, and submit the calculations which he has checked for completeness and accuracy, along with the design layout as required, and his signed and dated form E-213, to the Manager of Design."

Paragraph II.A.6 dated January 29, 1976, of the Drafting Room Practice, states, "Important calculations should be written in the proper notebook, maintained in the department files."

Contrary to the above, regarding calculations for redesign of defective EDG jacket water pumps located at Shoreham Nuclear Power Station:

1. Calculations for the first occurrence (1979) which are written in the proper notebook had not been signed and dated in the spaces provided.

2. Calculations for the second occurrence (1982) had not been (a) signed, and (b) written in the proper notebook.

D. Section 6 dated February 27, 1981, of the QAM, contains the following requirements:

1. Paragraph 6.1.1 states, "Documents establishing and defining processes and procedures pertaining to the quality of the product shall be controlled by the subdivision that has the initial responsibility of issue."

2. Paragraph 6.2.1 states, in part, "All documents relating to the quality of the product shall be reviewed by the manager of the issuing section or his representative."

3. Paragraph 6.3.1 states, in part, "All documents such as Engineering drawings . . . must have a mechanism for identification, authority of issuance and revision."

Contrary to the above, "D Sheets" which pertain to quality of the product are issued by the Engineering Department; however, they are not reviewed by the manager as evidenced by the lack of provisions to identify the date, preparer, reviewer, approver, or revision. Examples are D-4986 and D-4956, which are entitled, "Assembly Instructions," and pertain to the EDG jacket water pump. It was noted that the latter document reflected the release date, four revision levels and dates in the lower margin of the affected sheets.

E. Paragraphs 5.3.2 and 5.3.3 of Section 5 dated February 27, 1981, of the QAM, require that Manufacturing Engineering provide written instructions in the form of route sheets, tooling sheets, or special written instructions, etc., to Manufacturing and Assembly Departments.

Paragraph 16.2.1 of Section 16 dated February 27, 1982, of the QAM states, in part, "Manufacturing and assembly Route Sheets are used as records of in-process inspection of parts, components, and assemblies. All Route Sheets are retained by Quality Control as objective evidence of inspection acceptance."

Contrary to the above, route sheets for the assembly of the EDG jacket water pump reflected on Drawing No. 101973, Revision C, had not been retained by Quality Control as objective evidence of inspection acceptance.

F. Paragraphs 2.4.1 and 9.1.1 of Quality Control Inspection Procedure No. 300 dated April 1, 1981, requires that the area inspector (1) inspect, (2) stamp and date the Production Routing Sheet (PRS) in the space provided, and (3) stamp and date and enter quantity accepted in the final acceptance block of the PRS.

Contrary to the above, regarding EDG jacket water pump parts that were manufactured during the time period when defective jacket water pumps were being modified:

1. Stamp and date had not been entered at Operation No. 90 and final accept block of PRS No. 03-426-08-AE Water Pump Shaft which was processed in October 1982. Further, the quantity accepted had not been entered in the quantity accepted block.

2. Stamp had not been entered in the final accept block of PRS No. 101969 Seal Retainer which was processed in September 1982.

G. Stone and Webster Engineering Corporation Specification No. SH1-89 dated June 24, 1981, provides the bidder with the option of testing or dynamic analysis of mechanical equipment for seismic qualification.

[redacted]

Paragraph 15.3.1 and its subparagraph 5 of EOP 1 dated April 20, 1981, state that the engine driven jacket water pump will be shake tested. The "Qualification Statement for 03-425-04 Jacket Water Cooling Pump Revision" dated October 18, 1982, states, in part, "We submit that these changes do not have any negative effect on the seismic qualification of the subject pump . . . ."

Contrary to the above, dynamic analysis or testing had not been conducted on the redesigned EDG jacket water pumps to assure that the seismic qualification had not been compromised.

H. Paragraph A.1 of EOP 7 dated April 20, 1981, states, in part, "This procedure outlines those steps taken in accomplishing release or revision of . . . purchase specifications." Purchase specifications contain a space for approval.

Contrary to the above, Purchased Material Specification No. RL 019000 dated October 6, 1982, had not been approved as evidenced by the lack of a signature in the approval block.

I. TDI's 10 CFR Part 21 report letter dated June 23, 1983, concerning a potential problem with the isoprene flexible elements of drive couplings, states, in part, "a copy of this letter will be sent to each of the cognizant parties as listed in paragraph 2, no later than July 15, 1982."

Contrary to the above, the TDI notification letters to 10 affected customer cognizant parties were dated August 18, 1982.

ORGANIZATION: TRANSAMERICA DELAVAL, INCORPORATED
ENGINE AND COMPRESSOR DIVISION
OAKLAND, CALIFORNIA

~~THIS DOCUMENT HAS NOT BEEN REVIEWED FOR PROPRIETARY INFORMATION PER 10 CFR~~

REPORT NO.: 99900334/83-01	INSPECTION DATE(S) 7/11-15/83	ON-SITE HOURS: 81

CORRESPONDENCE ADDRESS: Transamerica Delaval, Incorporated
Engine and Compressor Division
ATTN: Mr. C. Mathews, General Manager
550 85th Avenue
Oakland, California 94621

ORGANIZATIONAL CONTACT: Mr. R. E. Boyer, Manager, Quality Assurance
TELEPHONE NUMBER: (415) 577-7422

PRINCIPAL PRODUCT: Emergency diesel generators.

NUCLEAR INDUSTRY ACTIVITY: Transamerica Delaval, Incorporated (TDI) has no current contracts for domestic nuclear emergency diesel generators (EDGs).

ASSIGNED INSPECTOR: J. W. Sutton
J. W. Sutton, Reactive and Component Program Section (R&CPS) — Date: 9/26/83

OTHER INSPECTOR(S): W. E. Foster, R&CPS
R. E. Oller, R&CPS

APPROVED BY: I. Barnes
I. Barnes, Chief, R&CPS — Date: 9/27/83

INSPECTION BASES AND SCOPE:

A. BASES: 10 CFR Part 50, Appendix B and 10 CFR Part 21.

B. SCOPE: This inspection was made as a result of the issuance of several 10 CFR Part 21 and 50.55(e) reports. The reports pertained to: (1) incorrectly identified bolt material, (2) failure of high pressure fuel oil injection lines, (3) failure of jacket water pump shafts, (4) failure of a crankcase cover bolt, (5) unqualified isoprene material, and (6) deficient piston skirts. These conditions were observed singly or in combination at one or more nuclear generating stations.

PLANT SITE APPLICABILITY:

Incorrectly identified bolt material: 50-400. Failure of high pressure fuel oil injection lines: 30-322, 50-206, 50-361, 50-362, 50-416, and 50-417.
(cont. on next page)

PLANT SITE APPLICABILITY: (cont.)
Failure of jacket water pump shafts: 50-322. Failure of a crankcase cover bolt: 50-416. Unqualified isoprene material: 50-416, 50-417, 50-400, 50-413, 50-414, 50-424, and 50-425. Deficient piston skirt: 50-413, 50-414, 50-518, 50-519, 50-553, 50-554, 50-400, 50-401.

A. VIOLATIONS:

Contrary to Section 21.21(b)(1) of 10 CFR Part 21 dated December 30, 1982, a director, responsible officer, or designated person had not notified the Commission in regard to:

1. Jacket water pump shaft failures on EDGs that had been furnished to the Shoreham Nuclear Power Station.

2. A potential defect in the fuel injection line tubing that was used on EDGs furnished to Grand Gulf and San Onofre.

This is a Severity Level IV violation (Supplement VII).

B. NONCONFORMANCES:

1. Contrary to Criterion V of Appendix B to 10 CFR Part 50, paragraph 4.6.2 of Section 4 of the Quality Assurance Manual (QAM) and paragraph 4.1.1 of Quality Control Procedure I.P.200, the receiving inspector accepted material on Purchase Order (PO) 45333, for which required mill test reports had not been received, without issuing a nonconformance form P-249.

2. Contrary to Criterion V of Appendix B to 10 CFR Part 50 and the commitment date of July 15, 1982, in TDI's 10 CFR Part 21 report dated June 23, 1982, concerning unqualified material in flexible drive couplings of EDGs, the notification letters were not sent until August 18, 1982.

3. Contrary to Criterion V of Appendix B to 10 CFR Part 50 and subparagraphs II.A and II.B dated January 29, 1976, and November 10, 1969, respectively, of the Drafting Room Practice, the following layout drawings for the late 1982 redesign of the EDG jacket water pump had not been (1) drawn on tracing paper and (2) signed and dated: (a) 101973, (b) 03-425-08-AA, and (c) 03-425-10-AE (lined through).

4. Contrary to Criterion V of Appendix B to 10 CFR Part 50, paragraphs 2.2 and 2.3 of Engineering Operating Procedure (EOP) 4 dated April 19, 1979, and paragraph II.A.6 dated January 29, 1976, of the

Drafting Room Practice, regarding calculations for the redesign of defective EDG jacket water pumps located at Shoreham Nuclear Power Station:

a. Calculations for the first occurrence (1979), which are written in the proper notebook, had not been signed and dated in the spaces provided.

b. Calculations for the second occurrence (1982) had not been (a) signed, and (b) written in the proper notebook.

5. Contrary to Criterion V of Appendix B to 10 CFR Part 50 and paragraphs 6.1.1, 6.2.1, and 6.3.1 of Section 6 dated February 27, 1981, of the QAM, "D Sheets" which pertain to quality of the product are issued by the Engineering Department; however, they are not reviewed by the manager as evidenced by the lack of provisions to identify the date, preparer, reviewer, approver, or revision. Examples are D-4986 and D-4956 which are entitled, "Assembly Instructions," and pertain to the EDG jacket water pump. It was noted that the latter document reflected the release date, four revision levels, and dates in the lower margin of the affected sheets.

6. Contrary to Criterion V of Appendix B to 10 CFR Part 50 and paragraphs 5.3.2, 5.3.3, and 16.2.1 of Sections 5 and 16, respectively, dated February 27, 1981, of the QAM, route sheets for the assembly of the EDG jacket water pump reflected on Drawing No. 101973, Revision C, had not been retained by Quality Control as objective evidence of inspection acceptance.

7. Contrary to Criterion V of Appendix B to 10 CFR Part 50 and paragraphs 2.4.1 and 9.1.1 of Quality Control Inspection Procedure No. 300 dated April 1, 1981, regarding EDG jacket water pump parts that were manufactured during the time period when defective jacket water pumps were being modified:

a. Stamp and date had not been entered at Operation No. 90 and final accept block of PRS No. 03-426-08-AE water pump shaft which was processed in October 1982. Further, the quantity accepted had not been entered in the quantity accepted block.

b. Stamp had not been entered in the final accept block of PRS No. 101969 seal retainer which was processed in September 1982.

8. Contrary to Criterion V of Appendix B to 10 CFR Part 50, Stone and Webster Engineering Corporation Specification No. SHI-[illegible] dated June 24, 1981, paragraph 15.3.1 and its subparagraph 5 of EOP 1 dated April 20, 1981, and the "Qualification Statement for 03-425-04 Jacket Water Cooling Pump Revision" dated October 18, 1982, dynamic analysis or testing had not been conducted on the redesigned EDG jacket water pumps to assure that the seismic qualification had not been compromised.

9. Contrary to Criterion V of Appendix B to 10 CFR Part 50, and paragraph A.1 of EOP 7 dated April 20, 1981, Purchased Material Specification No. RL 019000 dated October 6, 1982, had not been approved as evidenced by the lack of a signature in the approval block.

C. UNRESOLVED ITEMS:

None

D. STATUS OF PREVIOUS INSPECTION FINDINGS:

1. (Closed) Nonconformance A (Report No. 82-02): The Quality Assurance/Quality Control organizational chart had not been updated to reflect changes in the QA/QC organization since January 1, 1982.

   The NRC inspector reviewed the current QA/QC organizational chart which was revised on January 15, 1983, showing that the Nondestructive Examination (NDE) Level III examiner is no longer the Manager of Quality Engineering.

2. (Closed) Nonconformance B (Report No. 82-02): Kobe Steel Ltd. had not been surveyed at a minimum of once every three years as required by paragraph 4.4.3 of Section 4 of the QAM.

   The NRC inspector reviewed a revision to the QAM, subparagraph 4.4.5, issued April 22, 1983, which indicates that vendors who hold current ASME certificates of authorization or Quality Systems Certificates need not be surveyed or audited. Chemical analysis of subject crankshaft materials were performed and the materials found to be acceptable. The NRC inspector was informed by TDI that they intend to perform a physical inspection at Kobe Steel Ltd. within the next three months.

3. (Closed) Nonconformance C (Report No. 82-02): (a) Component drawings released by engineering did not constitute the final instructions to assembly for definition of acceptance criteria for the governor lube oil cooler, and (b) instructions for assembly of the governor lube oil cooler had not been provided in writing from manufacturing engineering to assembly.

   The NRC inspector reviewed the lube oil governor assembly drawing and verified that the location of the cooler was not identified. In addition, the parts list for this drawing was reviewed for content. The route sheet now indicates the assembly drawing. TDI's corrective action commitments contained in the January 5, 1983, letter to the NRC have been complied with.

E. OTHER FINDINGS AND COMMENTS:

1. Carolina Power and Light Company's (CPL) 10 CFR Part 50.55(e) notification report, dated January 18, 1983, identified that bolting material for the CPL Shearon Harris, Unit 1, EDG was not properly identified in accordance with design requirements.

   The NRC inspector reviewed documents and correspondence between TDI, Ebasco, and CPL pertaining to this subject. It appeared to the NRC inspector that a misunderstanding existed as to whether the bolts and nuts were requested to be fabricated to AISI 4140 or ASTM specifications. The nuts and bolts were bought to the AISI 4140 specification which conforms to ASTM A193 Grade B7 chemical and mechanical property requirements. Specification CAR-SH-E-11, Revision 6, did not require ASTM materials to be purchased. TDI's letter of June 22, 1983, to Ebasco outlines this finding. This is not considered a generic problem.

2. Tennessee Valley Authority (TVA) 10 CFR Part 50.55(e) report to the NRC dated February 10, 1982, addressed the failure of TDI to take corrective action on TVA audit findings described in TVA audit B1V-47, conducted December 1-3, 1981. Documentation and correspondence between TVA and TDI to date was reviewed. Reaudits have been performed by TVA to determine compliance to their findings. TDI had taken action to make sure that proposed corrective actions were implemented before signing off on the corrective action form. Documentation for compliance to this requirement was reviewed.

   All outstanding items were closed out by TVA during a TVA reaudit. TVA's letter to TDI dated August 24, 1982, indicated no findings.

3. Long Island Lighting Company (LILCO) filed a 10 CFR Part 50.55(e) report on April 20, 1983, with the NRC, Region I. The report stated that failures had occurred in fuel oil injection lines to the EDGs that had been furnished to Shoreham Nuclear Power Station, Unit 1. As a result of the documentation review by the NRC inspector, the following conditions were found to exist:

   a. Three diesel generators were supplied to the Shoreham Nuclear Station for emergency power.

   b. A failure occurred to the high pressure fuel oil injector line during routine testing of Generator No. 102 on March 3, 1983. The tubing was replaced and on March 5, 1983, a fuel injection line failed on Generator No. 103.

   c. Both lines were sent to an independent laboratory for failure analysis.

   d. A failure analysis issued by TDI dated June 24, 1983, concluded that the failure was attributable to the presence of a discontinuity on the inside diameter (I.D.) of the injection tube. This discontinuity acted as a stress riser and combined with the line operating pressures resulted in the fatigue endurance limit of the material being exceeded. The report indicated that the discontinuity was a draw seam that had been created during manufacture of the tubing.

   e. TDI conducted a 10 CFR Part 21 meeting on June 27, 1983, as required by the Division 10 CFR Policy Procedure, to evaluate the findings and to determine reportability to the NRC. The committee determined that this problem was an isolated case and was not reportable. On July 5, 1983, another meeting was held which still determined the condition to be nonreportable due to the fact that many engines had been and are running with the same type of tubing that had been installed at Shoreham.

   f. The NRC inspector requested a search be made as to when the tubing used in the Shoreham Units was purchased and if other nuclear sites could have injection lines installed that had been manufactured from the same lot of tubing.

g. TDI searched their records and found that the tubing was purchased in 1976. Purchase lots are made in 2000 ft. increments with approximately 200 ft. being used per diesel unit. The record checks indicated that besides the Shoreham nuclear site, EDGs had been furnished to Grand Gulf and San Onofre nuclear sites which had utilized tubing from the same purchase lot.

h. TDI Design Specification D-266 dated October 2, 1972, and Revisions A and B dated August 18, 1978, and August 15, 1980, contain the applicable requirements required to be followed in regard to tubing manufacturing operations. The supplier was required to furnish material certificates of conformance and test reports with each order. Purchase documentation for this period of time (1976) was not retained by TDI in that the QA program only requires retention for 5 years. The NRC inspector reviewed a recent PO for tubing, No. 45333 dated October 1, 1981, for conformance to purchase requirements. The PO required that mill test reports be furnished. A nonconformance was identified as a result of the acceptance of the material by the receiving inspector, although mill test reports had not been received (see paragraph B.1).

i. The action to preclude recurrence was contained in the failure analysis report, June 24, 1983, and indicated "more rigid QA procedures were called for. Sections from each length of tubing should be cut off, sawed lengthwise at 90° intervals, and inspected to ensure there are no draw marks on the tubing ID. Since draw seams would run the entire length of the tubing, this inspection measure will ensure that no draw seams are present in any line manufactured from that length of tubing (200 ft.). Such a QA requirement should be called for on any high pressure fuel injection line destined for use on a nuclear stand-by emergency diesel generator."

j. As a result of the NRC inspector's review of documentation, consistency of drawings, procedures, POs, letters, in-house memos, and reports, it was concluded that this failure may not be an isolated occurrence and that a potential existed for draw seams to be present in fuel injection lines of diesel generators supplied to Grand Gulf and San Onofre. In addition, review of 10 CFR Part 21 evaluation activities concerning the fuel oil line failure consisted of side notes on letters and records, etc., produced by TDI personnel during Delivered Product Trouble (DPT) meetings. These were considered

as inadequate by the NRC inspector to establish the reason for classifying this occurrence as one of a kind. The violation detailed in paragraph A was identified as a result of this review.

k. Subsequent to the inspection, TDI filed a 10 CFR Part 21 report with NRC, Headquarters. The report is dated July 20, 1983, and identifies the following nuclear generating stations with the potential defect: (1) Shoreham, (2) Grand Gulf, and (3) San Onofre.

4. LILCO filed a 10 CFR Part 50.55(e) report on October 15, 1982, with the NRC, Region I. The report stated that jacket water pump shafts had failed on EDGs that had been furnished to Shoreham Nuclear Power Station, Unit 1. Further, the report stated that the failures occurred on jacket water pumps that had been modified to preclude failures that had been experienced in similar units operating overseas.

The following conditions were observed during the course of the inspection:

a. The Engine and Compressor Division of TDI filed a 10 CFR Part 21 report on September 20, 1979, regarding "a potential failure of the drive shaft for the engine driven jacket water pump which would result in engine nonavailability." The report stated that jacket water pumps of the same design as those that failed had been installed on the three EDGs that had been furnished to Shoreham Nuclear Power Station. The NRC inspector was informed that the jacket water pumps had been modified.

b. A TDI memo dated October 18, 1982, states, in part, "In the past five months, Lilco [Long Island Lighting Company] has experienced three jacket water pump failures." Information presented as a record of evaluation was included in open areas of a form entitled, "Authorization For No Charge Billings" dated October 7, 1982, and identified LILCO as the customer. The following hand written/printed information was exhibited in the open areas: "Review 10 CFR 21 no-only site conditions at LILCO diff OK other plants not a 10 CFR 21 LILCO unique only site with this problem attendees [list of names dated 10-11-82] LILCO is aware of problem TDI & LILCO will solve [signed, dated 11/11/82]." The information is not sufficiently detailed to enable an adequate evaluation of the decision regarding reportability. The failure of the jacket water pumps had not been reported to the Commission. As a result of the foregoing, the violation detailed in paragraph A was identified.

c. Layouts are created by redlining existing drawings rather than by initiating new drawings. The redlined drawings (layouts) had not been subjected to the required signature/date cycle. Calculations had not been controlled in the manner specified. There was no indication that assembly instructions had been reviewed/approved. Route sheets for assembly of the jacket water pump had not been retained; also, some route sheets for manufacturing activity had not been completed as required. The foregoing, along with other observations, resulted in the nonconformances detailed in paragraph B.3 through B.9.

d. A TDI memo dated July 16, 1979, which addresses jacket water pumps, identifies Gulf States along with LILCO and a foreign customer. Requested documents were not presented regarding Gulf States; as a result, this issue will remain open in order to determine whether or not Gulf States received suspect jacket water pumps.

e. TDI identifies the cause as engineering and assembly induced. The NRC inspector concurs; however, in his judgement, the quality organization cannot be excluded. Based upon the observations of this area of the inspection, it is not apparent that adequate corrective actions and preventive measures have been taken. However, the NRC inspector was informed that the pumps at Shoreham Nuclear Power Station have operated past the times of the previous failures.

f. In an effort to assess the effectiveness of the corrective actions and preventive measures, the following areas were evaluated: (a) change control, (b) manufacturing process control, and (c) records. This area of the inspection was accomplished by evaluating the following documents for requirements and/or implementation of requirements: 12 drawings, 3 specifications, 6 procedures, 3 sections of the QA Manual, 5 memoranda, 7 letters, and 24 other documents identified as: analysis/calculations, packaging/shipping notifications, production routing sheets, qualification statement, material requisitions, authorization for no charge billing, failure analysis report, assembly instructions, and requests for drafting room action. The findings are indicated at other locations of this report.

g. Subsequent to the inspection, TDI filed a 10 CFR Part 21 report dated July 20, 1983, with NRC, Headquarters.

5. Two 10 CFR Part 50.55(e) reports by Mississippi Power and Light (MP&L) Company to the NRC were filed on March 22, 1982, and April 21, 1982. These reports concerned the shorting of the generator by a sheared crankcase capscrew head of a Unit I, Division II, diesel generator furnished by TDI. This matter was reported in several interim reports by MP&L with the most recent one being Interim Report No. 6.

   a. During a 24-hour performance test, the unit tripped on a "Generator Differential" which was accompanied by electrical arcing inside the generator. Later inspection verified that the stator insulation had been damaged and the head from a 5/8 x 11 threads x 1 3/4" long capscrew was embedded in the stator. It was determined that the capscrew head was from the diesel engine's rear crankcase cover. All of the capscrews were replaced by the utility, and an analysis of the failed capscrew indicated the head broke off due to low-stress fatigue cracking during service. This cracking appeared to have been initiated by over or under torqueing of the capscrews.

   b. Findings: Review of the problem with TDI's Grand Gulf site service personnel provided the following information: The source of the capscrew head found in the generator stator was from a top capscrew in the vertical crankcase cover. The screw shank was still in the cover hole. The screws are classed as noncritical service and require torqueing of 60 foot pounds (Ft. Lb.). Since the metallurgical analysis indicated a fatigue failure mechanism, the cause appears to have been over or undertorqueing coupled with operating stresses. No information was available to indicate when this incorrect torqueing may have occurred. TDI service personnel indicated that the site Bechtel craftsman would have had a minimum of two occasions when they would have removed and replaced the crankcase cover for bearing checks after the diesel generator was delivered to the site. In addition, they would have had a TDI instruction manual which showed the required torque value of 60 Ft. Lb. for this size bolt while using a special lubricant. The TDI service personnel also indicated that this incident of a sheared screw head shorting the generator was a first time occurrence for the TDI diesel generators. The matter was discussed between TDI and MP&L personnel, but no meeting notes were made available to the NRC inspector by TDI.

6. In 10 CFR Part 50.55(e) reports to the NRC by four electric utility companies, a misapplication of unqualified isoprene material in the flexible element of the couplings for diesel generators supplied by TDI was identified. This material was not suitable for use in the high temperature oil atmosphere of the diesel generator and would deteriorate rapidly in service. The couplings were manufactured by Koppers Company. The utilities reporting were: (1) MP&L for Grand Gulf Nuclear Station, Units 1 and 2; (2) CP&L for Shearon Harris Nuclear Power Plant, Unit 1, (3) Duke Power for Catawba Nuclear Station, Units 1 and 2, and (4) Georgia Power for Vogtle Nuclear Plant, Units 1 and 2. This matter was also reported by TDI in 10 CFR Part 21 reports to the NRC on June 23 and July 13, 1982.

a. The action necessary to correct this deficiency was to change out the existing flexible element in the coupling with one made of neoprene which was suitable material for service. TDI, in their report, identified 10 nuclear power plants which have affected diesel generators, and indicated these cognizant parties would be notified no later than July 15, 1982.

b. Findings: The NRC inspector verified the following information through observations, discussions, and review of documents:

(1) The incident which prompted TDI to report on June 23, 1982, was a failure of a coupling flexible element made of isoprene in a nonnuclear diesel generator. The utilities reported subsequent to the above date. The suspect couplings were manufactured by Koppers Company starting in 1977 and purchased as stock items by TDI based on TDI's purchased material specification for "Couplings-Elastomeric, Part No. AK-007-000," dated November 11, 1976. The original version of this specification did not specify the type material of the flexible element. After the above failure, TDI issued Revisions A, B, and C to the specification in 1981, 1982, and 1983, respectively. Change A specified that the flexible element should be neoprene which is a suitable material. Change B specified service in a 175°F oil atmosphere, and Change C specified that the flexible element must have a 1/2 " wide red band on it to distinguish it as neoprene.

(2) Review of TDI notification letters verified that all nuclear order customers with affected diesel generators were notified of the deficiency. However, 10 of the TDI notification letters were dated August 18, 1982. This date was contrary to the TDI commitment date of July 15, 1982, in their 10 CFR Part 21 report and resulted in the nonconformance identified in paragraph B.2.

(3) Observation of a coupling flexible element in the stores department verified that it did not have a red band on it as required by Revision C of the purchase specification. However, this flexible element was identified only by part number and it could not be traced to specific POs placed with Koppers Company after April 25, 1983.

(4) Review of receiving inspection cards, "Vendor Inspection Report," for Koppers Company, indicated that the bases for receiving inspection of the couplings was Mil-Std 105 D.

(5) Review of 10 CFR Part 21 evaluation records concerning the isoprene flexible element established that records were inadequate to establish the cause of the misapplication and the basis for the determination that the item was reportable under 10 CFR Part 21. The only records available were entries dated June 15 and June 22, 1982, in the DPT committee weekly log. The June 15, 1982, entry indicated Product Engineering was to compile a list of engines using Kopper's Elastomer GDV drive couplings, and the June 22, 1982, entry indicated that it was determined that the Kopper's Elastomeric coupling was a 10 CFR Part 21 reportable item and the responsible individuals were to issue the appropriate notification. These DPT committee meeting notes did not provide sufficient information to show the bases for the evaluation (and do not appear to meet the requirements 10 CFR Part 21, paragraph 21.51(a) and (b)).

7. In five 10 CFR Part 50.55(e) reports to the NRC by three electric utility companies, a deficiency in the piston skirt castings of diesel generators was identified. This matter concerned the potential failure of the engine piston skirt castings of diesel generators supplied by TDI. Such failures would result in the unavailability of the diesel generators. The castings were manufactured by TDI between December 1978 and October 1981. The utilities reporting were: (1) Duke Power for the Catawba Nuclear Station, Units 1 and 2; (2) TVA for Hartsville

Nuclear Plant, Units 1 and 2, and Phipps Bend Nuclear Plant, Units 1 and 2; and (3) CP&L for the Shearon Harris Nuclear Power Plant, Units 1 and 2. This matter was also reported by TDI in a 10 CFR Part 21 report to the NRC on October 28, 1982.

The NRC inspector ascertained the following information by discussions and review of doruments:

a. The incident which prompted TDI to report was a failure of a type "-AN" piston skirt casting in early 1980. The utilities subsequently made their reports to NRC. Subsequently, TDI produced a report entitled, "Failure Analysis No. 152, Piston Skirt, P/N 03-041-02-AN," dated June 20, 1983. This report included a description of events leading up to a change in foundry heat treating practice to include fan cooling of the castings. This cooling method was determined to have resulted in high residual stresses in the castings which, when combined with operating stresses, could result in failure of the castings. The report also provided recommended corrective measures including NDE, stress relieving at 1050°F, and selective grinding of the affected castings.

b. Review of six TDI notification letters verified that all utility nuclear units with affected diesel generators were accounted for. The letters included a list of foundry shop order numbers and serial numbers of the affected castings to aid the utilities in identifying the suspect castings. The letters also recommended that the castings be returned to TDI for NDE and stress relieving if possible, or replacement with suitable castings, and return for reinstallation. As of this inspection date, only Duke Power Company and Gulf States Utilities have returned skirt castings to TDI.

c. Review of a current process routing for Job No. 69501 covering reprocessing of returned castings verified that corrective action was being performed under controlled conditions using process travelers, qualified personnel, and procedures. Other records reviewed for Job No. 69501 consisted of: (a) special instruction specification No. 750R; (b) a certificate of compliance; (c) a packaging and shipping notification; (d) a magnetic particle inspection report; (e) an NDE technician's qualification record; and (f) heat treatment records for Iron ASTM A-536, Grade 100/70/03 castings. The review also

included the original master engine book of records for diesel generator S.N. 75018-2762. Within this area of the inspection, no nonconformances or unresolved items were identified.

F. EXIT INTERVIEW:

During the exit interview, at which time the inspection findings were discussed, the NRC inspectors were informed by TDI's management that they would take exception to all of the violations that had been identified during the inspection. The NRC inspector indicated that this position would be identified in the inspection report. It was determined by staff review subsequent to the inspection to defer issue of one violation which had been identified to TDI management until after performance of further inspection. This violation subject pertained to inadequate evaluation records.

PERSONS CONTACTED

Company TRANSAMERICA DeLAVAL INC.

Docket/Report No. 99900534/83-01

[redacted]

Page 1 of 1

NAME (Please Print)	TITLE (Please Print)	ORGANIZATION (Please Print)	
T. W. Sutton	[redacted] Reactor Insp.	USNRC.	
EDWARD S. DOBREC *	FOUNDRY MANAGER	TRANSAMERICA DELAVAL	
RICHARD L. PEITT *	Mgr. Cust. Service	"	"
R. J. PABERS *	GENERAL SALES MGR	"	"
R E BOYER *	MGR - QA	"	"
C.H Wilson *	Mfg. Mgr.	"	"
LONNIE L. MILLS *	MGR. - QUALITY ENGR	"	"
C.S. MATHEWS *	V.P. & GEN MGR	"	"
L. WONG	Project mgr	"	"
T. DAVIS			
W.L. Mc Hugh	Engineer	Customer Service TDI	
R.T. M. Yang	Manager	Applied Mechanics TDI	
M. HILL	Foundry QC Supervisor	TRANSAMERICA DeLAVAL.	
J. Litherland.	Purchasing Mgr	"	"
A MARCHUS	Receiving Inspector	"	"
[redacted]	[redacted]		
*	Attended Exit Meeting		

Inspector J.J. Lester

Docket No. 71
Report No. 01
Page — of —

Scope/Module Followup on Regional Request

DOCUMENTS EXAMINED ~~THIS DOCUMENT HAS NOT BEEN REVIEWED FOR PROPRIETARY INFORMATION PER 10 CFR SECTION 2.790~~

1	2	TITLE/SUBJECT	3	
1	1	No. 03-425-06-AG - Shaft, Water Pump	5-3-79	
2		- 03-425-07-AE - ~ ~ ~	~	
3		- 101973 - Water Pump & Bracket Assy	11-12-82	
4		- 03-425-10-AG - Impeller, 10" Dia R.H. C.C.W.	10-6-82	
5		- 03-426-03-AE - Shaft, Water Pump	10-5-82	
6		- 101969 - Retainer, Seal	11-8-77	
7		- 101973 (Layout - 9/23/81)	11-16-79	
8		- 03-426-03-AA ~ - 10/5/82	7-30-79	
9		- 03-425-10-AE (Lined through) ~ ~	5-2-80	
10		- 03-425-01-AF ~	10-12-82	
11		- 03-426-6770 - Water Pump & Bracket Assy	5-11-81	D
12	1	[1 03-425-07-04 - Pump ... Jkt Wtr Emg Drives	6-19-80	1
13	2	No. RL 017 060 - Impeller ...	10-6-82	
14		S&W No. SH1-81 - DG Sets Shoreham NPS Unit 1	6-29-81	1
15	2	No. RL 017 059 (Layout)		
16	1	Div 10 CFR 50 Policy	1-21-81	

Document Types:
1. Drawing
2. Specification
3. Procedure
4. QA Manual
5. Purchase Order
6. Internal Memo
7. Letter
8. Other (Specify-if necessary)

Columns:
1. Sequential Item
2. Type of Document
3. Date of Document
4. Revision (If

Inspector J.L. Lester

Scope/Module Followup on Regional Requests

DOCUMENTS EXAMINED

Docket No. 411-
Report No. 83-
Page of

~~THIS DOCUMENT HAS NOT BEEN REVIEWED FOR PROPRIETARY INFORMATION PER 10 CFR SECTION 2.790~~

1	2	TITLE/SUBJECT	3	4
12	3	No. EP300 - Fr. Process Inspection	4-1-81	0
15		Engrg Oper Procd 1 - Communications and Responsibilities	4-20-81	
17		— — — 4 - Analysis By The Design Group	4-13-79	
20		Mfg Engrg Procd Sect IV - Route Sheets	2-27-81	
21	3	Sect 11 of Drafting Rm Proc - Layouts	11-10-69 1-27-76	
22	4	Sect 5 - Instructions, Proposed, Design; 16 - QC Records; 10 - Inputs	2-27-81	
23	6	To: G.E. Tanswell, Fr: M.H. Lowery - SW Wtr Pump Trainer LILCO Gulf States	7-16-79	
24		To: A. Harris, Fr: J. Gee - Eng Spec SW Wtr Pmp Mod ... LILCO ...	12-11-79	
25		To: G.E. Tanswell, Fr: N.V. Schilling - Long Island Lighting Co. 10-6796 SW Pumps...	10-26-82	
26		To: J. Gee/D. Wolf, Fr: D. West - LILCO ... Wtr Pump Shaft & Impeller Torsional Analysis	10-13-82	
27		To: G.E. Tanswell, Fr: D.P. Wolf - Long Island Lighting Co. ... SW Wtr Pump Redesign Analysis	12-19-82	
28	7	To: Dir OIE NRC, Fr: TDI - Potential Failure of LILCO SW Pumps	9-20-79	
29		To: S&W Engrg Co, Fr: TDI - Long Island Lighting Co ... Delaval Engines, S/N 74010-12	1-25-80	
30		— — — — — — — — ... Diesel Generating Sets WC80-58921	2-25-80	
31		— — — — — — — — Shoreham Nuclear Power Station	3-10-80	
32	7	To: TDI, Fr: LILCO - Ref. LILCO PO # 146114	9-21-81	

Document Types:
1. Drawing
2. Specification
3. Procedure
4. QA Manual
5. Purchase Order
6. Internal Memo
7. Letter
8. Other (Specify-if necessary)

Columns:
1. Sequential Item
2. Type of Documen
3. Da of Documen
4. Revision (If ap

Inspector W. E. Foster

Scope/Module Followup on Regional Requests

Docket No. [illegible]
Report No. [illegible]
Page — of —

DOCUMENTS EXAMINED

THIS DOCUMENT HAS NOT BEEN REVIEWED FOR PROPRIETARY INFORMATION PER 10 CFR SECTION 2.790

1	2	TITLE/SUBJECT	3	
31	7	To: TDI, Fm LILCO ... Deficient Items Returned to Del...	2-25-81	
32	7	— — — — - P.O. # 360114	1-2-82	
33	8	TWX # [illegible] to LILCO - [illegible] Pump [illegible] EDG [illegible] 74210/[illegible]	10-[illegible]-82	
34		Authorization for [illegible] Billing LILCO Eng [illegible] 74010/11	10-7-82	
35		Analysis, [illegible] for LILCO JW Pump [illegible]	9-30-82	
36		[illegible] Statement for 03-425-04 Jkt Wtr Cooling Pump Rotor	10-18-82	1
37		Prod Rtng Sheet - J. W. Pump P/N 1A-7151/00	10-27-82	[illegible]
40		— — — - Pump Assy, Wtr P/N 1A-6781	6-17-82	1
41		— — — - Shaft, Wtr Pump P/N 03-426-03-AE	10-11-82	0
42		— — — - Retainer, Seal P/N 101269	11-14-79	0
43		— — — - Impeller... P/N 03-415-10-AG	10-11-82 11-7-82	[illegible] 01
44		Nucl Pkg/Shpg Notification # 79-111	12-10,11/79	
45		— — — — — # 82-705	11-4,8,9/82	
46		— — — — — # 82-717	11/9/82	
47		— — — — — # 82-725	11-11,12-82	
48	8	— — — — — # 82-733	11-17,18-[illegible]-82	

Document Types:
1. Drawing
2. Specification
3. Procedure
4. QA Manual
5. Purchase Order
6. Internal Memo
7. Letter
8. Other (Specify-if necessary)

Columns:
1. Sequential Ite
2. Type of Docume
3. Da of Docume
4. Revision (If a

Inspector W. E. Foster

Scope/Module Williamsburg Regional Research

Docket No. 99:
Report No. 83-
Page — of —

DOCUMENTS EXAMINED

~~THIS DOCUMENT HAS NOT BEEN REVIEWED FOR WITHHOLDING INFORMATION PER 10 CFR SECTION 2.790~~

1	2	TITLE/SUBJECT	3	
42	6	Mail Requisition - Req No. W-13149	11-12-79 12-7-79	
52		Certificate of Compliance To LILCO for P.O. # 110552	12-12-79	
51		" " " " " "	11-9,7,14,20-82	
51		Nuclear Shaft Failure Analysis Rpt No. 8146	9-22-82	
51		Eng Calc for DW Pop Recirc in 1977		
54		Assembly Instructions D-4756	9-27-82	D
55		" " " D-4986		
56		Request for Drafting Action - DW Pop for LILCO	10-15-82	
52		" " " " - R-48 DW Wtr Pop Shaft	12-6-79	
55	8	Design Chg Notice for Assy Instructions, Wtr Pop	2-17-82	

Document Types:
1. Drawing
2. Specification
3. Procedure
4. QA Manual
5. Purchase Order
6. Internal Memo
7. Letter
8. Other (Specify-if necessary)

Columns:
1. Sequential Ite
2. Type of Docume
3. Date of Docume
4. Revision (If a

Scope/Module 21/31 50.55(e) Report

Capscrew failure

DOCUMENTS EXAMINED

~~THIS DOCUMENT HAS NOT BEEN REVIEWED FOR PROPRIETARY INFORMATION PER 10 CFR SECTION 2.790~~

Report No.

1	2	TITLE/SUBJECT	3	4
1	3	Transamerica Delaval Inc. (TDI) diesel generator Instruction Manual pages 8-5 and 8-5A.	—	N/A
2	8	TDI's copy of Mississippi Power & Light's consultants study concerning the GGNS diesel generator capscrew failure.	8-17-82	"

Document Types:

1. Drawing
2. Specification
3. Procedure
4. QA Manual
5. Purchase Order
6. Internal Memo
7. Letter
8. Other (Specify-if necessary)

Columns:

1. Sequential Item #
2. Type of Document
3. Date of Document
4. Revision (If appl

Scope/Module TDI, 10 CFR Part 21 Report
Diesel Generator Coupling Defect

DOCUMENTS EXAMINED

1	2	TITLE/SUBJECT	3	4
1	4	TDI's QA Manual, Rev. 2, 3rd Edition Sections 4, 7, 14 & 15	6-10-83	2
2	7	TDI's Amendment Letter to their 10 CFR Part 21 report dated 6-23-82.	7-18-82	N.A.
3	7	TDI's 10 CFR Part 21 notification letters to 10 customers concerning the generic coupling defect	8-18-82	"
4	8	Minutes of TDI's "DEC" committee meetings on June 15 and 22, 1982	—	"
5	3	TDI's "Division 10 CFR 21 Policy" reporting procedure	1-26-81	"
6	2	TDI's "Purchased Material Specification" for "Couplings - Elastomeric" for Part No. AR-007-000	4-25-83	C
7	8	TDI's "Change Notices A, B, & C for the above specification	various	N.A.
8	8	TDI's "Vendor Inspection Report" receiving inspection record card for Koppers Company (couplings)	—	"
9	6	Following TDI purchase orders to Koppers Company for couplings and flexible elements: — P.O. 13185; P.O. 12938, P.O. No. 12244 and P.O. 49263	Various	"

Document Types:
1. Drawing
2. Specification
3. Procedure
4. QA Manual
5. Purchase Order
6. Internal Memo
7. Letter
8. Other (Specify-if necessary)

Columns:
1. Sequential Item No.
2. Type of Document
3. Date of Document
4. Revision (If appli

Scope/Module TDI's 10 CFR Part 21 Report
Piston Skirt Casting Stress

DOCUMENTS EXAMINED ~~THIS DOCUMENT HAS NOT BEEN REVIEWED FOR PROPRIETARY INFORMATION PER 10 CFR SECTION 2.790~~

1	2	TITLE/SUBJECT	3	4
1	8	TDI's "Failure Analysis No. 152, Piston Skirt" report for S/N 03-341-02-AN.	6-30-83	NA
2	7	TDI's 10 CFR Part 21 notification letters to six electric utility customer's concerning diesel generator piston skirt casting potential problem due to stress.	11-18-82	"
3	8	Ulster Engine Book records for SN. 75018-2762	—	"
4	8	Production Routing traveler for Part 14-6552/00, Job No. 69501	Various	"
5	8	Nuclear Packaging/Shipping Notification, Job No. 69501	6-10-83	"
6	8	Certificate of Compliance, Job # 69501	—	"
7	8	Magnetic Particle Inspection Report, Job No. 69501, Part 03-341-02-AN	5-17-83	"
8	2	Special Instruction Specification No. 7500	2-7-83	"
9	8	Heat Treating Record for Iron ASTM A-536, Gr. 100/70/03, Job No 69501.	5-18-83	"
10	8	Hardness Verification Report, Job No. 69501	—	"
11	8	Qualification record for NDE Technician AE. Clampett	11-6-81	"

Document Types:
1. Drawing
2. Specification
3. Procedure
4. QA Manual
5. Purchase Order
6. Internal Memo
7. Letter
8. Other (Specify-if necessary)

Columns:
1. Sequential Item #
2. Type of Document
3. Date of Document
4. Revision (If appl

Scope/Module 92702
92716
92705

DOCUMENTS EXAMINED ~~THIS DOCUMENT HAS NOT BEEN REVIEWED FOR PROPRIETARY INFORMATION PER 10 CFR SECTION 2.790~~

Page 1 of 2

1	2	TITLE/SUBJECT	3	4
1	4	Organizational chart.	1-5-83	
2	4	Manual Revision 4.4.5	12-22-83	
3	1	NO 102 367	9-17-81	
4	8	Parts List 02-415-02-01	1-5-83	Rev 1
5	7	Seller Re: Crank Shaft.	Sept 13, 1982	-
6	8	Casting Certification Part No 03-310-05-AK	" " "	
7	8	Material Test Report. ABS	Oct 13-81	
8	8	Assembly - Test Parts Sheet.	2-11-81	
9	4	Section 8 - Identification / Control of Material.		
10	5	PO 45333.		
11	4	Section 4. Inspection Section -	8-21-81	
12	3	Procedure IP 2.00 Shipping & Receiving Insp.	4-1-81	
13.	2	Design Specification - NO 45333		
14.	8	Audit Rept TVA. 81V-47 -	12-1-3-81	
15	4	TVA - TDI.	1-16-82.	
16	7	TVA - TDI	2-2-82	
17.	7	TVA - TDI	5-25-83	
18	7.	TVA - TDI.	6-25-82.	

Document Types:
1. Drawing
2. Specification
3. Procedure
4. QA Manual
5. Purchas Order
6. Internal Memo
7. Letter
8. Other (Specify-if necessary)

Columns:
1. Sequential Item Number
2. Type of Document
3. Date of Document
4. Revision (If applicable

ATTACHMENT 8

Delaval Diesel Generator Operation Experience

U. S. Nuclear Experience

In 1974, the Long Island Lighting Company (LILCo) contracted with TDI to purchase three emergency diesel generators for the Shoreham Nuclear Power Station. This was the first order received by TDI to provide an EDG for a commercial nuclear power station. In the next seven years, engines for 14 other plants were ordered from TDI.

San Onofre 1

- Two TDI Diesel Engines Installed in 1976 - DSRV-20
- Serial Nc. 75041/42, Rated at 6000KW (nominal)
  8800KW (peak)
- Engine Run Time to Date - 450 hours per engine

The first plant to actually place a TDI engine into nuclear service was San Onofre Unit 1 (SONGS 1), which purchased two V-20 units to provide emergency power for its feed pumps, which also serve as Emergency Core Cooling System pumps.

The engines at SONGS 1 were installed in 1976, and declared operational in April 1977. Since then, SONGS has experienced some problems with the operation of the engine turbochargers, a lube oil pressure sensing line failure which resulted in a fire, and several other minor problems. Because SONGS did not commit to meet the guidelines of Regulatory Guide 1.108, but rather Regulatory Guide 1.9, the program it used to test the engines before they were placed in service was more abbreviated than for a new plant. A detailed list of problems to date follows.

Date	Problem	Cause/Solution
12/80	Excessive Turbocharger thrust bearing wear.	No lube oil during standby. Lube oil system modified. 10 CFR Part 21 report issued because problem generic.
7/81	Lube oil leak and fire.	Excessive vibration of a lube oil test line which had inadvertently been left installed by the licensee. Line removed.
12/81	Piston modification to prevent crown separation.	Pistons reworked by TDI to respond to Part 21 report. Problem identified at Grand Gulf.
9/83	Unqualified instrument cable.	Replaced in accordance with Part 21 report.

Grand Gulf

- Two TDI engines installed - Model DSRV-16
- Serial No. 74033/34, Rated at 7000KW
- Operating Hours to Date - Division I = 1100 hours; Division II = 700 hours

In 1981, Mississippi Power & Light (MP&L) commenced pre-operational testing of two V-16 engines installed at Grand Gulf Unit 1. They represent the first V-16 units ordered from TDI, and in fact, one of the Grand Gulf engines was used to qualify the entire TDI V-16 line of machines for nuclear applications.

The Grand Gulf engines have experienced significant problems in completing the pre-operational test program, have had several major failures, including a fuel line break which caused a fire, and many minor failures. A detailed list of problems at Grand Gulf follows.

Date	Problem	Cause/Solution
11/81	Piston crown separation during operation.	Holddown studs failed. Pistons returned to TDI for rework. Generic problem.
3/81	Excessive turbocharger thrust bearing wear.	No lube oil during standby. Lube oil system modified.
6/11/82	Air starting valve capscrews replaced. Too long for holes.	Response to Part 21 report.
8/23/82	Flexible drive coupling material incompatible with operating environment.	Replaced with different material.
8/82	Latching relay failed during testing.	Relay replaced.
3/8/82	Air start sensing line not seismically supported.	Sensing line relocated and properly supported.
1/29/82	Governor lube oil cooler located too high. Possibility of trapping air in system.	Lube oil cooler relocated to lower elevation.
3/23/82	Engine pneumatic logic improperly design. Could result in premature engine shutdown.	Pneumatic logic design corrected.

Date	Problem	Cause/Solution
4/29/81	Non-Class 1E motors supplied with EDG auxiliary system pumps.	Motors replaced with Class 1E qualified motors.
3/15/82	Crankcase cover capscrew failed. Head lodged in generator and shorted it out.	Capscrews replaced with higher strength screws. Lock tab washers installed. Generator screens installed.
8/2/83	High pressure fuel injection line failed.	Manufacturing defect in tubing. Tubing replaced.
9/4/83	Fuel oil line failed. Caused major fire.	High cycle fatigue of Swagelock fitting. Additional tubing supports to be installed.
8/11/83	Cracks in connecting push rod welds.	All push rods replaced.
1983	Turbocharger vibration.	Turbocharger replaced.
1983	Cracked jacket water welds.	Excessive turbocharger vibration. Cracks re-welded.
1983	Turbocharger mounting bolt failures.	Excessive turbocharger vibration. Bolts replaced.
7/83	Air start valve failures.	Cause unknown. System cleaned and several valves replaced. More frequent maintenance scheduled.
10/28/83	Fuel oil leak. Cracked push rod weld.	Tubing replaced. Push rod replaced.
During EDG Installation	Cylinder head cracks.	Head replaced.
12/83	Cylinder head cracks.	Two heads replaced.
12/83	Cracks in piston skirts on Division II EDG.	All Division II pistons replaced. Division I pistons to be inspected.
9/83	Unqualified instrument cable.	Replaced in response to Part 21 report.

Shoreham

- Three TDI Diesel Engines installed, Model DSR-48
- Serial No. 74010-12, Rated at 3500KW
- Operating hours at time of crankshaft failure (8/83)
  - #101 = 646 (cracked crankshaft)
  - #102 = 718 (failed crankshaft)
  - #103 = 818 (cracked crankshaft)

The engines at Shoreham are the first straight-8 units to be placed in nuclear service in the U. S. One of the Shoreham engines (#101) was used to qualify the straight-8 series (R48) diesel engine for nuclear service.

Pre-operational testing of the engines at Shoreham started in late 1981 and continued until the major failure of the #102 crankshaft on August 12, 1983. After the performance of extensive tests in late September and early October, which were observed by staff members from NRR and Region I, as well as an NRC consultant, LILCo presented the results of its crankshaft failure investigation in a meeting on November 3, 1983. It reported that the crankshaft had been improperly designed, and had failed because the loading function used in the original design calculations was too small. LILCo also reported that it was investigating four failed connecting rod bearings which were discovered when the EDGs were disassembled. Their preliminary finding was that the failures occurred because the bearing material did not meet specifications, and the bearing loads had not been properly accounted for. A detailed list of the EDG problems at Shoreham follows.

Date	Problem	Cause/Solution
3/81	Excessive turbocharger thrust bearing wear.	No lube oil during standby. Lube oil system modified.
12/81	Piston modifications to prevent crown separation.	Pistons reworked by TDI to respond to Part 21 report. Problem identified at Grand Gulf.
9/82	Engine jacket water pump modifications.	Water pumps reworked by TDI.
6/82	Air starting valve capscrews replaced. Too long for holes.	Response to Part 21 report.
9/82	Engine jacket water pump shaft failed by fatigue.	Pump shafts redesigned and replaced.
Spring/1983	Cracks in engine cylinder heads.	Fabrication flaws. All heads replaced.

Date	Problem	Cause/Solution
3/83	Two fuel oil injection lines ruptured.	Manufacturing defect in tubing. Tubing replaced with shielded design.
3/83	Engine rocker arm shaft bolt failure.	High stress cycle fatigue. Bolts replaced with new design.
8/12/83	Broken crankshaft. Cracks in remaining crankshafts.	Inadequate design. Replaced with larger diameter crankshafts.
9/83	Cracked connecting rod bearings.	Inadequate design and substandard material. Replaced with new design.
10/83	Cracked piston skirts.	Replaced all piston skirts with new design. Generic problem.
11/83	Broken cylinder head stud nuts.	Replaced all head stud nuts.
9/83	Cracked bedplates in area of main journal bearings.	Cracks evaluated by LILCo and determined to not be significant.
9/83	Unqualified instrument cable.	Replaced in response to Part 21 report.

Operating Experience - Non-Nuclear

Marine Applications

Besides being used for stationary electric power generation, TDI diesel engines have been placed in service as propulsion units on commercial cargo vessels. As part of the Shoreham operating license hearing, an intervenor, Suffolk County, requested and was granted by the Licensing Board, subpoenas for the State of Alaska, U. S. Steel, and Titan Navigation, Inc. These three organizations operate vessels which use TDI V-16 diesel engines which are very similar to most of the TDI units installed in nuclear power plants. The responses which were received indicate that the TDI engines in marine service for these organizations have experienced severe reliability problems. Most have related to faulty cylinder heads, but they have also included problems with pistons, cylinder liners, turbochargers, cylinder blocks, connecting rods, connecting rod bearings, main journal bearings, and camshafts. A detailed experience list follows. The staff is reviewing this material to see how much of it is applicable to engines in nuclear service.

Marine Experience with TDI Diesel Generators

State of Alaska, M. V. Columbia

- Vessel fitted with two DMRV-16-4 Engines - Serial No. 72033/34
- Rated at 9200 HP (6900 KW) at 450 RPM
- Vessel and engines placed in service in June 1974.
- Each engine has approximately 30,000 hours of operating time to date.

Document Date	Problem Description
12/76	All cylinder liner seals replaced. All cylinder heads have been removed, reinstalled, or renewed at least three times.
	All pistons have been removed and reinstalled at least once.
	Turbochargers have been removed, repaired and reinstalled, or renewed 16 times due to leaking oil seals, vibration, rotor damage, or defective bearing seal housing.
	Exhaust manifolds have been removed and reinstalled because of frozen expansion joints and resulting cylinder head flange face damage.
	Lube oil consumption is excessive.
6/15/78	Rapid deteriorations of fire seal rings causing blowby across gasket surface of cylinder heads.
	Very low lube oil filter life (40 hours). Caused by blowby of pistons and valve guides.
	Stainless steel exhaust bellows burn out rapidly. Installed backwards by TDI.
11/28/78	(Letter to Alaska from TDI).
	Recommends timing changes to improve turbocharger performance.

Document Date	Problem Description
1/31/79	Valve seats and valve guides not concentric. Results in bad valve contact.
	Defective piston rings shipped as replacement parts.
	Reworked cylinder head received from TDI without all required modifications and with damaged gasket face.
	Newly furnished cylinder liners received with incorrect surface finish (twice).
	Connecting rod bearings furnished as spare parts were wrong size - 13" vice 12".
	Turbocharger exhaust flex section incorrectly furnished by TDI.
2/2/79	Chrome plating failure of piston rings. Caused heavy scoring of cylinder liner. Associated cylinder head found cracked.
	Seven cylinder heads replaced during 15 weeks of operation.
	Excessive lube oil filter change out rate. Due to piston blowby.
	Fuel injector spray tips changed at TDI recommendation to reduce carbon buildup and eliminate washing of liner walls with fuel oil.
	Three major overhauls of engines in 5 years of operation.
	Carbon accumulations in rocker box areas.
	Excessive oil vapor discharge from engine crankcases.
	Heavy carbon deposits on valve springs. Suspect valve blowby.
	When exhaust valve guides were modified by TDI, they did not follow the procedure outlined in their SIM (Service Information Memo).

Document Date	Problem Description
	Loose piston pin end caps.
	Incorrect piston crown to skirt bolt torque.
	Bad connecting rod bearings. Excessive wear, cracks.
	Damaged connecting rod bolts.
	Valve push rods cracked at weld of ball to pipe. QC problem.
	Crankshaft size changed after engines for ship installed. No notice to owners of reason for change.
	Excessive main bearing wear.
	Camshaft lobe hard facing worn.
	TDI recommended the installation of a new flexible exhaust duct which was too short (new design). Installation attempted at insistence of TDI. Unit damaged by attempt and returned to TDI for repair.
3/19/79	QC or material problems with respect to non-concentricity/out-of-round valve seats, push rods, rod bolts, bearing shells, valve stem plating.
6/14/79	Thermal growth and cracking of exhaust manifold.
12/26/79	Failure of new connecting bearings.
	Cracks of 25% of connecting rods.

Document Date	Problem Description
1/16/80	Ten (10) new cylinder heads have cracks. This includes 8 that were previously repaired.
	Fifteen (15) valves are defective with chrome flaking off the valve stems.
	Valve stems are being deformed.
	Five additional push rods have cracks.
	Turbocharger air cooler inlet housing is cracked for fourth time.
	Internal bracing in engine intercoolers is cracked.
2/5/80	Piston rings installed improperly because mistake by TDI in the drawing used by TDI shop.
2/29/80	Piston crown-to-skirt nut torque inconsistent among nuts on various pistons.
	Excessive link rod bushing bail wear caused by improperly relieved, drilled oil passages on the matching link rod pins.
3/24/80	Abnormal carbon deposits and formations noted on pistons and cylinder head assemblies.
	Fretting of jaw areas of connecting rods.
	Insufficient turbo (manifold) air except at near full speed operation.
	Cracked exhaust manifold end plates.
	Cracking of connecting rod boxes.
	Cracking of newly installed connecting rod bearing shells at 4500/hours.

Document Date	Problem Description
	Fretting of link rod and link rod pins at their attachment together.
	Fretting between link rod bushings and link rod bushing bore.
	Galling of link rod bushings in way of link rod pin outer drilled oil passages.
	Improper wear/contact pattern on newly installed connecting rod bearings at 4500/hours. Four-point loading.
	Insufficient connecting rod bearing wear/contact area to journal wherein it is less than 15% of the total bearing area.
	Upsetting of stems in valve keeper area.
	Damage to number four piston ring and ring groove on all pistons modified during the 1978-79 engine teardown and rebuilt after 4500/hours operation.
	Fretting between piston crown and skirts at 4500/hours since piston modifications.
	Variations in piston bolt torque, beyond specified limits, at 4500/hours since piston modifications.
	Damage to rod bolts, including cracking, and damage to threads on both the bolt and in the rod boxes.
4/18/80	Exhaust manifold conversion kits received with cuts and grooves in finished surface. Required rework by owner before installation.
5/12/80	New connecting rods received without required code (American Bureau of Shipping) approval. TDI did not have record of which rods were shipped with approval or without approval.
	Some new connecting rods shipped with oversize bearings but no note to customer informing of difference.

Document Date	Problem Description
5/14/80	Cylinder head returned to TDI has been lost by TDI. Cannot be located.
5/15/80	Customer received new connecting rod bolt in rusty condition with damaged threads.
5/27/80	Customer received reworked cylinder heads with lip left on exhaust seats which prevents valves from seating.
	Customer noted that it now was in possession of two cylinder heads with the same serial number.
	Could not install lockwire in new connecting rod cap screw. Hole drilled partway through with drill broken off in center of hole. Also noted that edges of lockwire holes on other screws had not been rounded to prevent damage to lockwire.
5/29/80	Discovered leaks in newly installed exhaust manifold head plates.
9/4/80	(Meeting Summary)
	TDI says that all cylinder head problems should be corrected by new design.
	TDI reports that connecting rod bearing cracks could have resulted from bad bearing alloy makeup by vendors. TDI looking at different bearing materials.
	TDI stated that they had erred on piston modifications. Effected others besides COLUMBIA.
9/30/80	Eleven remaining master connecting rods to be sent to TDI to have oversize bearings and other modifications installed.
	Many of the original cylinder heads that were returned to TDI for rework were exchanged for other used heads.

Document Date	Problem Description
11/6/80	Cylinder head changed due to heavy external water leakage.
	Severe smoke causing excessive lube oil contamination and engine room atmosphere problems. Engine secured to prevent possible crankcase explosion.
12/10/80	All connecting rods removed. New rod cap screws and washers to be installed because increased torque specified by TDI caused galling.
	New connecting rod bearing shell found cracked.
	Heavy wear noted on piston side thrust areas. Heavy hard carbon buildup noted in area of compression rings. Fourth ring groove area to be reworked by TDI due to design/machine error by TDI during previous modifications.
	Nineteen (19) of 32 cylinder liners exceed spec for out-of-round. TDI to modify limits to permit continued usage.
	Twenty-one (21) of 32 liners lost crush. New phenomena. Repairs require machining of engine block.
	Fuel injectors removed and to be changed from 140° spray pattern to 135° pattern. Original nozzles had 150° pattern.
1/16/81	Cylinder block bores found to be distorted.
	Four new engine camshafts installed.

Document Date	Problem Description
3/13/81	Reworked cylinder heads were returned to the customer without removing the grinding compound from the valves and valve seats.
	Two reworked pistons returned to customer without roll pins, which lock the securing nuts in place.
	Cylinder liner delivered with wrong surface finish.
	Cracks found in cylinder blocks. All replaced.
	Main engine blocks found to be cracked and warped. The main block-to-base through bolts appear to have been improperly torqued during initial assembly.
	One "new" camshaft found to be a rebuilt unit containing several damaged bearing journal areas.
	The threaded head stud holes in the new cylinder blocks were not counterbored deeper, as TDI had indicated they currently do. This was to eliminate cracking of the block near the stud holes. The customer re-machined each of the 256 head studs to accomplish the same intent.
4/9/81	Several reworked pistons were returned without groove pins.
	In response to a request for 20 1½" capscrews and washers, TDI supplied 1 7/8" capscrews.
	Drawings furnished by TDI for head stud modifications were not applicable to the studs in question.
	50% of the fuel pump bases would not fit onto the new cylinder blocks because of slight changes in the design of the blocks.

Document Date	Problem Description
	Two new cylinder liners provided with incorrect surface finish.
	One new cylinder liner provided with flange thickness larger than manufacturer's maximum tolerance.
	New connecting rod capscrews were found to be galled and unfit for use.
4/29/81	Service manual showed incorrec installation of engine camshafts.
	2/3 of fuel cam tappet assemblies on one engine could not be installed on one engine because the new cylinder blocks had not been properly counterbored.
	Cylinder liner counterbore depths were off to such an extent that difficulty experienced in establishing proper liner crush.
	Weld spatter noted on many seating surfaces.
	Dirt, sand, and metal showings found in passages and holes which should have been clean.
	Cylinder head water port outlet locations varied considerably, causing a water flow restriction.
	Air start distributor not properly assembled at factory.
6/1/81	Exhaust manifold head plate developed a leak. Cracks found around 2 of 3 tie rods due to poor initial welding.
11/19/81	Defective valve springs found on one engine.
7/29/82	Valve rotator failed.
	Cracks discovered in the intercooler.

Document Date	Problem Description
7/29/82	"In nine years of operation every basic engine component has been modified or replaced with an improved item, at least once, with the exception of the crankshaft (which is obsolete and has not been used for years), the engine base, the fuel pumps and the governor. The last two items are not manufactured by TDI."
10/15/82	Turbochargers replaced. Exhaust valve lubricating system to be installed.
3/9/83	Cracks discovered in three cylinder heads. Reworked cylinder returned to customer with tap broken off in threaded hole. Others returned with internal cracks and damaged flange faces.

Titan Navigation, M. V. Pride of Texas

- Vessel fitted with two DMRV-12-4 engines, Serial No. unknown
  Rated at 7800 HP at 450 RPM
- Engines installed 1981 - no information on total engine hours to date.

Document Date	Problem Description
7/16/82	Catastrophic piston failure. Due to crack in piston skirt. Engine had 5791 hours of operation.
4/1/82	Cylinder block broken and cracked.
	Cylinder head cracked.
	Cylinder liner cracked.
	Piston skirt fractured.
	Suspect that all of above problems caused by water leaking into cylinder from air intake manifold. Leaking tubes found in air intercooler.
8/19/82	Cracks discovered in six piston skirts.
7/22/82	Cracked exhaust valve seats in cylinder heads. Engine had 3000 hours service.
	Camshaft lobe design appears to be deficient. Causes excessive stress on fuel cam lobe and roller.
	Tappet assembly rollers severely galled. Believed to be due to camshaft and lobe placement and inadequate heat treatment.
	Fuel cam lobes have failed twice due to improper heat treatment.
	Chrome plating lost from one piston wrist pin.
	All four intercoolers have failed because of erosion due to high fluid velocity.
	Air start valves have suddenly ceased to function, for no apparent reason.

Document Date	Problem Description
	Plugs in crankshaft oil ways may be cracking because improper material used. Under investigation.
	Fuel oil return lines have failed. To be replaced with heavier wall tubing.
4/1/83	Exhaust valves fail after about 2000 hours of use. Serious problems with cylinder head cracks.
	Turbochargers experiencing difficulty supplying sufficient air.

U. S. Steel, MV E. H. Gott

- Vessel fitted with two DMRV engines (model unknown)
  Engine Serial No. 75039-40
- No information on engine hours to date.

Document Date	Problem Description
11/13/80	Cracked cylinder head. Replaced.
11/1/79	Cracked cylinder head. Replaced.
6/1/80	Cracked cylinder head. Replaced.
10/8/81	Cracked cylinder head. Replaced.

Note: This information was summarized from documents provided by U. S. Steel in response to a subpoena which asked specifically for information about cyliner head failures. Many other portions of the documents were deleted by U. S. Steel, and it appears that the deleted portions referred to problems with other engine parts.

Other Applications

The staff understands that other TDI engines are in service as stationary electric power generators. The operating history of these engines will be taken into consideration during the staff assessment of TDI engines.

Reference List

Shoreham

Letter dated 1/6/84 from B. McCaffrey (LILCo) to H. Denton (NRC)

Board Notification 83-160 dated 10/21/83

Board Notification 83-160 dated 11/17/83

Letter dated 12/9/83 from J. Smith (LILCo) to T. Muley (NRC)

Letter dated 12/9/83 from A. Schwencer (NRC) to M. Pollock (LILCo)

Letter dated 12/29/83 from A. Schwencer (NRC) to M. Pollock (LILCo)

Letter dated 12/16/83 from C. Matthews (TDI) to T. Novak (NRC)

Letter dated 12/16/83 from J. Smith (LILCo) to T. Murley (NRC)

Letter dated 12/16/83 from A. Dynner (Suffolk County) to A. Earley (LILCo)

Letter dated 10/20/83 from A. Earley (LILCo) to L. Brenner (NRC)

Letter dated 10/16/83 from R. Boyer (TDI) to NRC

Letter dated 11/17/83 from A. Earley (LILCo) to L. Brenner (NRC)

IE Information Notice 83-51, dated 8/5/83

IE Inspection Report 99900334/83-01, dated 10/3/83

IE Information Notice 83-58, dated 8/30/83

Grand Gulf

Letter dated 11/15/83 from L. Dale (MP&L) to H. Denton (NRC)

Letter dated 10/19/83 from L. Dale (MP&L) to H. Denton (NRC)

LER 50-416/83-171/03L-0 dated 11/28/83

Letter dated 10/26/83 from L. Dale (MP&L) to H. Denton (NRC)

LER 50-416/83-082/01T-0

LER 50-416/83-126/01T-0

San Onofre Unit 1

LER 50-206/81-017 dated 8/12/81

Letter dated 9/15/81 from H. Ray (SCE) to R. Engelken (NRC)

LER 50-206/80-039 dated 12/23/80

Letter dated 6/8/81 from J. Haynes (SCE) to R. Engelken (NRC)

Marine Applications

Letter dated 12/21/83 from A. Dynner (Suffolk County) to A. Earley (LILCo)

Includes many other individual documents.

ATTACHMENT 9

Vendor Inspection History

To date, the Region IV Vendor Inspection program has inspected the TDI facility in Oakland, California, nine times. The following inspection reports have been published in the PDR regarding these inspections:

1. Docket No. 99900334/79-1, dated 3/20/79
2. Docket No. 99900334/80-01, dated 1/22/81
3. Docket No. 99900334/81-01, dated 5/27/81
4. Docket No. 99900334/81-02, dated 9/18/81
5. Docket No. 99900334/82-01, dated 4/15/82
6. Docket No. 99900334/82-02, dated 12/8/82
7. Docket No. 99900334/83-01, dated 10/3/83

Attached is a summary by the Vendor Inspection Branch of the TDI inspection history. The history includes some results from the last two inspections, which are being reviewed for proprietary information, and which will be published when that review is complete.

ATTACHMENT

TRANSAMERICA DELAVAL INSPECTION HISTORY
VENDOR PROGRAM BRANCH FINDINGS 1979-1983

MANUFACTURING PROCESS CONTROL:

1. Performance of required inspections for completed operations on Shop Engine No. 2931 Tank Lube Oil Sump Inlet Compartment could not be verified, in that neither inspection acceptance stamps were present on the route sheets for the completed operations nor were inspection reports available to indicate rejectable conditions had been found upon inspection.

2. Route sheets were not available to confirm required inspection acceptance of assembly operations for the emergency diesel generator (EDG) jacket water pump reflected on Drawing No. 101973, Revision C.

3. Absence of evidence of inspection acceptance for components manufactured during jacket water pump modifications performed in September and October 1982.

4. a. Acceptance signoff by QC inspectors was made on route sheets in regard to installation of rocker arm hold down bolts. These bolts were subsequently found to be missing on inspection at the Shoreham Nuclear Power Station (SNPS).

   b. Shipment of reworked pistons to San Onofre, Unit 1, prior to dates indicated on route sheets by QC inspectors that various manufacturing operations were accepted.

5. a. Route sheets not issued for rework of 92 pistons from SNPS and Grand Gulf EDGs and there is, thus, no evidence of inspection acceptance of the various manufacturing operations.

   b. No records of quality activities for rework activities on Grand Gulf EDG pistons which was a specific requirement of the procurement specification.

6. Absence of required NDE reports for SNPS replacement cylinder head castings.

7. Apparent use of unqualified personnel for performance of NDE operations on SNPS replacement cylinder head assemblies.

8. Improper signoffs and dates for acceptance of SNPS replacement cylinder heads with respect to personnel identity and use of a surrendered inspection stamp prior to expiration of the minimum 6-month period.

9. Use of a different hard facing welding procedure specification to that specified on the route sheets for valve seats in SNPS replacement cylinder head assemblies.

10. Requirements not provided for welding of and acceptance of Shearon Harris EDG fuel oil line clamps.

11. Prior to October 1981, manufacture of piston skirt castings did not comply with engineering component drawing instructions with respect to performance of specified stress relief heat treatment.

12. Route shee·s for Job No. 02933 did not provide instructions in regard to swaging operations performed on crankshaft oil plugs.

13. No assembly route sheets available for SNPS replacement cylinder head assemblies.

CONTROL OF SPECIAL PROCESSES:

1. Absence of procedures for examination of Level III NDE personnel and failure to qualify personnel performing visual examinations in accordance with ASME Code requirements.

2. a. Performance of vertical up position welding on ASME Section III piping (Shop Engine No. 2931, Shop Order No. 94302) by welder qualified only for flat position welding.

   b. Welding of a 2-inch ASME Section III piping assembly by unqualified welder.

3. Observations during three different inspections of failure to return unused welding electrodes in required 4-hour issuance period.

4. Identification of welders used for certain operations on Shop Engine Nos. 2931 and 2959 could not be verified.

5. Unacceptable fillet weld size in Shop Engine No. 2931 Tank Lube Oil Sump Inlet Compartment due to bad fitup of tank roof and sidewall resulting in almost flush condition.

6. Use of welding electrode sizes that were not permitted by applicable welding procedure specifications on Job Nos. 94922 and 96632.

7. Use of Job No. 95395 of welding amperage and voltage in excess of welding procedure specification requirements.

8. Performance of welding on Job Order No. 97-485-3085 without specified revision of welding procedure specification being in welder's possession.

9. Certification records for nondestructive examination personnel did not indicate the use of ten checkpoints by the examiner during the practical examination as required by SNT-TC-1A and internal procedures.

PROCUREMENT CONTROL:

1. Failure of Quality Engineering to both update Qualified Suppliers List every 3 months and to provide a monthly summary of vendor quality ratings to QC and Purchasing.

2. Evidence not available to assure that the seller of auxiliary lube oil and jacket water pump motors complied with the requirements of the purchase order.

3. Betts Spring Company, a supplier of critical valve springs, had not been surveyed every 3 years. The available evidence showed it was approximately 5 years since a survey had been made.

4. Associated Spring Company (Barnes Group) was placed on the Approved Suppliers List and used for procurement without completion of a survey or audit.

5. Kobe Steel Ltd., a supplier of crankshaft, was not surveyed every 3 years as required by the quality assurance program. The only available record was a self evaluation survey form completed by Kobe Steel's American representative.

6. Fuel oil tubing for Purchase Order No. 45333 was accepted by receiving inspection without issue of a nonconformance report, although required mill test reports had not been received.

7. Purchased Material Specification No. RL 019000 dated October 6, 1982, was not approved as required by Engineering Operating Procedure 7.

8. A QA program was not imposed on the manufacturer of exhaust silencers for EDGs furnished to Perry, Units 1 and 2, as required by Perry Specification Nos. SP-750-4549-00 and SP-706-4549-00.

9. Purchased material specifications for engine mounted electrical control cables required only commercial grades of cable and did not invoke applicable customer specification requirements.

10. a. No available evidence to indicate that materials which were used to fabricate EDG ASME Section III Code Class 3 component supports (Midland) and fuel oil systems (Midland and Grand Gulf) were procured from vendors who were either identified on the Approved Suppliers List or had been subject to audits.

    b. Prior to 1982, ASME Section III Code fasteners were procured from vendors who had neither been audited nor were identified on the Approved Suppliers List as being approved for supply of this product.

11. Acceptance by receiving inspection of ASME Section III Code fastener certifications which did not comply with purchase order requirements with respect to: (a) conformance of chemical composition to material specification requirements, (b) completeness of mechanical test data, and (c) compliance with ASME Section III Code requirements for reporting of material heat treatment.

12. Failure to comply with testing requirements of paragraph NCA-3867.4(e) in the ASME Section III Code when purchasing stock materials from unsurveyed vendors.

MATERIAL IDENTITY AND CONTROL:

Eleven discrepancies in material identity observed in a sample of 45 between the identity of material issued and that recorded as being used for Midland EDG S/N 77002 piping system component supports.

DESIGN AND DOCUMENT CONTROL:

1. Failure to comply with Division Standard Practice Nos. 4.101 and 4.201 requirements with respect to:

   a. Release of a drawing revision to the shop without receiving approval of the applicable Engineering Change Notice from Industrial Engineering.

   b. Maintenance of the Engineering Change Log, classification of changes as major or minor, and initiation of required forms.

2. Parts list and component drawings released by Engineering did not define acceptance criteria for installation of crankshaft oil plugs.

3. Absence of any instructions in regard to installation location of governor lube oil cooler to engine.

4. Failure to comply with Drafting Room Practice during 1982 redesign of the EDG jacket water pump in regard to certain layout drawings not being either drawn on tracing paper or signed and dated.

5. Dynamic analysis or testing not performed in accordance with Stone & Webster Specification No. SHI-89 after redesign of the SNPS EDG jacket water pumps.

6. Failure to comply with Engineering Operating Procedure 4 and Drafting Room Practice requirements with respect to signing and dating of calculations by the designer for the SNPS jacket water pump redesign.

7. No evidence of required approval of "D Sheets" by the applicable Engineering manager. Examples noted were D-4986 and D-4956 which were entitled, "Assembly Instructions," and pertained to the EDG jacket water pump.

8. Jacket water pump analyses dated September 24 and October 4, 1982, and July 15, 1983, for SNPS had not received required certification from the staff Registered Professional Engineer.

NONCONFORMANCES AND CORRECTIVE ACTION:

1. No evidence to indicate that required quarterly submittal of completed corrective action activity to the Division General Manager had ever been accomplished.

2. Failure of Quality Engineering to process a required Corrective Action Request Form after customer identification of TDI failure to meet weld quality requirements in ASME Section III Code Class 3 diesel generator piping.

3. a. Removal and replacement of a defective weld in Shop Enginer No. 2931, Part No. 02-717-02YR, without required rejection and documentation on an Inspection Report.

   b. Disposition of a dimensional nonconformance on Shop Engine No. 2931, Part No. 02-540-07-B7, made by QC supervision without required submission of the Inspection Report to the Material Review Board for review.

4. Failure to comply with ASME QA Manual requirements with respect to immediate identification of nonconforming items on Inspection Reports and segregation of the items.

5. Weld shop audit not performed in the fall of 1981 in accordance with corrective action commitments made to the NRC.

EQUIPMENT CALIBRATION:

1. Actual calibration measurements for micrometers and a pressure gage were not recorded as required by Quality Control Procedure No. IP-100.

2. Gage used to measure, accept/reject the diameter and depth of the link rod dowel counterbore had not been identified in accordance with QA program requirements for calibration equipment.

3. Measures were not established to assure that tools used in crankshaft oil plug installation were properly controlled and adjusted at specified periods to maintain accuracy within necessary limits.

4. a. A welding machine in Weld Area No. 3 (Foundry) was observed in September 1983 to have calibration stickers showing a calibration due date of August 30, 1980. The QA program calibration frequency requirement for this equipment is 12 months.

   b. A heat treat furnace was observed in September 1983 to have calibration stickers on the meters and temperature recorder showing a calibration due date of March 13, 1983.

INTERNAL AUDITS:

Failure to perform required semiannual audits of the Foundry, Manufacturing and support activities.

10 CFR PART 21 PRACTICES:

1. Records were not available with respect to fractured thermostatic control valves in Grand Gulf, Unit 1, EDGs to indicate either that an evaluation had been conducted in accordance with 10 CFR Part 21 requirements or that actions had been taken to determine whether the product deviation contributing to the valve fractures (i.e., improper use of raised face flanges in connecting piping) was present in equipment supplied to other customers.

2. Notification to affected parties in regard to a potential problem with isoprene flexible elements of drive couplings was made after the committed date in the 10 CFR Part 21 report.

3. Failure to notify the NRC in regard to:

   a. Jacket water pump shaft failures at SNPS.

   b. Potential defect in fuel injection line tubing that was used on EDGs furnished to Grand Guld and San Onofre, Unit 1.

QA RECORDS:

1. Records not available to demonstrate environmental qualification of auxiliary lube oil and jacket water pump motors with respect to Bechtel Specification Nos. 9645-M-018.0 and 9645-G-QA-1.

2. Failure to protect records against fire in accordance with QA Manual requirements noted during two separate inspections.

MISCELLANEOUS:

Failure to have Certificate of Compliance for SNPS replacement cylinder head assemblies notarized in accordance with customer specification requirements.

TRANSAMERICA DELAVAL, INCORPORATED
VENDOR PROGRAM BRANCH INSPECTION HISTORY SUMMARY
OF NINE INSPECTIONS DURING 1979-1983

Subject	Number of Nonconformances/Violations
Manufacturing Process Control	13
Control of Special Processes	11
Procurement Control	12
Material Identity and Control	1
Design and Document Control	8
Nonconformances and Corrective Action	5
Equipment Calibration	4
Internal Audits	1
10 CFR Part 21 Practices	3 (Violations)
QA Records	3
Miscellaneous	1

ATTACHMENT 10

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

A Meeting on TDI DIESEL GENERATORS

Phillips Building
Bethesda, Maryland
Thursday, January 26, 1984

A meeting on TDI Diesel Generators convened at 3:04 p.m., Harold Denton presided.

APPEARANCES:

(Attendance List will be Generated.)

MR. DENTON: Good afternoon. My name is Harold Denton. What we are going to discuss today is the results of the staff review of the reliability of the Delaval diesel.

We started looking intensively in this area when problems began to develop at San Onofre, Grand Gulf, and at Shoreham. Since that time, our review has expanded.

We are prepared today to discuss with you in detail the results of all the information that has come to our attention regarding the operating performance of these diesels.

We also have with us today the Regional Administrator from Region IV, John Collins, who conducts our vendor inspection program. He will describe the results of his vendor inspections at the factory of Delaval Diesels.

I understand that the Owner's Group has been informed of the utilities who own these diesels, and they are represented today by Jim McGaughy, who is the Chairman of the Owner's Group. I understand that the Chief Executive of Delaval Diesel Corporation is also present, and that his representatives will be making a presentation.

Let me discuss a few ground rules to begin

with, to make the meeting go smoother. We are taking a transcript of this meeting. The issue is in contention, as you know, at several proceedings. And this makes it easier for us to provide the Hearing Boards a complete and accurate record of what information is made available today. Because of this transcript, it's very important that anyone who has questions or comments be sure to identify themselves for the record when they ask questions.

The way I would like to walk through this process is to have the staff first describe in some detail the information that has become available in the last few months on the performance of these diesels in the field. This is mainly at nuclear power plants, but we also collected data from some non-nuclear sources.

Then, we will cover the vendor inspection, as I mentioned. Then, we turn the meeting over to the utility Owner's Group, who I understand is prepared to describe their remedial program to try to establish the reliability of these diesels.

I understand, Jim, that you may have an opening -- opening remarks to say before we begin. Why don't you do that now?

MR. McGAUGHY: Good afternoon. My name is Jim McGaughy. I am Vice-President of Mississippi Power and Light Company. I am speaking to you today as Chairman

of the Delaval Diesel Owner's Group.

The issues that will be presented here, we feel the problems that have been found in our pre-operational testing program and our subsequent research and reported to the NRC, as they've been found, using the proper prescribed methods. For some time, all the owner's of these engines have bound together putting the best minds available in the world on these issues in the one effort to study and correct these issues.

Our goals and the goals of the NRC are the same. We are committed to provide our plant to reliable emergency backup power supplies. We feel this comprehensive program we have in place, in place now, working now, will do just that.

We are here today to tell you about what it is that we have been doing. The elements of our program are four. The first element is resolve the known problems, both generic problems and problems in the specific engines themselves, to design and find fixes to these problems.

In addition, we will take -- and are in the process of taking each engine from the ground up, reviewing its design, its construction, its procurement and doing a quality revalidation on each and every engine. From the results of the quality revalidation, then we go into testing, and the testing involves non-destructive

testing, destructive testing, operational testing of components, operational testing of the engines. This work is in progress now.

And also then we will, through this group, respond to the questions, of course, that the NRC will put to us. The participants in our program are as follows. We have the eleven owners, and I will have a list of those for you later. Eleven utilities. FaAA Associates, who are renown in doing failure analysis work. We have the wholehearted support of Delaval in this effort, both in gathering of information and gathering of design data, and in review of this data. Stone and Webster Engineering is supporting this effort. And also several diesel generator consultants from around the world.

The organization the Owner's Group has set up has me as Chairman, Mr. Joe George of Texas Utilities as Vice-Chairman. Executive Committee made up of the eleven utilities. The Technical Director of the program is Mr. Bill Museler of LILCO. We have taken the program that LILCO has started on their site, adding to it. The work is being done at the LILCO site.

As you see, in resolving the known failures and determining solutions to those problems, FaAA is taking the lead; that is their speciality. In terms of design

review and quality revalidation, we have FaAA, Stone and Webster, our various consultations, and we have engineers from each utility working in this effort. The testing program definition and carrying out the testing program will be done, of course, by the utilities who own the engines and operate them, and by FaAA who will assist us in that effort.

To give you an idea of the extent of this program, I would like to put this chart up. This is the organization that is in place. We have over a hundred and twenty people full-time working on this effort, working on this effort now. This is in progress. We are confident that when we complete this program, that we will have reliable engines to provide backup power supplies for these plants.

Thank you.

MR. DENTON: As those of you know, who own these diesels, this is a very important safety issue for the NRC. There are about fifty-seven engines made by Transamerica Delaval that are in this, owned by the sixteen utilities that are on our list. None of the Delaval diesels are at operating plants, which means it's not an imminent safety problem today, but certainly it has profound implications for schedules for some of the utilities if the problem is not adequately addressed.

I did want to mention my perspective on the safety side to be sure it's well understood. The only plants that are operating that have Delaval diesels are San Onofre Unit 1. That plant is shut down for a seismic modification. Grand Gulf, which is limited to a five percent power license and is presently shut down. And, Rancho Seco, which is using other diesels, but I understand has ordered, or has in place, several Delaval diesels which they have intended to install.

We view this as a very serious problem for the industry. It is unique to have a problem in what I will call a convention component of American technology. You wouldn't think that diesel generators would get on the critical path of the nuclear power reactors, but that's very likely wnat has happened.

And just so there is no doubt about where the staff stands on this issue, we are not prepared to go forth and recommend the issuance of new licenses on any plant that has Delaval diesels until the issues that are raised here today are adequately addressed. It sounds like we have a very ambitious program. What I want to do is make sure you have all the information we have.

And if we come to an understanding about the factual basis that we are working with, so we can move to a discussion of the information we have been able to

gather, and if everyone would hold their questions to the extent they can, we can get through the presentations faster.

We will provide ample opportunity for discussion after we have gotten the factual basis on the table. Then, we will turn to a detailed presentation of your program. And I plan to provide a break somewhere in the meeting. But we will probably go until about six o'clock.

The first presentation will be made by Frank Miraglia and assisted by Carl Berlinger. Carl Berlinger is a Senior Manager on the NRC staff. We designated him as the person responsible for ultimately reviewing your program and making sure that it is an acceptable, adequate program.

So, Frank, why don't I turn over to you to cover what we know about the operating experience.

MR. MIRAGLIA: My name is Frank Miraglia. I am the Assistant Director of the Safety Assessment Division of Licensing.

The first view graph is a list -- the first view graph indicates the fifty-seven Delaval diesels that have been procured for use at sixteen different nuclear power plant sites. May I have the second view graph?

We are going to discuss the U.S. experience with these diesels in the operating stations to date.

The next slide is a brief summary of the operating experience with San Onofre 1 station. The information on this view-graph is in a very summarized fashion. We have a more detailed handout that will be available at the end of the meeting that has additional details about the operating experience and chronology with some of these machines at the various nuclear power stations.

There are two Delaval diesels at San Onofre 1. They were installed in 1976. They are Delaval V-20 engines. They were declared operational in 1977. The operating time on each engine at San Onofre is approximately 450 hours. These are actually the first Delaval diesels to enter nuclear service.

Problems to date are indicated on the slide. They've had turbocharger thrust bearing problems. This event resulted in a Part 21 report, was issued and problem was considered to be of a generic nature.

They've had a lube oil leak and fire, which was a result of a fuel line failure, test line off a lube oil line which failed because of vibration. And it was a small fire.

The pistons have been modified at San Onofre 1 to correct a problem that is noted at Grand Gulf and resulted in a Part 21 notification there, to prevent crown separation.

They've had an unqualified instrument cable, which also was replaced in conformance with reported Part 21 occurrence. And just recently in another Part 21 report, there is potentially defective coupling material. That Part 21 report was filed earlier this month.

The next slide is a summary of the experience on the -- of the Grand Gulf diesels. They have Delaval diesels. They are the V-16. The operational hours on the diesels are 1100 hours on the Division I diesels, and seven hundred hours on the Division II diesels.

These are the first V-16 Delaval diesels to enter nuclear service. The problems to date are the -- Number one is the pistol crown separation. That was a generic problem and identified this particular problem as a Part 21 for the Delaval diesels.

They have experienced piston skirt cracks, and piston skirts have been replaced on the Division II diesels.

They've had a fuel line failure, which resulted in a fire. And the fuel line failure was due to fatique. They have experienced cylinder head cracking on these diesels. The heads have been replaced.

In addition to those, they've had the turbo-charger problems. I believe three different instances of turbocharger problems. And, again, you can see commonality

between this experience and the San Onofre experience.

They have experienced push rod cracking problems. In addition, they've had the generator short due to an engine fastener. This was a crankcase capscrew failed and had lodged in the generator and shorted the generator out.

In addition, Grand Gulf has also experienced problems with their air starting valves which has resulted in failure of the generators to start.

This summarizes the experience with the San Onofre and the Grand Gulf units. I would like to have Ralph Caruso summarize for you the experience to date on the Shoreham machines and also to present a brief summary of the information that we have been able to gather from non-nuclear marine experience with similar type diesels.

Ralph Caruso.

MR. CARUSO: The engines installed at Shoreham are Model DSR-48, straight-8 engines. They are rated at 3500 kilowatts and ~~have~~ had approximately 700 hours roughly on each engine at the time of a major failure of crankshaft in August of 1983.

These engines were the first straight-8 engines to be installed in the United States in service. Shoreham has had a number of minor problems and one major problem.

To date, they've had problems with jacket water pump propellors. This problem occurred twice. Two fuel oil lines have ruptured due to manufacturing defects. Those two ruptures resulted in Part 21 reports being issued for San Onofre and Grand Gulf.

In August they had the failure of the crankshaft in the Number 102 diesel generator. Subsequent inspections of Number 101 and 103 engines revealed cracks in the crankshafts of those engines, and in approximately the same location as the failure of the 102 engine.

Upon disassembly of the engine to repair the crankshaft problems, connecting rod bearing failures were discovered, not just on the engine with the failed crankshaft but also on another engine. Subsequent inspection revealed problems with piston skirts, with cracks in the piston skirts. Those piston skirts have been replaced at Shoreham.

And, in addition, over the life of the plant they have experienced several problems with different types of fasteners used to attach critical components together in the engine.

The staff has received a considerable amount of information regarding marine experience from three different operators of marine engines. The Marine engines we are talking about, ~~or~~ are the V-16 and V-12 engines. They are

very similar, if not identical, to engines that are being installed in nuclear power plants in the United States.

The operating experience for these engines is varied at this time, with engine operating hours varying from 3000 to 30,000 hours. To date, all three operators have reported cylinder head cracking to various different extents.

Two operators have reported piston cracking. One operator reported the complete failure of two pistons.

Problems have also been noted with excessive bearing wear, turbocharger instability, and turbocharger vibration. Cracks have been noted in push rods, ~~valves~~. Cracks have been noted in connecting rods.

In addition, cylinder blocks have been replaced by one of the operators.

This is a summary of the marine experience to date.

MR. DENTON: We have given you a very quick summary, but there is extensive information available in what we will hand out later in the presentation.

And just because we have gone through it quickly, I don't want you to think that this is all there is. There is really quite a bit of poor operating history with this piece of equipment in the time that we have been able to assemble it.

I think some of the reasons for this poor performance will be obvious when you hear from our next speaker, John Collins, who I mentioned heads up the vendor inspection program. John.

MR. COLLINS: Thank you, Harold. Now, we are passing out the view-graphs which cover a summary of the major findings that we've had of the inspection.

Since 1979, we have made nine inspections of Delaval. Seven of those inspection reports are identified in handout material. They are available in the PDR. If you would like copies and you cannot get copies, contact myself in Arlington or Ian Barnes of our Vendor Branch, we will be very happy to see that copies of these reports are sent to you.

The remaining two reports have been forwarded to the Company for proprietary review. That review period should be up tomorrow. If there are not any proprietary problems, they will be placed in the PDR and they will be available, too. So, if you want to contact me, my number in Arlington is Area Code 817-860-8225. Or, Mr. Barnes, same area code, 860-8176.

We have -- as I hope everybody has the slides now, our finding of deficiencies covered just about every subject. They included areas on manufacturing process control, control of special processes, procurement control,

material identity and control, design and document control, equipment calibration, lack of internal audits or improper or not sufficient disposition of audit findings, and then deficiencies in QA records.

At this time, I am going to ask Ian Barnes, who is the Chief of the Reactor Section for the Vendor Program to go through some of the highlights of the inspection findings with you. We are not going to read them to you. You have them, but I think it's important we at least identify some of them.

The other handout material has a more complete summary of all of the findings that were made or documented in the nine reports. So, Ian, why don't you walk us through some of the significant findings?

MR. BARNES: Good afternoon. The first slide that is on now shows a categorization of the vendor program branch inspection findings by subject area. It represents a total of sixty-two non-conformances and violations that were issued as a result of the nine inspections.

As John has just indicated, a description of all of the findings in that particular slide are included in a handout that is being passed around. From this inspection history summary, we have extracted examples of inspection findings that raise concerns with

regard to the adequacy of implementation and the effectiveness of the Transamerica Delaval program.

The next slide, please. The first subject I am going to address is manufacturing process control. We have put specific examples of inspection findings in a subject area, but bringing the question of implementation effectiveness, manufacturing process controls, and the performance of quality function of Transamerica Delaval.

As you will note from this slide, instances were noted where route sheets were not available to the Vendor Branch review. For example, the first item on the slide, jacket water pump. Reworked operations for ninety-two pistons that were supplied to Shoreham and Grand Gulf, that's the fifth item. Replacements of cylinder head assemblies for Shoreham, that's the final item on the slide.

Route sheets from Transamerica Delaval provide the primary basis for verifying that the inspection operations have been performed. The absense of those route sheets did not allow us to verify that required inspections of manufacturing operations had, in fact, been accomplished.

Examples of findings which address the performance of the quality control function is shown in the second, third and fourth items, i.e. there was no evidence

of acceptance of certain operations on components for jacket water pumps pertaining to modification efforts.

As Ralph indicated earlier, there had been two successive problems involving jacket water pump problems at Shoreham. And, so evidence of sign-off to installation of rocker arm hold down bolts were found subsequent at Shoreham, were found subsequent to be missing.

In regard to San Onofre, piston reworked, with the date of sign-off for manufacturer operations occurring actually two to three weeks after the pistons had been returned to San Onofre.

If you look, in regard to the seventh item on this list, is the apparent use as indicated by the route sheets of unqualified personnel performing non-descriptive examinations on SNPs replacement cylinder head.

The eighth item, which is an absence of any documented provisions for control of installation of fuel oil line clamps in regard to Shearon Harris. We believe that's generic to all of the engines, in that one of the fuel oil line failures at Grand Gulf has been attributed in part to the absence of required line clamp. We believe this finding is quite significant.

It has been mentioned earlier about cracking problems in piston skirts. Review of engineering drawings

for the various designs of piston skirts show, in fact, that there was an engineering requirement to perform stress relief heat treatment after normalizing of the castings. The corrective action that, in part, is being carried out for piston skirts is to perform stress relief. There was an initial requirement always in effect to do that very thing.

The next slide. This slide shows a few examples of inspection findings in regard to procurement document control deficiencies, use of vendors, the materials that without performing any service or audits of those vendors to establish adequacy of their own programs, and inadequate receiving inspection.

In the more comprehensive handout that is being distributed, you will find additional examples of inadequate receiving inspection and using other vendors without performing required service or audits.

Next slide. In the area of material identity and control, an inspection of this subject showed eleven discrepancies were observed in a smaple of forty-five, I believe, in material identity between that recorded at the time of the misuse of the material to a given job and the identity of the material that was recorded on the finished engine.

Next slide. We have included the next slide

to show examples of the failure of the quality issuance function to comply with both QA program requirements for corrective action and non-conformance conditions to be identified and the specific instance of failure to comply with corrective action commitments made to the NRC in regard to the performance of their ASME weld shop. In the same context, their ASME weld shop, recurring examples were noted during successive inspections for failure to enforce program commitments with respect to control of welding electrodes in regard to that console moisture.

Next slide. The next slide is an additional example of the failure of the QA function to comply with program requirements for audits of their manufacturing activities.

The final slide, John. We have included this to illustrate that we have certain concerns in regard to the adequacy of the Delaval evaluation and reporting practices in regard to 10 CFR Part 21.

MR. COLLINS: As we indicated at the beginning, we have summarized in these slides the findings. But, as I also indicated, I think there is a lot more that's of interest. If you carefully review the findings that were handed to you that were documented in the handout to you, one thing it says to me, in my opinion, is that

not only has there been problems at the manufacturing shop but also, in my opinion, calls into question the adequacy of the vendor programs or surveillance programs that are being conducted by the utilities. Had some of these been identified up front by utilities on-site inspection programs, or receiving inspection programs, or procurement programs, I think they could have been identified even sooner than now.

So, it really calls into question your own programs. Darrell.

MR. EISENHUT: Well, let's see, we went through the two aspects in such a short summary fashion, the operating experience and the inspection findings, that one might draw connections that they infer, or might leave it to the operating experience, these were meant to be short summaries. We certainly are going to be, on the staff, undertaking a more detailed look at all these aspects, in both the experience, the inspection results.

As mentioned earlier, Carl Berlinger is heading a major review effort. But I guess you have to sit back and say: Where does this leave us right now?

And right now, our preliminary conclusion -- and that conclusion is based on these limited looks -- is that certainly our level of confidence in the overall reliability of TDI diesels in general is significantly

reduced. We've got to say that from the front end.

And, secondly, as Harold Denton mentioned in the beginning, is that before we undertake the licensing of any plants with TDI diesels at this time, these issues clearly are going to have to be addressed. These issues are clearly the quality aspect from both the design, the construction, the operating experience is going to have to be factored in, and the overall ability of these diesels to reliably perform their function is going to have to be demonstrated.

That's basically where we are today. As we said early, and Jim McGaughy pointed out, there is a major industry undertaking, a major program has been laid out, that we hope is going to address all of these issues. And, obviously they are going to have to address them to the staff's satisfaction.

With that as a short summary, I guess I would like to open it up to the staff presentation for any questions before we go to the second part this afternoon on either piece, the operating experience piece, or on the inspection results found today. Any questions? (No reply.) Can't get off that easy.

Well, if there are no questions, why don't I suggest it would probably be easier, Jim, on your presentation if we took a short break now rather than

CERTIFICATE OF PROCEEDING

This is to certify that the attached proceeding before the NRC Staff

In the matter of: Meeting on TDI Diesel Generators

Date of Proceeding: January 26, 1984

Place of Proceeding: Phillips Building, Bethesda , Maryland

was held as herein appears, and that this is the original transcript for the file of the Commission.

MYRTLE H. TRAYLOR
Official Reporter - Typed

Official Reporter - Signed