UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY, ET AL.	)	Docket Nos. 50-440 50-441
	)	
(Perry Nuclear Power Plant, Units 1 and 2)	)	

APPLICANTS' DIRECT TESTIMONY OF
JOHN C. KAMMEYER ON ISSUE NO. 16

1. My name is John C. Kammeyer. I am employed by Stone & Webster Engineering Corporation as Assistant Head of the Site Engineering Office at Shoreham Nuclear Power Station. See discussion at ¶ 3. My business address is Shoreham Nuclear Power Station, P.O. Box 618, Wading River, New York 11792.

2. Prior to returning to my present position in February of 1985, I was employed by Stone & Webster Engineering Corporation as Program Manager for the Transamerica Delaval, Inc. ("TDI") Owners Group Design Review and Quality Revalidation ("DR/QR") Program. I acted as Program Manager for nearly one year, beginning in April of 1984. As Program Manager, I had the overall responsibility for implementation of the DR/QR Program. I was responsible for directing engineers and quality inspectors in the resolution of TDI diesel engine problems, and

the design review/quality revalidation of selected engine components at twelve nuclear power plants, including the Perry Nuclear Power Plant ("PNPP").

3. Prior to acting as Program Manager for the Owners Group, I was employed by Stone & Webster as the Assistant Head of the Site Engineering Office at Shoreham Nuclear Power Station, the position to which I have just returned. During the construction and start-up testing phase of the Shoreham Plant, I was responsible for directing engineers and designers in the resolution of problems involving fluid system and related components, such as piping, valves, mechanical equipment, and equipment erection. I also provided engineering and managerial support to Long Island Lighting Company for the Shoreham Plant's original DR/QR program and the plant's licensing effort. During the plant's pre-operational phase, my responsibilities included providing developmental support for the station modification programs and engineering the specific modification packages necessary for upgrading mechanical systems and equipment. My responsibilities specific to the TDI diesel generators installed at the Shoreham Plant included the following:1/

1/ My experience with the TDI model DSR-48 "inline" 8-cylinder diesel engine is relevant to the DSRV-16-4 16-cylinder "vee" diesel engine at PNPP since both are R-4 model engines.

a. June, 1980 to October, 1980:

Principle engineer assigned to the "Plant Maintainability Study," which included a review of all major diesel engine and auxiliary components for the purpose of assuring their accessibility and proper physical arrangement in order to meet maintenance requirements.

b. April, 1981 to June, 1984:

Principle engineer assigned to the resolution of all problems and technical issues involving the TDI diesel generators during final erection of equipment and the start-up testing phase of the Shoreham Plant. These responsibilities included:

(1) Resolution of non-conformances identified on engine and auxiliary components;

(2) Evaluation and implementation of all product improvements and design upgrades, including:

(a) Redesigned jacket water pumps,

(b) Modified turbocharger supports,

(c) Upgraded pistons,

(d) New crankshafts,

(e) New cylinder heads,

(f) Turbocharger prelubrication modification,

(g) New pushrods,

(h) Upgraded new subcover,

(i) New cylinder block;

(3) Development of procurement requirements for replacement and spare parts;

(4) Working with TDI in the general revision and upgrade of the diesel engine operation and instruction manuals;

(5) Directing engineers and designers in the development of detailed procedures for disassembly and rebuilding of the diesel engines;

(6) Development of an engine vibration qualification program;

(7) Participation in a diesel generator "Operational Review Program," to assess the significance of diesel generator modifications, non-conformances, etc., on the operational capability and reliability of the diesel generators; and presentation of the results and conclusions of this program to the Nuclear Regulatory Commission ("NRC").

c. November, 1983 to April, 1984:

Special assignment to the Shoreham Plant DR/QR program, which evolved into the TDI Diesel Generator Owners Group DR/QR Program. Areas of responsibility included the following:

(1) Assisted in the development of the Shoreham DR/QR program, including its conception, development of procedures, and structuring of the basic organization;

(2) Participated in the development of a computerized database chronicalling experiences with diesel engine components in both nuclear and non-nuclear applications;

(3) Participated in the identification of components to be subjected to a design review and/or quality revalidation;

(4) Expanded the Shoreham-specific DR/QR program to cover TDI engines installed at eleven other nuclear power plants;

(5) Participated in site-specific engine inspections to review the results of quality inspections at a number of plants;

(6) Participated in the review of all Phase I design review reports, generated as a result of the Owners Group Program.2/

2/ As more fully described beginning at ¶ 8.

My present responsibilities at Shoreham include consolidation of all Stone & Webster activities on the site under one manager, myself, to be effective in June of 1985. Additionally, as Stone & Webster's contact to the Owners Group Executive Committee, I am responsible for Stone & Webster's continuing support to the Owners in the following areas:

a. Engine startup consulting and support activities;

b. Special testing (including engine vibration monitoring);

c. Maintenance program development and support;

d. Implementation of modifications or development of alternatives; and

e. Development of responses to NRC staff information requests.

4. I am a graduate of Ohio State University, from which I obtained a Bachelor of Science degree in mechanical engineering. Prior to attending college, I spent six years in the U.S. Navy's Nuclear Power Program. My final three years in the service were spent as a reactor operator aboard a nuclear submarine. I am a member of the American Society of Mechanical Engineers.

5. The following testimony addresses Ohio Citizens for Responsible Energy's ("OCRE") contention regarding the TDI diesel generators in place at PNPP. As admitted by the Licensing Board, Issue No. 16 states:

> Applicant has not demonstrated that it can reliably generate emergency on-site power by relying on four Transamerica Delaval diesel generators, two for each of its Perry units.

The following testimony illustrates that the TDI Diesel Generator Owners Group Program provides assurance that the TDI diesel generators in place at PNPP are fully capable of reliably performing their intended safety-related functions.

I. THE TDI DIESEL GENERATOR OWNERS GROUP PROGRAM PLAN

A. Background

6. On October 25, 1983, as a result of a number of diesel generator operating experiences involving various nuclear power plant utility owners and diesel engine types, a technical information exchange meeting hosted by Mississippi Power & Light was held in Atlanta, Georgia. As a result of discussions at this meeting, twelve U.S. utility owners, including Cleveland Electric, formed the TDI Diesel Generator Owners Group to address operational and regulatory issues relating to TDI diesel generator sets used as back-up power supplies in U.S. nuclear power plants.

7. The structure of the TDI Diesel Generator Owners Group was formalized and approved at an executive meeting held in Atlanta, Georgia on December 21, 1983. It consisted of an Executive Committee consisting of company officers from each participating utility and a technical program director. Reporting to the technical program director were the project engineer, the DR/QR program manager, and the DR/QR report review manager, each of whom was responsible for a different aspect of the program. Details of the organization of the Owners Group are presented in the "TDI Diesel Generator Owners Group Program Plan," which was submitted to the NRC on March 2, 1984.

8. The Program Plan established by the Owners Group provides an in depth assessment of the adequacy of the respective utilities' TDI diesel generators to perform their intended safety-related function through a combination of design reviews, quality revalidations, engine tests and component inspections. High quality technical resources were used in the implementation of the Program. Organizations and individuals with expert knowledge in the various areas requiring investigation, inspection and analysis were employed to ensure that the evaluations of the individual TDI diesel generators would be thorough and meaningful. The major technical resources utilized in this comprehensive Program, and their function were:

	Organization	Role in Owners Group Program
a.	Stone & Webster Engineering Corporation (SWEC)	Management of quality revalidation and design review effort; Performance of design review tasks; Provision of licensing and logistical support.
b.	Failure Analysis Associates (FaAA)	Analysis of known problems; Performance of design review tasks.
c.	FEV (German Diesel Consulting Firm)	Technical evaluation of known problems.
d.	Transamerica Delaval (TDI)	Provision of technical and experience data; Review of design review and quality revalidation results.
e.	Owners Group	Provision of plant-specific technical and experience data; Provision of working level engineers familiar with diesel generator plant-specific applications; Provision of overall program management.
f.	Impell	Performance of design review tasks.
g.	Subvendors	Provision of technical expertise on unique components;

Organization	Role in Owners Group Program
	Provision of support for investigations and site-specific disassembly/reassembly of engines.

9. The NRC staff's evaluation of the Owners Group Program Plan was presented in "Safety Evaluation Report-Transamerica Delaval, Inc. Diesel Generator Owners Group Program Plan," dated August 13, 1984. This safety evaluation report ("SER") included a review of the technical evaluation report ("TER"), "Review and Evaluation of TDI Diesel Generator Owners' Group Program Plan," (PNL-5161) of June, 1984, which was prepared by Pacific Northwest Laboratory ("PNL").3/ Based on its review, the NRC staff's overall finding was that the Owners Group Program Plan incorporates the essential elements needed to resolve the outstanding concerns relating to the reliability of the TDI diesel generators for nuclear service, and to ensure that the TDI diesel engines comply with GDC 1 and GDC 17. These essential elements include: (1) resolution of known generic problems (Phase I); (2) systematic design review and quality revalidation of all components important to reliability and operability of the engines (Phase II); (3)

3/ PNL is under contract to the NRC to perform technical evaluations of the TDI Owners Group generic program, in addition to plant-specific evaluations relating to the reliability of TDI diesels.

appropriate engine inspections and testing as identified by the results of Phase I and II; and (4) appropriate maintenance and surveillance programs as indicated by the results of Phase I and Phase II.

B. Phase I - Resolution of Generic Problems

10. In Phase I of the Owners Group Program, one of the first activities undertaken was the assemblage of experience data pertinent to TDI engines. Using input from various nuclear data sources4/ (i.e., INPO, SOERs, LERs, 10 C.F.R Part 50.55(e)'s, and 10 C.F.R. Part 21's, etc.) as well as non-nuclear sources (both marine and stationary), supplemented by data obtained as a result of feedback from the utilities' own inspection and testing results (conducted as part of the Owners Group Program), TDI engine/component operational experiences were documented. A review of the accumulated data resulted in a conclusion by the Owners Group technical staff (i.e., SWEC, FaAA, FEV, etc.) that a limited number of components warranted consideration as significant known problems with potentially generic applicability to TDI diesel generators. Accordingly, these sixteen components received priority attention within the Owners Group design review group. The sixteen components were as follows:

4/ As more fully described at ¶ 17.

a. Turbocharger,

b. Base and bearing caps,

c. Crankshaft,

d. Cylinder block,

e. Cylinder head studs,

f. Connecting rods,

g. Connecting rod bearing shells,

h. Pistons,

i. Airstart valve capscrews,

j. Cylinder heads,

k. Fuel oil injection tubing,

l. Main and connecting pushrods,

m. Rocker arm capscrews,

n. Jacket water pump,

o. Wiring and termination,

p. Cylinder liner.

11. A detailed design review of each of these components was conducted by the Owners Group consultants to establish the adequacy of their design. Specific design and/or manufacturing concerns were identified and resolved through analyses, testing and documentation reviews. Establishment of maintenance requirements and the preparation of inspection plans for these components also formed part of the Phase I effort.

12. The following list of the evaluations performed in the course of the crankshaft review illustrates the comprehensiveness of the Phase I process:

a. Review of TDI calculations and tests.

b. Conduct engine tests of 13-inch x 12-inch shaft.

c. Conduct modal superposition and Holzer torsional analyses of the following engines:

1. Shoreham (R-48)

2. Midland (RV-12)

3. Grand Gulf (RV-16) [PNPP has RV-16 engines]

4. San Onofre (RV-20)

d. Conduct finite element analysis of R-48 engine 12-inch crankpin fillets.

e. Compare measured and calculated stresses of R-48 engine 13-inch x 12-inch shaft.

f. Compare measured and calculated output torque and free end torsiograph traces for R-48 engine.

g. Compare stress levels with endurance limit for R-48 engine.

h. Compare nominal stresses of R-48 and RV-16 engines with those recommended by industry standards.

i. Compare nominal stresses of RV-12 and RV-20 engines with those recommended by industry standards.

j. Complete final report on Shoreham and Grand Gulf crankshaft integrity.

k. Complete final report on Midland RV-12 and San Onofre RV-20 engines.

As a result of the above reviews, three Phase I crankshaft reports were issued, one each for the DSR-48 lead engine, the DSRV-16-4 lead engine and the DSRV-12 and 20 engines. The result of the DSRV-16-4 engine review was that the crankshaft is adequate for its intended service and meets applicable standards.

13. It is important to note that while TDI drawings and certain TDI information were used as input to both the Phase I and Phase II (DR/QR) programs, the actual technical evaluations were performed independent of TDI, thereby providing an independent verification of the critical design aspects of each component. Independent design verification was achieved as follows:

a. The attributes of the component to be verified by design review were determined by a thorough investigation of the component's service history and identification of likely failure modes.

b. Methodology for verification of the critical attributes was established, and significant engine components (i.e components designed by TDI), were evaluated by the Owners Group, <u>not</u> by review of TDI analysis.

14. The Owners Group Program achieved independence from TDI's Quality Assurance ("QA") program by inspection and testing of the diesel generator equipment installed at each of the nuclear plant sites, including PNPP. These inspections were performed by both Owners Group personnel and by PNPP personnel. Examples of inspections performed by Owners Group personnel included field walkdowns of pipe, tubing and electrical conduit, safety-related wiring, and generator control equipment. In addition, eddy current examinations were performed on components such as the crankshaft and connecting rods, and material comparator and hardness readings were taken on various components. The Owners Group recommended inspections are a specific means of verifying critical aspects of each component; and as this method verifies the suitability of the components actually installed, independence from TDI's QA program is achieved.

15. Review findings and final recommendations were outlined in thirty-six separate reports.5/ As these reports were completed, they were sent to the NRC staff for review and comment. The Owners Group has submitted all thirty-six reports to

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5/ Thirty-six reports (fifteen subject reports plus supplements) were required to address the sixteen components due to differences between types of engines (i.e., the DSR-48 and DSRV-16-4). All of the sixteen components were addressed in separate reports except for the cylinder block and cylinder liner which were evaluated together.

the NRC staff addressing each of the sixteen problem areas identified in Phase I of the Program. The testing and analysis in support of these thirty-six Phase I reports represents a significant effort, spanning over a year's time and involving more than a hundred engineers and technicians.

C. Phase II - Design Review/Quality Revalidation of Selected Engine Components

16. Phase II of the Program (design review and quality revalidation), examined the components of each owner's engine, not evaluated in Phase I, from the standpoint of both design and quality attributes, to assess their ability to reliably perform their intended function. A Component Selection Committee composed of a component selection chairperson, SWEC representative, FaAA representative, TDI representative, diesel generator specialist, and an owner's representative, formally reviewed each owner's engine components. Based on the specific component's function and role in the overall operation of the engine, applicable site and industry experience, and the engineering judgment and experience of the Committee, certain components were then selected for a detailed design review and/or quality revalidation.

17. The first step in component selection, review of engine experience, encompassed three areas of review: (1) nuclear industry experience; (2) non-nuclear industry experience;

and (3) utility site-specific experience. Nuclear industry experience associated with each component was gathered and entered into the component database (a computer summary of the selected diesel generator components compiled using the "TDI Parts Manual"). Sources of information included:

a. Licensee Event Reports (LERs);

b. Significant Event Reports (SERs);

c. Institute for Nuclear Power Operation ("INPO") Significant Operating Event Reports (SOERs);

d. 10 C.F.R. Part 50.55(e) reports;

e. 10 C.F.R. Part 21 reports;

f. INPO Nuclear Plant Reliability Data System entries (NPRDS);

g. Electric Power Research Institute reports;

h. Inspection and Enforcement (I&E) bulletins, notices, and circulars;

i. TDI Service Information Memos (SIMs).

The non-nuclear industry experience of the component was gathered on engines manufactured by TDI. Sources of information included:

a. Stationary/marine engine experience (including the engines used on State of Alaska's M/V Columbia);

b. Correspondence between TDI and purchasers;

c. Ships' logs; and

d. Engine inspection reports.

Each utility in the Owners Group gathered site-specific component experience which was entered into the database. Sources of information included:

a. Design change documents;

b. Repair/rework documentation;

c. Deficiency reports;

d. Inspection reports;

e. Maintenance logs.

All of the information in this database contributed to the Committee's selection of components.

18. During the component selection process, engine components were classified as either Type A, Type B, or Type C. These classifications were based on the effect the component's failure would have on diesel generator performance. A description of each of these classifications follows:

a. Type A Component - a component, based on the judgment and experience of the Component Selection Committee, whose failure would result in immediate diesel generator shut-down, or prevent start-up under emergency conditions.

b. Type B Component - a component, based on the judgment and experience of the Component Selection Committee, whose failure would result in reduced capacity of the diesel generator, or the eventual failure of a Type A Component, if not detected.

c. Type C Component - a component, based on the judgment and experience of the Component Selection Committee, whose failure would have little bearing on the effective use or operation of the diesel generator.

Examples of Type A, Type B, and Type C components follows:

a. Type A

Turbocharger
Crankshaft
Cylinder Block
Connecting Rods

b. Type B

Intercooler
Jacket Water Standpipe: pipe, fittings, gaskets
Base and Bearing Caps-Base Assembly
Cam Bearing

c. Type C

Turbo Tools
Pyrometer Wire
Turbo Charger Air Inlet Adapter
Crankcase Vacuum Fan

Examples of components which did not require classification were items such as nameplates and maintenance tools.

19. The Component Selection Committee chose the components to be subjected to a design review and/or quality revalidation on the foregoing bases (i.e., component classification as to criticality, past industry and other site-specific experience, etc. as inputted to the component database, as well as the engineering judgment and experience of the Component

Selection Committee). Absence of adverse operating experience did not necessarily exclude a component from the DR/QR process. The following illustrates the general guidelines for selection:

a. Type A Components - design review and/or quality revalidation normally required.

b. Type B Components - Component Selection Committee would determine if design review and/or quality revalidation was required.

c. Type C Components - design review and/or quality revalidation normally not required.

20. Engine components selected for design review and/or quality revalidation were then subjected to reviews, inspections, testing, etc., as required by the Component Selection Committee.

21. The nature of a specific component determined if a Design Review alone was required, Quality Revalidation alone was required, or both were required. The critical attributes of a given component, and how best to verify that attribute (i.e., analysis, inspection or both), dictated the nature of the required review.

22. An example of a Design Review-only component is the flywheel. It was determined that the only attribute required for review was the flywheel's effect on the crankshaft torsional system. Only design review was required to determine, for each plant, what differences, if any, existed between the

site-specific flywheel and the lead engine, and to evaluate any differences.

23. An example of a Quality Revalidation-only component is the control panel assembly terminal boards/switches/wiring. It was determined that the only review of attributes required was a visual inspection of the control panel for cleanliness and a verification that the wire was purchased to environmental qualification requirements.6/

24. Design review and/or quality revalidation requirements were reflected in specific task descriptions prepared for each component by the Owners Group Design Review Group and Quality Revalidation Group.7/ Task descriptions included any requirements specified in the selection process, as well as

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6/ Control panel assembly terminal verification is included in the PNPP diesel generator testing program described in Applicants' Direct Testimony of Edward C. Christiansen on Issue No. 16 ("Christiansen Testimony").

7/ The Design Review Group consisted of consultants from Stone & Webster, FEV, Impell, and FaAA. Stone & Webster was responsible for small bore piping and tubing equipment. Impell was responsible for large bore piping. FaAA and FEV were responsible for engine components. Each component was assigned a task leader from the various organizations. This task leader would develop a task description which was reviewed and approved by the Design Review Chairman and the Program Manager.

The Quality Revalidation Group consisted of Stone & Webster engineers, quality assurance engineers, and inspectors. Based upon the inspection and review requirements, as specified by the Component Selection Committee and the Design Review Group, they would develop specific task descriptions for each component.

more detailed descriptions of procedures, standards, or design review approaches to be applied.8/ The individual task descriptions were then implemented by the Owners Group technical staff, in the case of design reviews, and by the individual owner's quality revalidation group, as discussed in the Christiansen Testimony at ¶¶10 to 12.

25. The Owners Group Program is based on a lead engine and follow-on engine concept. The lead DSR-48 engines, at Shoreham, and lead DSRV-16-4 engines, at Comanche Peak, were extensively evaluated over an eight-month period. A full review was conducted on all the required components during this period, utilizing over a hundred engineers, designers and technicians. For each of the follow-on engines, including those at PNPP, each component requiring a design and/or quality review was evaluated to determine if the lead engine review was applicable. This evaluation involved identifying differences in design, loading, or application and evaluating any significant differences.

26. The gears provide a typical design task description for a PNPP Type A component. The design task description called for a comparison between the gear design for PNPP and

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8/ The task description for each component reviewed in Phase II of the Program is contained in or referenced in each owner's final DR/QR report.

the lead engines. To accomplish this, a review of the TDI parts list and applicable drawings was performed. This showed that the design at PNPP was the same as Comanche Peak and Grand Gulf. Gear loads were calculated by utilizing the lead engines. Gear analysis was conducted with input from the specific PNPP crankshaft torsional vibration analysis. The PNPP gear tooth loads were compared to the Comanche Peak and Grand Gulf loads to ensure that the PNPP loads were bounded. The calculations performed on the Comanche Peak and Grand Gulf gears showed that the TDI design was adequate to meet its intended function. Since PNPP's load was bounded by Comanche's and Grand Gulf's, the gear train installed in the PNPP engines was considered acceptable.

27. 171 components were reviewed for the PNPP engines. 153 of these components were the same as those selected for DR/QR on the lead engines. Each component report in the PNPP DR/QR Report contains a general description of the component, objective of the review, methodology used, results, and conclusions (and includes references to the lead engines' reports as required). A total of eleven reports (some of which address multiple components) were prepared for components unique to the PNPP engines. Exhibit A contains examples of two PNPP-unique reports (for the cylinder block and starting air manifold tubing supports) and two reports (for the connecting rod bearing shells and rocker shaft assemblies) which rely

on the previously-prepared lead engine reports (which are also included).

28. Upon completion of the DR/QR effort, inspection results, document packages, design review findings, and calculation results, were reviewed and approved by the Owners Group technical staff. Where results of these reviews and/or inspections indicated the need for additional action (i.e., component replacement, maintenance recommendations, etc.), follow-up activities were initiated.

29. Follow-up activities, if any, were generally a recommendation for increased maintenance, a one-time quality inspection, or, in some cases, a modification to the equipment. In the case of the gear train review discussed above, the following recommendations were made to ensure component reliability:

a. Visual inspections are to be performed during scheduled refueling outages for signs of progressive pitting.

b. Mating surfaces between idler gear and hub are to be thoroughly cleaned prior to assembly.

c. Hub nuts are tc be properly torqued to the recommended torque range and relocked.

D. <u>The Engine Revalidation Effort, Testing and Inspection</u>

30. The third major element of the Owners Group Program involves an enhanced engine testing program, coupled with specific inspections of both Phase I and Phase II components. The

Owners Group technical staff, in evaluating specific engine components, provided technical recommendations to the owners regarding special or expanded engine tests and component inspections which would be appropriate to ensure the adequacy of the engines and components to perform their intended safety-related functions. These recommendations were conveyed in each plant's DR/QR report.

II. CONCLUSIONS

31. At the completion of each owner's DR/QR effort, a final report is issued summarizing and transmitting results of the DR/QR reviews, identifying any corrective actions or recommendations, and providing conclusions regarding the adequacy of the diesel generators to perform their intended safety-related service.

32. The Owners Group has completed its review and issued the final DR/QR report on the DSRV-16-4 diesel engines installed at PNPP.9/ Both the scope, and the comprehensiveness of this review represents a significant effort by the Owners Group technical staff and Cleveland Electric Illuminating Co. personnel. The results of this review, as presented in the PNPP DR/QR Report, establish that the important components of

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9/ This report, "TDI Diesel Generator Design Review and Quality Revalidation Report, prepared for Cleveland Electric Illuminating Company, Perry Nuclear Power Plant," was submitted to the NRC in January of 1985.

the TDI diesel generators have been assessed to be adequate for their intended safety-related function.

33. Nuclear standby diesel generator reliability has been a major concern of both the industry and the NRC. Although previous programs have been sponsored by the NRC, EPRI, and other industry groups, to quantify and improve diesel generator reliability, the Owners Group Program is unprecedented in its approach and analytical detail. Many of the components reviewed have been analyzed using techniques exceeding the detailed engineering effort which originally went into their design. The TDI Diesel Generator Owners Group Program provides assurance of the reliability of the TDI diesel generators by establishing the reliability and acceptability of their critical engine components. Recommendations made by the Owners Group, when implemented, will further improve component reliability, thereby improving the overall reliability of the TDI diesel generators. The Owners Group effort provides a sound basis for concluding that the TDI diesel generators in place at PNPP are fully capable of reliably performing their intended safety-related functions.

Exhibit A

TDI OWNERS GROUP

for

PERRY NUCLEAR POWER PLANT - UNIT 1

CYLINDER BLOCK
COMPONENT PART NO. 02-315A

I INTRODUCTION

The TDI Emergency Diesel Generator Owners Group Program for the Perry Nuclear Power Plant requires Design and Quality Revalidation reviews of the cylinder blocks to determine the adequacy of design for the intended use at Perry. The blocks are manufactured by TDI and are supplied under their part number 02-315-03-AE. The cylinder block forms the framework of the liquid cooled engine and provides passage for coolant and support for the cylinder liners and cylinder heads.

II OBJECTIVE

The objective of this review was to evaluate the structural adequacy of the cylinder block for its intended use at Perry Nuclear Power Plant.

III METHODOLOGY

In order to meet the stated objective, the following methods were used:

- Review of engine operating conditions at Perry and identification of any differences from those at Comanche Peak.
- Performance of dimensional check and evaluation of liner/block interaction.
- Evaluation of steady state stresses, alternating stresses and stiffness in key portions for the cylinder block.
- Evaluation of crack growth rate for cylinder block landing and counterbore diameter by comparison with conservative Shoreham data and analysis.
- Review of liquid penetrant inspections of Perry DSRV-16-4 1A and 1B engine blocks.
- Review of metallurgical/microstructure analysis of cylinder block material.
- Review of Perry site, nuclear and non-nuclear experiences (see Appendix C).
- Review of Quality Revalidation Checklist results for acceptability.

IV RESULTS AND CONCLUSIONS

Diesel generators 1A and 1B have had limited operational experience. Engine hours of operation accumulated to date consist of factory test hours performed by TDI.

The engine operating conditions at Perry were compared to those at Comanche Peak and Shoreham. No significant differences were found that would affect the structural integrity assessment of the Perry blocks.

It is recommended that cylinder liner bore and mating block dimensions be checked in order to evaluate the interaction of the block and cylinder liner. For the purpose of analyzing the steady state and alternating stresses present, the cylinder liner/bore interaction is assumed to be similar to that present at Shoreham. This assumption must be verified for Engines 1A and 1B. These results were utilized in the cumulative damage analysis. The cumulative damage algorithm is explained in Reference 2.

Evaluation of steady state stresses, alternating stresses and stiffness in key portions of the cylinder block was accomplished as part of the strain gage testing at Shoreham and the results were included in the cumulative damage and crack growth analyses (Ref. 2).

The power output for this engine is 7000 kW at 100 percent load. Maximum output required for LOOP/LOCA is 4460 kW (Ref. 3). The duration of a LOOP/LOCA used in this analysis is 168 hours.

Strain gage testing of the original Shoreham EDG 103 block, inspection data from before and after testing, and materials testing were used as a basis to predict adequate life for cylinder blocks. The apparent rate of propagation of cracks between stud holes in the original Shoreham EDG 103 when compared with the Perry LOOP/LOCA requirements, indicates that even if the Perry blocks had ligament cracks they are predicted to withstand with sufficient margin a LOOP/LOCA event (Ref. 2) provided that block material is shown to be characteristic of typical Class 40 grey cast iron.

To date, no inspection results for Engine 1A and 1B block tops have been reported. It is required that, prior to placing the engines in emergency standby service, the visual and NDE examinations consistent with those identified in Appendix B be performed on Engines 1A and 1B to determine whether or not block top cracks are present.

Further, it is recommended that a material microstructure evaluation be performed on all engine blocks at Perry, to verify that the block material is characteristic of typical Class 40 grey iron. Without satisfactory material verification, there is no analytical basis for continued engine operation. Increased operational time between inspections can be justified with demonstration of block material characteristics as typical Class 40 grey cast iron.

Application of the cumulative damage algorithm (Ref. 2) shows that the Perry engines, with Class 40 grey cast iron material blocks, could perform 260 hours at 100 percent load (or operation resulting in equivalent cumulative damage), without inspection, with sufficient margin for a LOOP/LOCA event. Subsequent time periods of operation can be justified after reinspection of the block top for detectable ligament, stud-to-stud and stud-to-end cracks. If none are found, then engine operation may be performed until the future cumulative damage equals the total cumulative damage accrued to the last inspection, minus 3 times the damage postulated during a LOOP/LOCA. This process may be repeated indefinitely throughout the life of the engines.

The above recommendations are a direct application of the cumulative damage algorithm and are described in Reference 1, Figure 5-1.

There are no TERs associated with this component.

Quality Revalidation Inspection results identified in Appendix B have been reviewed and considered in the performance of this design review, and the results are consistent with the final conclusions of this report.

Based on the above review, subsequent completion and review of block top inspections, block material evaluations and cylinder liner/block bore dimensional check as identified in Appendix B for Engines 1A and 1B, and implementation of routine inspections, it is concluded that the cylinder blocks are acceptable for their intended use at Perry.

IV REFERENCES

1. Design Review of TDI-R4 Series Emergency Diesel Generator Cylinder Blocks and Liners. FaAA-84-9-11.

2. FaAA Support Package Number SP-84-6-12(i).

3. Letter from E. C. Christiansen (Perry Nuclear Power Plant) to C. L. Ray, Jr. (TDI Owners Group), dated 7/23/84.

APPENDIX A

COMPONENT DESIGN REVIEW CHECKLIST
PERRY NUCLEAR POWER PLANT - UNIT 1

COMPONENT Cylinder Block-Liners and Water Manifold: Cylinder Block

UTILITY Cleveland Electric Illuminating Co.

GROUP PARTS LIST NO. 02-315A

TASK DESCRIPTION NO. DR-03-02-315A-0

SNPS GPL NO. 03-315A

CLASSIFICATION TYPE A

TASK DESCRIPTIONS

Review liquid penetrant inspections of Perry DSRV-16-4 engine block tops and review engine operating experience.

Review engine operating conditions of Perry and identify any differences from those at Comanche Peak.

Perform dimensional check on cylinder block and cylinder liners and evaluate liner/block interaction.

Evaluate steady state stresses, alternating stresses and stiffness in key portions of the cylinder block.

Evaluate crack growth rate for cylinder block landing and counterbore diameter by comparison with conservative Shoreham data and analysis.

Review metallurgical/microstructural analysis of cylinder block top material.

Review of Perry site, nuclear and non-nuclear experiences (see Appendix C).

Review of Quality Revalidation Checklist results for acceptability.

Review information provided on TERs.

PRIMARY FUNCTION

To provide framework for engine components and to provide cooling water passages.

COMPONENT DESIGN REVIEW CHECKLIST

ATTRIBUTE TO BE VERIFIED

That components have sufficient strength and stiffness to react major loads.

SPECIFIED STANDARDS

None.

REFERENCES

None.

DOCUMENTATION REQUIRED

Manufacturer's drawings for DSR-48 and RV blocks, liners and studs, including all specifications for material, torques, valve train loads and gas cycles.

Engine operating history (time vs. load) for operation prior to block top inspection, and for total engine hours.

Anticipated engine operating profile (time vs. load) for fuel cycle, including pre-operational, qualification, and surveillance testing.

Engine factory test logs that report firing pressures and exhaust temperatures for each cylinder.

GROUP CHAIRPERSON _____ PROGRAM MANAGER _____

Appendix B

COMPONENT QUALITY REVALIDATION CHECKLIST

COMPONENT Cylinder Block

UTILITY Cleveland Electric Illuminating Co.
Perry Nuclear Power Plant - Unit 1

GPL NO. 02-315A

REV. NO. 2

SNPS GPL NO. 03-315A

TASK DESCRIPTIONS

Engine 1A

1. Assemble and review existing documentation.

2. Perform a dimensional check on the area around the cylinder liner for all cylinder block liner landings.

3. Perform a Liquid Penetrant test or Magnetic Particle test on the cylinder block liner landing along the top landing surface, fillet radius, and vertical face adjacent to the landing surface. Liner landings 3L, 4L, 5L, 6L and 3R, 4R, 5R, 6R should be inspected with the liners removed. If linear indications are found, increase inspection plan to all liner landings.

4. Perform a Liquid Penetrant test or Magnetic Particle test on the cylinder head mating surface on top of the cylinder block. The area between stud hole and liner, and between adjacent cylinder stud hole should be inspected. The inspection plan should include cylinders 3L, 4L, 5L, 6L and 3R, 4R, 5R and 6R. If linear indications are found, increase inspection plan to all cylinders.

5. Perform an Eddy Current test on the cylinder head stud holes if required (i.e. linear indications found at stud hole extending into threads).

6. Remove a sample from each cylinder block by drilling and cutting. The samples shall be tetrahedral in shape with a one inch square base and a height of 5/8 inch. Attachment B shows the locations where the samples should be taken.

COMPONENT QUALITY REVALIDATION CHECKLIST

TASK DESCRIPTIONS (continued)

Engine 1B

Same as Engine 1A

ATTRIBUTES TO BE VERIFIED

Engine 1A

1. Quality status of Component Document Package
2. Dimensions of the cylinder block liner landing area

3-5. Surface integrity of the cylinder block liner landing

6. Samples are taken from the cylinder block in accordance with TER #99-016.

Engine 1B

Same as Engine 1A

ACCEPTANCE CRITERIA

Engine 1A

1. Satisfactory Document Package
2. Review of inspection report by Design Group

3-4. See Attachment A

5-6. Review of inspection report by the Design Group

Engine 1B

Same as Engine 1A

COMPONENT QUALITY REVALIDATION CHECKLIST

REFERENCES

Engine 1A

1. QCI No. 52
2. Approved Site NDE Procedures
3-4. TER#s 99-004, 99-018, 99-036
5. FaAA Procedure NDE 11.8
6. TER #99-016, 99-031

Engine 1B

Same as Engine 1A

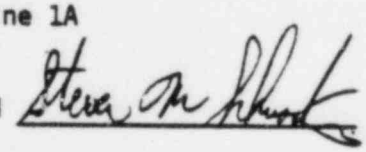
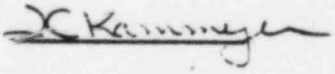
DOCUMENTATION REQUIRED

Engine 1A

1. Document Summary Sheet
2-6. Inspection Report

Engine 1B

Same as Engine 1A

GROUP CHAIRPERSON  PROGRAM MANAGER 

COMPONENT REVIEW

Engine 1A

1. No EDGCTS site experience documents are in evidence.

COMPONENT QUALITY REVALIDATION CHECKLIST

COMPONENT REVIEW (continued)

Engine 1A (continued)

2-6. No inspection reports have been received which fulfill these requirements.

Engine 1B

Same as Engine 1A

RESULTS AND CONCLUSION

Engine 1A

The Quality Revalidation effort with respect to this component, as outlined above, is complete. The results have been forwarded to the Design Review Group for their evaluation and conclusions in support of the final report.

Engine 1B

Same as Engine 1A

GROUP CHAIRPERSON Nicholas A Sabella PROGRAM MANAGER J Kammiger

Attachment A

COMPONENT QUALITY REVALIDATION CHECKLIST

ACCEPTABLE CRITERIA

A) Area to be inspected
   1. Top of Block
   2. Liner counterbore

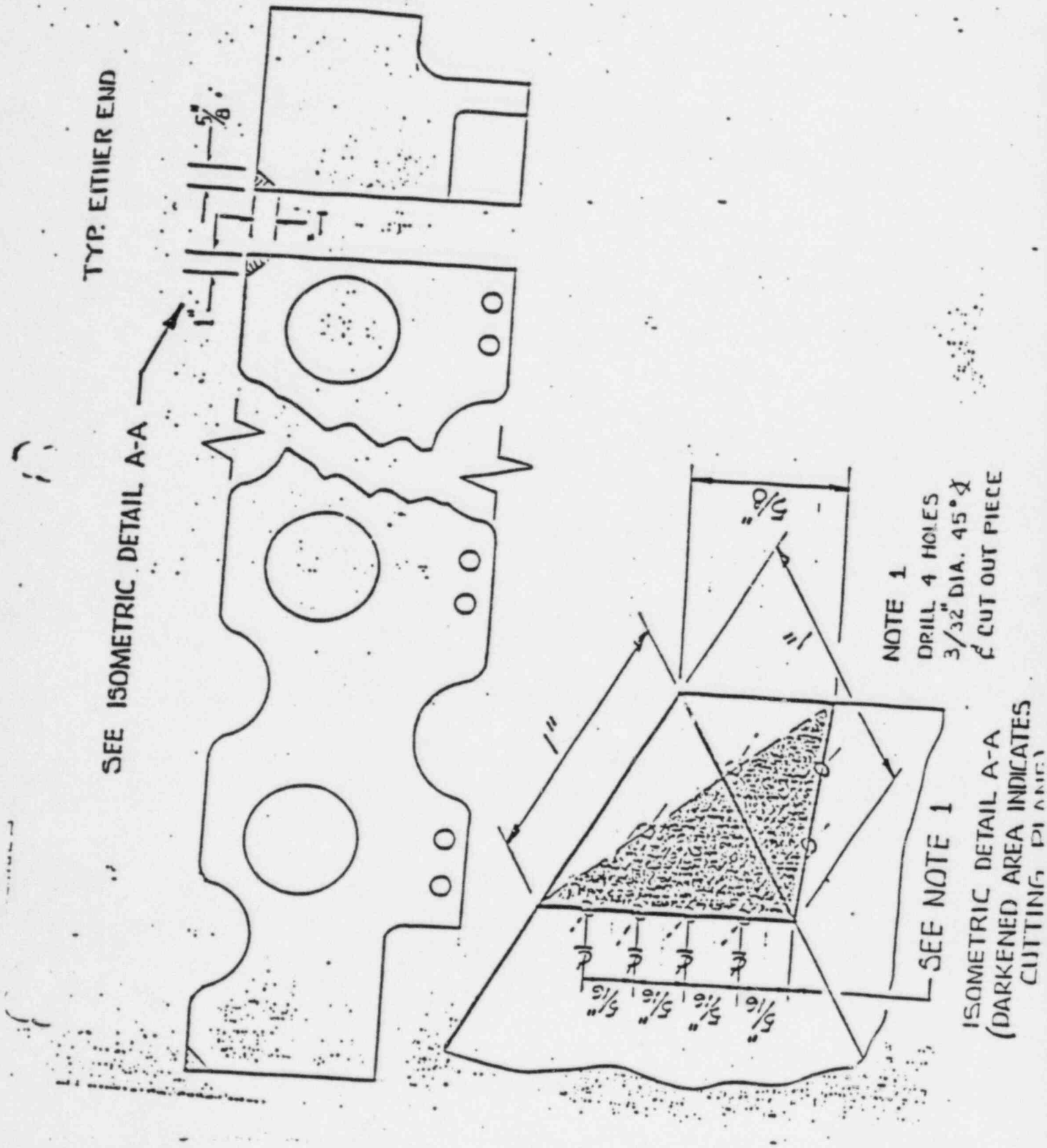
B) Reference Standard ASTM E125

C) Evaluation of indications
   1. Relevant indications are:
      a) Hot tears and cracks, linear indications that exceed ASTM E125 Class I-2
      b) Shrink that exceeds ASTM E125 Class II-3
      c) Inclusions that exceed ASTM E125 Class III-3
      d) Porosity that exceeds ASTM E125 Class V-1
   2. All indications exceeding the specification listed above shall be documented and submitted to the Design Group.
   3. Indications that do not exceed the ASTM E125 reference regardless of size and quantity are acceptable.

D) Non Relevant Indication
   1. The indications referenced below shall be considered non relevant.
      a) Magnetic writing
      b) Linear grain boundaries (carbon, ferrite, or graphite induced)
      c) Rounded grain boundaries (carbon, ferrite, or graphite induced)

Attachment B

COMPONENT QUALITY REVALIDATION CHECKLIST



TDI OWNERS GROUP

for

PERRY NUCLEAR POWER PLANT - UNIT 1

STARTING AIR MANIFOLD - SUPPORTS
(SMALL BORE SCOPE ONLY)
COMPONENT PART NO. 02-441C

I INTRODUCTION

The TDI Emergency Diesel Generator Owners Group Program for the Perry Nuclear Power Plant requires Design and Quality Revalidation reviews of the structural adequacy of the starting air manifold tubing supports to withstand the effects of normal operating and earthquake loadings. The primary function of these supports is to provide adequate restraint to the starting air manifold tubing components.

II OBJECTIVE

The objective of this review was to perform an engineering evaluation of the tubing supports to assure that the component will perform its intended design function during normal operating and earthquake loadings.

III METHODOLOGY

In order to meet the stated objective, the following methods were used:

- The TDI Emergency Diesel Generator Component Tracking System was reviewed for the Perry site, nuclear, and non-nuclear industry experience. See Appendix C for results.
- The Quality Revalidation Checklist results were reviewed for acceptability.
- Engines 1A and 1B, both partially disassembled, were evaluated using actual walkdown information and by comparison with the Comanche Peak lead engine report.

Refer to the review procedures as described in Reference 1 for a detailed methodology for this evaluation.

IV RESULTS AND CONCLUSIONS

The tubing supports, as defined by this component design review have been evaluated in accordance with Reference 1 and have been found acceptable with modifications.

There are no TERs associated with this component.

The Quality Revalidation Inspection results identified in Appendix B have been reviewed and considered in the performance of this design review, and the results are consistent with the final conclusions of this report.

Based on the above review, and information contained in Reference 2, it is concluded that the tubing supports will perform their intended design function at Perry under all normal operating and earthquake loadings with the provision that the following recommended modifications be implemented as detailed in Refenence 3.

Engines 1A and 1B

Line-Distributors to Start Valves in Cylinder Heads

The ½-inch tubing from the distributors to the cylinder heads is only partially installed because of the dissassembled state of the engines. Upon installation of the air start distributors, the existing tube supports should be reinstalled. Tubing spacers should be modified by the addition of cover plates and secured to the engine blocks.

In order to support the tubing of component 02-441A it is recommended that the following supports be added:

Engines 1A and 1B

Line-Manifold to Governor Oil Booster Servo

A two-directional restraint should be added on the 3/8-inch tubing located in the riser at the governor base plate elevation, typical on both engines.

Line-Air Supply from Manifolds to Filters to Air Start Distributors

A two-directional restraint should be added on the 3/4-inch tubing at approximately mid-span between the air supply manifold and the air filter inlet, typical on left bank and right bank on both engines.

The body of each filter should be secured with a U-bolt to prevent torsion on fittings during a seismic event.

Air start distributors and the 3/4-inch tubing from the filters to the distributors were not installed during the field walkdown. Intermediate seismic restraints should be added if the linear length of tubing exceeds 4 feet - 9 inches.

Line-Distributors to Start Valves in Cylinder Heads

Two-directional restraints should be added as required to ensure 3 feet - 6 inch maximum span lengths are not exceeded.

Engine 1B

Air Purge Lines

A two-directional restraint in the ¼-inch tubing from the air start manifolds to the combustion air headers should be added at approximately mid-span to meet 3 feet - 6 inch maximum span length requirements, typical on both sides of the engine.

Engine 1A

Air Purge Lines

The ¼-inch tubing from the air start manifold to the combustion air headers was not installed during the field walkdown. Installation of this tubing should be similar to Engine 1B, including modifications.

V REFERENCES

1. "Engineering Review Criteria Document for the Design Review of TDI Diesel Small Bore Piping, Tubing, and Supports for the TDI Owners Group," Report No. 11600.60-DC-02 Revision 0.

2. Stone & Webster Calculation number 11600.60-NP(B)-0301-XH.

3. Memo No. 6548 from C. Malovrh/SWEC to J. Kammeyer/SWEC dated 11/29/84.

APPENDIX A

COMPONENT DESIGN REVIEW CHECKLIST
PERRY NUCLEAR POWER PLANT - UNIT I

COMPONENT Starting Air Manifold - Tubing Supports (Small Bore Scope Only)

UTILITY Cleveland Electric Illuminating Compa

GROUP PARTS LIST NO. 02-441C

TASK DESCRIPTION NO.: DR-03-02-441C-0

SNPS GPL NO. 03-441C

CLASSIFICATION TYPE A

TASK DESCRIPTIONS

Perform an engineering review of the tubing supports to provide additional assurances that the component will perform its intended design function during normal operating and earthquake loading.

PRIMARY FUNCTION

Provide adequate restraint to the starting air manifold tubing components.

ATTRIBUTES TO BE VERIFIED

Structural adequacy of the tubing supports due to the effects of normal operating and earthquake loadings.

SPECIFIED STANDARDS

IEEE 387

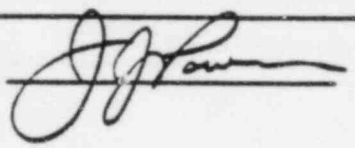
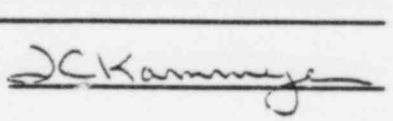
REFERENCES

"Engineering Review Criteria Document for the Design Review of TDI Diesel Small Bore Piping, Tubing, and Supports for the TDI Owners' Group" Report No. 11600.60-DC-02, Revision 0.

COMPONENT DESIGN REVIEW CHECKLIST

DOCUMENTATION REQUIRED

Delaval design documentation (specifications, calculations, drawings, etc.). In lieu of information from Delaval, the following information is required: verified support sketches and piping isometrics, material specifications, pipe size and schedule, and operating parameters (pressure, temperature, load combinations).

GROUP CHAIRPERSON  PROGRAM MANAGER 

Appendix B

COMPONENT QUALITY REVALIDATION CHECKLIST

COMPONENT Starting Air Manifold: Supports

UTILITY Cleveland Electric Illuminating Co. Perry Nuclear Power Plant - Unit 1

GPL NO. 02-441C

REV. NO. 2

SNPS GPL NO. 03-441C

TASK DESCRIPTIONS

Engine 1A

1. Assemble and review existing documentation.
2. Obtain sufficient data to support the design review effort. This may be accomplished by developing quality verified as-builts in accordance with Procedure DG-7, or by the Design Group performing a field walkdown.

Engine 1B

Same as Engine 1A

ATTRIBUTES TO BE VERIFIED

Engine 1A

1. Quality status of Component Document Package
2. Information necessary for the design review effort.

Engine 1B

Same as Engine 1A

COMPONENT QUALITY REVALIDATION CHECKLIST

ACCEPTANCE CRITERIA

Engine 1A

1. Satisfactory Document Package
2. Review of detailed information by the Design Group

Engine 1B

Same as Engine 1A

REFERENCES

Engine 1A

1. QCI No. 52
2. Procedure DG-7

Engine 1B

Same as Engine 1A

DOCUMENTATION REQUIRED

Engine 1A

1. Document Summary Sheet
2. Quality verified as-built isometric drawings for the supports if available from the Owner.

Engine 1B

Same as Engine 1A

GROUP CHAIRPERSON _____ PROGRAM MANAGER _____

COMPONENT QUALITY REVALIDATION CHECKLIST

COMPONENT REVIEW

Engine 1A

1. No EDGCTS site experience documents are in evidence.

2. The Design Group will be responsible for closing out the as-built drawings as per Procedure DG-7. The as-built drawings will be Quality verified by the appropriate site Quality organization. The performance of an engineering walkdown by the Design Group, precludes the issuance of a quality verified as-built drawing or sketch.

Engine 1B

Same as Engine 1A

RESULTS AND CONCLUSION

Engine 1A

The Quality Revalidation effort with respect to this component, as outlined above, is complete. The results have been forwarded to the Design Review Group for their evaluation and conclusions in support of the final report.

Engine 1B

Same as Engine 1A

GROUP CHAIRPERSON Nita A Saleta PROGRAM MANAGER K Kammeyer

COMPONENT DESIGN REVIEW CHECKLIST
PERRY NUCLEAR POWER PLANT - UNIT 1

COMPONENT Connecting Rod: Bearing Shells UTILITY Cleveland Electric Illuminating Co.

GROUP PARTS LIST NO. 02-340B TASK DESCRIPTION NO. DR-03-02-340B-0

SNPS GPL NO. 03-340B CLASSIFICATION TYPE A

TASK DESCRIPTIONS

Design review for this component is not required based on the following:

- A review of the Comanche Peak and Shoreham DR/QR reports, which establish the acceptability of the bearing shells for their intended purpose.
- The applicable engine dimensions and operating parameters at Perry are identical or very similar to those for the same component at Comanche Peak (Lead Engine).
- A review of the EDG Component Tracking System indicated that there was no site experience and no significant applicable nuclear or non-nuclear industry experience.

Maintenance recommendations based on the Comanche Peak DR/QR report to ensure proper performance under normal operating conditions are as follows:

- Inspect and measure connecting rod bearing shells to verify lube oil maintenance, which affects wear rate. The visual and dimensional inspection of the bearing shells should be conducted at the fuel outage that precedes 500 hours of operation by at least the sum of hours of operation in a LOOP/LOCA event plus the expected hours of operation between outages.
- Perform an X-ray examination on all bearing shells using a procedure with sufficient resolution to implement recommendations for acceptance criteria developed by Owners Group connecting rod bearing shells Phase I Report.

COMPONENT DESIGN REVIEW CHECKLIST

There are no modification recommendations for this component.

The following Quality Revalidation inspection recommendations are made to ensure proper component quality and performance, and should be performed on both diesel engines:

- Perform a visual inspection of the connecting rod bearing shells.
- Perform a liquid penetrant test of the connecting rod bearing shells.
- Perform a dimensional check of the connecting rod bearing shells.
- Perform a radiographic inspection of the connecting rod bearing shells.
- Perform an eddy current test as required to identify surface discontinuities.

PRIMARY FUNCTION

Not required

ATTRIBUTE TO BE VERIFIED

Not required

SPECIFIED STANDARDS

Not required

REFERENCES

Not required

DOCUMENTATION REQUIRED

Not required

GROUP CHAIRPERSON _____ PROGRAM MANAGER JC Kammeyer

TDI OWNERS GROUP

for

COMANCHE PEAK STEAM ELECTRIC STATION - UNIT 1

CONNECTING ROD BEARING SHELLS
COMPONENT PART NO. 02-3408

I INTRODUCTION

The TDI Emergency Diesel Generator Owners Group Program for the Comanche Peak Steam Electric Station requires Design and Quality Revalidation reviews of connecting rod bearing shells to determine the adequacy of their design for the intended use at Comanche Peak. The primary function of the connecting rod bearing shells is to provide a low friction sliding interface between the connecting rod and the crankpin through the formation of a hydrodynamic oil film. This interface transmits the cylinder firing pressure to the crankshaft, converting the force into torque.

The connecting rod bearing shells are manufactured by TDI from permanent mold aluminum alloy 852-T5 castings purchased from ALCOA (Ref. 1). The TDI part number for the components used at Comanche Peak is 02-340-04-AG.

II OBJECTIVE

The objective of this review was to evaluate the adequacy of the connecting rod bearing shells for their intended service at the Comanche Peak Steam Electric Station. Specifically, the following tasks were performed:

- Journal orbit analysis to determine the pressure distribution in the hydrodynamic oil film.
- Finite element analysis to determine the stress distribution in the connecting rod bearing shells.
- Fracture mechanics analysis to determine the resistance to fatigue cracking.
- Computation of acceptance criteria for radiographic NDE of connecting rod bearing shells.
- Evaluation of material selection and dimensional accuracy.
- A review of maintenance procedures.

- A review of Comanche Peak site, nuclear, and non-nuclear experience.
- A review of the Quality Revalidation Checklist results for acceptability.

III METHODOLOGY

As described in Reference 1, the design review of connecting rod bearing shells consisted of several steps. First, laboratory investigations of wear patterns, chemical, metallurgical and physical properties were conducted. A journal orbit analysis, using dimensions, weights, and weight distributions for DSRV-16-4 engines, as well as engine operation parameters, was performed. The output of the journal orbit analysis, which is the pressure distribution in the oil film under conditions of ideal geometry, was modified based on observed babbit contact patterns to provide input data to the finite element analysis using the ANSYS code. The stress distribution computed by the finite element analysis was used to calculate the fatigue life of the connecting rod bearing shells based on nuclear site experience. The stress distribution was also used to calculate the maximum discontinuity that could be present without decreasing the fatigue resistance.

The material selection was evaluated with respect to friction coefficient, and resistance to corrosion, fatigue and wear. Dimensional accuracy was evaluated from TER inspection results.

Details of the methodology and analysis are contained in Reference 1.

The applicability of the analysis to Comanche Peak was determined.

The TDI Emergency Diesel Generator Component Tracking System was reviewed for the Comanche Peak, nuclear, and non-nuclear industry experience.

IV RESULTS AND CONCLUSIONS

Calculation of the maximum tensile stress in the connecting rod bearing shells in DSRV-16-4 engines, in combination with other nuclear experience, was used to predict a fatigue life of about 38,000 hours for the DSRV-16-4 bearing shells (Ref. 1 and 3). This fatigue life, which safely exceeds the expected usage of the engines during the operational life of the station, can be assured if an approved radiographic procedure such as Failure Analysis Associates' "Radiographic Examination of Diesel Engine Upper and Lower Bearing Shells," (Ref. 2) is followed.

Design and operating parameters for the Comanche Peak DSRV-16-4 engines (Ref. 4) were compared to the generic analysis of Ref. 1. Those parameters were found to be within 5 percent of the generic case, confirming the applicability of the generic analysis to Comanche Peak.

The material selection was appropriate based on professional judgment and experience with similar bearings. Dimensional accuracy was verified as summarized in Appendix B.

The wear resistance of the connecting rod bearings has been proven adequate in nuclear experience, provided all TDI recommended lubricating oil maintenance procedures (Ref. 4) are followed.

The connecting rod bearing shells should be inspected visually and dimensionally to verify lubrication maintenance which affects wear rate. The visual and dimensional inspection of the bearing shells should be conducted at the fuel outage which precedes 500 hours of operation by at least the sum of expected hours of operation in a LOOP/LOCA event plus the expected hours of operation between outages.

The information provided on the following TERs has been reviewed and is consistent with the final conclusions of this report: 10-079, 10-008, 10-026.

Quality Revalidation Inspection results identified in Appendix B have been reviewed and considered in the performance of this design review and the results are consistent with the final conclusions of this report.

Based on the above review and assuming implementation of the radiographic acceptance criteria, it is concluded that the connecting rod bearing shells are acceptable for their intended use at Comanche Peak Steam Electric Station.

V REFERENCES

1. Failure Analysis Associates, "Design Review of Connecting Rod Bearing Shells for Transamerica Delaval Enterprise Engines," FaAA-84-3-1, Palo Alto, California, March 12, 1984.

2. Failure Analysis Associates, "Radiographic Examination of Diesel Engine Upper and Lower Bearing Shells," NDE 9.3, Palo Alto, California, February 6, 1984.

3. FaAA Support Package No. SP-84-3-1(b).

4. TDI Instruction Manual for Comanche Peak DSRV-16-4 Diesel Generators.

Appendix A

COMPONENT DESIGN REVIEW CHECKLIST
TEXAS UTILITIES

COMPONENT Connecting Rod Bearing Shells CLASSIFICATION TYPE A

COMPONENT PART NUMBER 02-340B TASK DESCRIPTION NO.: DR-10-02-340B-1
(SNPS PART NUMBER 03-340B)

TASK DESCRIPTIONS:

Compare and evaluate differences in design and operating conditions which are site specific.

Review NDE and other inspection results.

Review information provided on TERs.

PRIMARY FUNCTION:

Provides hydrodynamic oil film sliding surface and load transmission between connecting rod and crankpin.

ATTRIBUTES TO BE VERIFIED:

Corrosion, fatigue, and wear resistance.

Coefficient of friction, dimensional accuracy, operation parameters.

SPECIFIED STANDARDS:

None.

Appendix A

REFERENCES:

None.

DOCUMENTATION REQUIRED:

Manufacturer's drawings, cylinder firing pressure, lubrication specifications, and reciprocating weights.

GROUP CHAIRPERSON: _____ PROGRAM MANAGER: _____ for JCK

COMPONENT QUALITY REVALIDATION CHECKLIST

COMPONENT Connecting Rod Bearing Shells

UTIILITY Texas Utilities Generating Co., Comanche Peak Station

GPL NO. 02-3408

REV. NO. 2

SNPS GPL NO. 03-3408

TASK DESCRIPTIONS

D.G. CP1-MEDGEE-01

1. Assemble and review existing documentation.
2. Perform a visual inspection of the connecting rod bearing shells.
3. Perform a Liquid Penetrant test on the connecting rod bearing shells.
4. Perform a dimensional check of the connecting rod bearing shells.
5. Perform a Radiographic inspection of the connecting rod bearing shells.
6. Perform an Eddy Current test as required to identify surface discontinuities.

D.G. CP1-MEDGEE-02

Same as D.G. CP1-MEDGEE-01

ATTRIBUTES TO BE VERIFIED

D.G. CP1-MEDGEE-01

1. Quality status of Component Document Package

2-3. Surface integrity of bearing shells

4. Proper bearing shell dimensions

5-6. Integrity of the bearing shells

COMPONENT QUALITY REVALIDATION CHECKLIST

ATTRIBUTES TO BE VERIFIED (continued)

D.G. CP1-MEDGEE-02

Same as D.G. CP1-MEDGEE-01

ACCEPTANCE CRITERIA

D.G. CP1-MEDGEE-01

1. Satisfactory Document Package

2-3. Review of inspection report by Design Group

4. Dimensions are in accordance with the TDI Instruction Manual

5-6. Review of inspection report by Design Group

D.G. CP1-MEDGEE-02

Same as D.G. CP1-MEDGEE-01

REFERENCES

D.G. CP1-MEDGEE-01

1. QCI-FSI-F11.1-020

2-3. Approved Site NDE Procedures

4. TDI Instruction Manual or applicable drawing

5. Approved Site NDE procedure

6. FaAA NDE Procedure 9.2

D.G. CP1-MEDGEE-02

Same as D.G. CP1-MEDGEE-01

DOCUMENTATION REQUIRED

D.G. CP1-MEDGEE-01

1. Document Summary Sheet

COMPONENT QUALITY REVALIDATION CHECKLIST

DOCUMENTATION REVIEWED (continued)

D.G. CP1-MEDGEE 01 (continued)

2-6. Inspection Report

D.G. CP1-MEDGEE-02

Same as D.G. CP1-MEDGEE-01

GROUP CHAIRPERSON _____ PROGRAM MANAGER _____

COMPONENT REVIEW

D.G. CP1-MEDGEE-01

1. All EDGCTS site experience documents were assembled and reviewed with unsatisfactory results. NCR 80-00220 remains open.

2. A visual inspection was performed with unsatisfactory results. This was reported by TER# 10-008 and dispositioned by NCR 84-0076.

3. A Liquid Penetrant test was performed with unsatisfactory results. This was reported by TER# 10-026 and dispositioned by NCR 84-0076.

4. A dimensional check was performed with results reported by TERs# 10-026 and 10-008.

5. A Radiographic test was performed with unsatisfactory results. This was reported by TER# 10-026.

6. An Eddy Current test was performed on selected bearings with satisfactory results as reported by TER# 10-026.

D.G. CP1-MEDGEE-02

1. All EDGCTS site experience documents were assembled and reviewed with unsatisfactory results. NCR 80-00220 remains open.

2. A visual inspection was performed with unsatisfactory results. Subsequently, the bearing shells with indications were replaced due to the Radiographic test results. This was reported by TER# 10-079.

3. A Liquid Penetrant test was performed. Unsatisfactory bearing shells were replaced because of the Radiographic test results. This was reported by TER# 10-079.

4. A dimensional check was performed with satisfactory results. This was reported by TER# 10-079.

COMPONENT QUALITY REVALIDATION CHECKLIST

COMPONENT REVIEW (continued)

D.G. CP1-MEDGEE-02 (continued)

5. A Radiographic test was performed with unsatisfactory results. Bearing shells with indications were replaced with new bearing shells. This was reported by TER# 10-079.

6. An Eddy Current test was not required. This was reported by TER# 10-079.

RESULTS AND CONCLUSION

D.G. CP1-MEDGEE-01

The Quality Revalidation effort with respect to this component, as outlined above, is complete. The results have been forwarded to the Design Review Group for their evaluation and conclusions in support of the final report.

D.G. CP1-MEDGEE-02

Same as D.G. CP1-MEDGEE-01

GROUP CHAIRPERSON Nuita A. Salata PROGRAM MANAGER X Kammeyer

TDI OWNERS GROUP

for

SHOREHAM NUCLEAR POWER STATION - UNIT 1

CONNECTING ROD BEARING SHELLS
COMPONENT PART NO. 03-340-B

I INTRODUCTION

The TDI Emergency Diesel Generator Owners Group Program for the Shoreham Nuclear Power Station requires Design and Quality Revalidation reviews of the connecting rod bearing shells to determine the adequacy of its design for the intended use at Shoreham. The primary function of the connecting rod bearing shells is to provide a low-friction sliding interface between the connecting rod and the crankpin, through the formation of a hydrodynamic oil film, which transmits the cylinder firing pressure to the crankshaft, converting the force into torque.

The connecting rod bearing shells are manufactured by TDI from permanent mold aluminum alloy B-852-T5 castings purchased from ALCOA (Ref. 1). The TDI part number for the components used at the Shoreham Nuclear Power Station is 03-340-05-AE.

II OBJECTIVES

The objective of this review was to evaluate the adequacy of the connecting rod bearing shells for their intended service at the Shoreham Nuclear Power Station. Specifically, the objective was to perform the following analyses:

- Journal orbit analysis to determine the pressure distribution in the hydrodynamic oil film.
- Finite element analysis to determine the stress distribution in the connecting rod bearing shells.
- Fracture mechanics analysis to determine the resistance to fatigue cracking.
- Computation of acceptance criteria for radiographic NDE of connecting rod bearing shells.
- Evaluation of babbitt adhesion.
- A review of maintenance procedures.
- A review of nuclear, non-nuclear and Shoreham site experience.

III METHODOLOGY

As described in Reference 1 Report on connecting rod bearing shells, the analysis consisted of several steps. First, laboratory investigation of wear patterns, chemical, metallurgical and physical properties, and fracture surface morphology were conducted. Journal orbit analysis, using dimensions, weights and weight distributions confirmed by direct measurement at Shoreham, as well as engine operating parameters from the Shoreham engines, was performed. The output of the journal orbit analysis, which is the pressure distribution in the oil film under conditions of ideal geometry, was modified based on observed babbitt contact patterns to provide the input data to finite element analysis using the ANSYS code. The stress distribution computed by the finite element analysis was used to calculate the fatigue life of the connecting rod bearing shells based on the Shoreham experience with the bearing shells, and to calculate the maximum discontinuity that could be present without decreasing the fatigue resistance.

The influence of babbitt adhesion was assessed by inspection of bearing shells with marginal babbit adhesion after significant exposure to operating conditions in the Shoreham diesel engines.

Details of the methodology and analysis are contained in the Reference 1 Reports.

IV RESULTS AND CONCLUSIONS:

Comparison of the maximum tensile stress in the original and the current connecting rod bearing shells at Shoreham shows that the stress is reduced by 50 percent in the replacement bearing shells (Ref. 1). This result was used to predict a fatigue life of about 38,000 hours for the current bearing shells. This fatigue life, which safely exceeds the expected usage of the engines during the 40-year operational life of the plant (Ref. 1), can be assured if an approved radiographic procedure such as Failure Analysis Associates "Nondestructive Examination of Diesel Engine Upper and Lower Bearing Shells" (Ref. 2) followed. This procedure has been reviewed and approved by LILCO, and is followed at Shoreham. The recommendation is implemented in E&DCR F-46505 (Ref. 4).

Babbitt adhesion was found to be adequate for successful functioning of the connecting rod bearing shells at Shoreham. The normal inspection intervals are adequate to monitor performance of the babbitt overlay.

Quality Revalidation Inspection results identified in Appendix B have been reviewed and considered in the performance of this design review and the results are consistent with the final conclusions of this report.

Based on the above review and implementation of the radiographic acceptance criteria, it is concluded that the connecting rod bearing shell is acceptable for its intended design function at Shoreham.

V REFERENCES

1. Failure Analysis Associates, "Design Review of Connecting Rod Bearing Shells for Transamerica Delaval Enterprise Engines", FaAA-84-3-1, Palo Alto, California, March 12, 1984.

2. Failure Analysis Associates, "Radiographic Examination of Diesel Engine Upper and Lower Bearing Shells", NDE 9.2, Palo Alto, California, February 6, 1984.

3. FaAA Support Package No. SP-84-3-1.

4. E&DCR F-46505

APPENDIX A

COMPONENT DESIGN REVIEW CHECKLIST

COMPONENT Connecting Rod Bearing Shells CLASSIFICATION A

PART NUMBER 03-340-B

TASK DESCRIPTION:

Obtain and review pressure vs crank angle data. Perform journal orbit analysis, finite element analysis, and fracture mechanics life estimate. Determine maximum void size in castings. Examine GGNS bearing shells. Evaluate babbit adhesion and thickness variation effects. Evaluate maintenance procedures.

Review information provided on TERs: Q-42, Q-47, Q-69, Q-182, Q-216, Q-221, Q-303, Q-312, Q-332, Q-334, Q-359, Q-372, Q-436, Q-447, Q-485, DR-34, DR-110, DR-248, Q-505.

PRIMARY FUNCTION:

Provides hydrodynamic oil film sliding surface and load transmission between connecting rod and crankpin.

ATTRIBUTE TO BE VERIFIED:

Corrosion, fatigue, and wear resistance. Coefficient of friction, dimensional accuracy, operation parameters.

SPECIFIED STANDARDS:

None

REFERENCES:

Seismic Qualification Review, TDI Emergency Diesel Generators at Shoreham Nuclear Power Station, "Stone & Webster Engineering Corp., Shoreham Project Job Book No. 244.7.

DOCUMENTATION REQUIRED:

Manufacturer's drawings, cylinder firing pressure, lubrication specifications and reciprocating weights.

GROUP CHAIRPERSON for E.W. Rogers PROGRAM MANAGER for JCK

COMPONENT REVIEW:

Journal orbit analysis to determine the pressure distribution in the hydrodynamic oil film.
Finite element analysis to determine the stress distribution in the connecting rod bearing shell.
Fracture mechanics analysis to determine the resistance to fatigue cracking.
Computation of acceptance criteria for radiographic NDE of connecting rod bearing shells.
Evaluation of babbitt adhesion.
A review of maintenance procedures.
A review of nuclear, non-nuclear and Shoreham site experience.

RESULTS AND CONCLUSIONS:

Based on the above review and implementation of the radiographic acceptance criteria, it is concluded that the connecting rod bearing shells are acceptable for their intended design function at Shoreham.

Seismic qualification for the connecting rod bearing shells is addressed in "Seismic Qualification Review, TDI Emergency Diesel Generators at Shoreham Nuclear Power Station, "Stone & Webster Engineering Corp., Shoreham Project Job Book No. 244.7.

GROUP CHAIRPERSON for E.E. Rogers PROGRAM MANAGER for JCK

Appendix B

COMPONENT REVALIDATION CHECKLIST

COMPONENT Connecting Rod Bearing Shells DOCUMENT NO. QR-03-340B

PART NO. 03-340B INCORPORATES DOC. NOS. QR-1,Rev.1,QR-2,QR-3

TASK DESCRIPTIONS

ENGINE 101

1. Assemble and review existing documentation.
2. Perform a Radiographic Test on the connecting rods 1 through 8.
3. Perform a Liquid Penetrant Test on all the connecting rod bearing shell surfaces for all 8 cylinders. (Thoroughly clean with solvent only the bearing shell O.D. Do not use any form of abrasive cleaner.)
4. Perform a visual inspection of the connecting rod bearing on the upper shell of cylinder 8.

ENGINE 102

1. Assemble and review existing documentation.
2. Perform a Radiographic Test on the connecting rods 1 through 8.
3. Perform Liquid Penetrant Test on all the connecting rod bearing shell surfaces for cylinders 5, 7 and 8. (Thoroughly clean with solvent only the bearing shell O.D. Do not use any form of abrasive cleaner.)

ENGINE 103

1. Assemble and review existing documentation.
2. Perform a Radiographic Test on the connecting rods 1 through 8.
3. Perform a Liquid Penetrant Test on all the connecting rod bearing shell surfaces for all 8 cylinders. (Thoroughly cleaning with solvent only the bearing shell O.D. Do not use any form of abrasive cleaner.)

SPARES

1. Perform a material analysis of the connecting rod bearing shells.

ATTRIBUTES TO BE VERIFIED

ENGINE 101

1. Quality status of Component Document Package
2. Internal discontinuities are within engineering guidelines for the connecting rod bearing shells.
3. Surface integrity of the connecting rod bearing shells
4. Surface integrity of the cylinder 8 on the upper connecting rod bearing shell

ENGINE 102

1. Quality status of Component Document Package
2. Internal discontinuities are within engineering guidelines for the connecting rod bearing shells.
3. Surface integrity of the connecting rod bearing shells

ATTRIBUTES TO BE VERIFIED (continued)

ENGINE 103

1. Quality status of Component Document Package
2. Internal discontinuities are within engineering guide lines for connecting rod bearing shells.
3. Surface integrity of connecting rod bearing shells

SPARES

1. Material of the connecting rod bearing shells

ACCEPTANCE CRITERIA

ENGINE 101

1. Satisfactory Document Package
2-4. Review of Inspection Report by Design Group

ENGINE 102

1. Satisfactory Document Package
2-3. Review of Inspection Report by Design Group

ENGINE 103

1. Satisfactory Document Package
2-3. Review of Inspection Report by Design Group

SPARES

1. Review of Inspection Report by Design Group

REFERENCES

ENGINE 101

1. QCI-FSI-F11.1-020
2. SH1-089, applicable Site/Vendor Documents, FaAA Bearing Report, Alcoa Design Manual, TERs DR-110, Q-91
3. TERs Q-216, DR-34, Q-91, LILCO Approved Inspection Procedures
4. TER DR-248, LILCO Approved Inspection Procedures

ENGINE 102

1. QCI-FSI-F11.1-020
2. TER DR-110, SH1-089, applicable Site/Vendor Documents, FaAA Bearing Report, Alcoa Design Manual
3. LILCO Approved Inspection Procedures

COMPONENT REVALIDATION CHECKLIST

REFERENCES (continued)

ENGINE 103

1. QCI-FSI-F11.1-020
2. TERs DR-110, Q-91, SH1-089, applicable Site/Vendor Documents, FaAA Bearing Report, Alcoa Design Manual
3. TER Q-91, LILCO Approved Inspection Procedures

SPARES

1. TER Q-485

DOCUMENTATION REQUIRED

ENGINE 101

1. Document Summary Sheet
2-4. Inspection Report

ENGINE 102

1. Document Summary Sheet
2-3. Inspection Report

ENGINE 103

1. Document Summary Sheet
2-3. Inspection Report

SPARES

1. Inspection Report

GROUP CHAIRPERSON _____ PROGRAM MANAGER _____

COMPONENT REVIEW

ENGINE 101

1. All preassembly EDGCTS Shoreham experience documents were assembled and reviewed with satisfactory results.
2. All sixteen bearing shells were subject to Radiographic Examination, five findings were reported by TER Q-372. This was dispositioned by LDR 2291 and remains open.

COMPONENT REVIEW (continued)

ENGINE 101 (continued)

3. Liquid Penetrant Examination was performed on fifteen of sixteen shells. The upper shell for cylinder 8 was rejectable upon visual examination as reported by TER Q-312. The other fifteen evidenced indications as reported by TER Q-332 and dispositioned by LDR 2278. The Eddy Current Examination showed that indications were cosmetic in nature and acceptable for use. LDR 2265 was generated to disposition the failed cylinder 8 shell (Q-312) which was replaced. The failed shell was forwarded to the Design Group for further analysis.
4. Visual inspection of cylinder 8 upper shell reported by Q-312 as noted above.

ENGINE 102

1. All preassembly EDGCTS Shoreham experience documents were assembled and reviewed with satisfactory results with the exception of LDR 2119 which remains open.
2. All sixteen bearing shells were subject to Radiographic Examination. Thirteen were accepted and three were rejected. All results were reported by TER Q-64. LDR 2119, generated for Liquid Penetrant indications recommends replacement of these three shells. Rejected shells were forwarded to Design Group for further analysis.
3. Liquid Penetrant Examination was performed on the six referenced shells with three displaying indications. These results were dispositioned by LDR 2119.

ENGINE 103

1. All preassembly EDGCTS Shoreham experience documents were assembled and reviewed with satisfactory results.
2. All sixteen bearing shells were subject to Radiographic Examination. Seven shells evidenced findings as reported by TER Q-182 with disposition recorded by LDR 2210. LDR 2210 remains open.
3. Liquid Penetrant Examination was performed on all sixteen shells with satisfactory results on all surfaces of all shells.

SPARES

1. Material analysis was performed on connecting rod bearing shells as reported by TER Q-505.

RESULTS AND CONCLUSIONS

ENGINE 101

The Quality Revalidation effort with respect to this component, as outlined above, is complete. The results have been forwarded to the Design Review Group for their evaluation and conclusions in support of the final report.

COMPONENT REVALIDATION CHECKLIST

RESULTS AND CONCLUSIONS (continued)

ENGINE 102

Same as Engine 101

ENGINE 103

Same as Engine 101

SPARES

Same as Engine 101

GROUP CHAIRPERSON Rudolph Cheung PROGRAM MANAGER JC Kammeyer

COMPONENT DESIGN REVIEW CHECKLIST
PERRY NUCLEAR POWER PLANT - UNIT 1

COMPONENT Rocker Shaft Assemblies: Intake/Intermediate & Exhaust

UTILITY Cleveland Electric Illuminating Co.

GROUP PARTS LIST NO. 02-390A&B

TASK DESCRIPTION NO. DR-03-02-390A&B-0

SNPS GPL NO. 03-390A&B

CLASSIFICATION TYPE B

TASK DESCRIPTIONS

Design review for this component is not required based on the following:

- A review of the Comanche Peak and Shoreham DR/QR reports, which establish the acceptability of the rocker shaft assemblies for their intended purpose.
- A review of nuclear and non-nuclear industry experience listed in the EDG Component Tracking System indicated there had been no design related failures associated with this component. There is no site experience listed in the Component Tracking System.

There are no maintenance or modification recommendations for this component.

The following Quality Revalidation inspection recommendations are made to ensure proper component quality and performance:

- Perform a visual inspection (both engines) of the intake, intermediate and exhaust rocker arm assemblies for signs of distress, linear indications and chipped pieces in the swivel pads and outer lips of the pushrod cups. The lips should be flush in the assembly.
- Perform a material comparator test on one intake/intermediate rocker arm shaft and one exhaust rocker arm shaft (one engine only).

PRIMARY FUNCTION

Not required

COMPONENT DESIGN REVIEW CHECKLIST

ATTRIBUTE TO BE VERIFIED

Not required

SPECIFIED STANDARDS

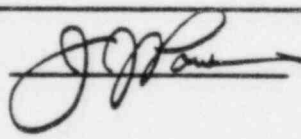
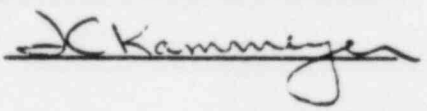
Not required

REFERENCES

Not required

DOCUMENTATION REQUIRED

Not required

GROUP CHAIRPERSON  PROGRAM MANAGER 

TDI OWNERS GROUP

for

COMANCHE PEAK STEAM ELECTRIC STATION - UNIT 1

INTAKE/INTERMEDIATE AND EXHAUST ROCKER SHAFT ASSEMBLIES
COMPONENT PART NOs. 02-390A and 02-390B

I INTRODUCTION

The TDI Emergency Diesel Generator Owners Group Program for the Comanche Peak Steam Electric Station requires a Design and Quality Revalidation review to determine the adequacy of the intake/intermediate and exhaust rocker shaft assemblies for their intended use at Comanche Peak. The primary function of the intake/intermediate and exhaust rocker shaft assemblies is to translate the motion of the main pushrods into the reciprocating motion of the intake and exhaust valves and connector pushrod. The part numbers for the rocker shafts as assigned by the manufacturer, TDI, are 1A-5532 and 1A-5465.

II OBJECTIVE

The objective is to evaluate the adequacy of the rocker shafts for their intended use at Comanche Peak. Specifically, the following tasks were performed:

- Review of Comanche Peak site, nuclear and non-nuclear industry.
- Evaluation of state of stress in rocker shaft assemblies.
- Evaluation of resistance to bending and fatigue.
- Review of pushrod socket installation.
- Evaluation of load in rocker arm assembly and pushrod sockets.
- Evaluation of rocker shaft supports.
- Review of Quality Revalidation Checklist results for acceptability.

III METHODOLOGY

The Emergency Diesel Generator Component Tracking System records for Comanche Peak were reviewed to determine the nuclear, non-nuclear, and specific Comanche Peak experience of the rocker shaft assemblies.

The calculations for loads and stresses of rocker arms at the Shoreham Nuclear Power Station were used for this analysis. The rocker arms used at Comanche Peak are nearly identical to those used at Shoreham with any differences being judged inconsequential to the results of these calculations (Ref. 1).

A theoretical model was developed to compute the dynamic response of the valve systems, and to estimate the pushrod, rocker arm, and shaft forces. These forces were used to conduct a stress analysis of the rocker shaft assemblies, and to evaluate their resistance to fatigue.

The bearing stresses on the rocker shaft support were calculated in order to verify that resistance to lateral loads on the rocker arms is provided by 1) the friction forces between the rocker support and shaft assemblies, and 2) the rocker shaft and support dowel and not by bearing between the rocker shaft bolt and the support.

IV RESULTS AND CONCLUSIONS

The maximum pushrod and rocker arm forces were computed (Ref. 2). These forces were used to compute the peak shear and bending stresses in the rocker shaft assemblies. The maximum shear stress was found to be 7.9 ksi, and the maximum bending stress was found conservatively to be 24 ksi. These are both below the endurance limit stresses of 19.2 ksi for shear and 30 ksi for bending (Ref. 2).

Conservative stress analysis of the intake, intermediate, and exhaust rocker arms indicate a minimum factor of safety against failure of 1.1 (Ref. 2). The forces acting on the pushrod sockets induce stresses in the sockets (59.2 ksi max, Ref. 2) which are below the allowable of 200 ksi.

The capscrew (P/N 02-390-05-AA) connecting the rocker shaft to the rocker support is torqued to 365 ft-lb (Ref. 2), which develops a tensile preload of 21.9 kips (Ref. 2). This is sufficient to provide frictional resistance to lateral forces on the intake rocker-side of both rocker shaft assemblies. On the other side (intermediate rocker), the support dowel (P/N 03-362-01-08) is engaged by the rocker shaft end, and transfers the shear from the rocker shaft to the sub-base assembly boss. The shear resistance supplied by friction at this end is minimal, due to the uplift forces on the rocker shaft by the main exhaust and intermediate pushrods (Ref. 2), and calculations indicate that these shear stresses exceed the endurance limit stress for the dowel at full engine load (Ref. 2). However, there is no evidence (nuclear or non-nuclear) indicating dowel failures. Specifically, Shoreham experience indicates that approximately 400 hours (Ref. 3 and 4) have been logged on these dowels at full engine load. Recognizing that the pushrod loads and material strengths used in the calculations may be conservative, and that the dowels have been subjected to more than 5×10^6 cycles at full load without failures, it is concluded that the dowels are capable of transferring the shear loads to the sub-base assembly.

The information provided on the following TERs has been reviewed and is consistent with the final conclusions of this report: 10-005, 10-006, 10-097.

Quality Revalidation Inspection results identified in Appendix B have been reviewed and considered in the performance of this review. These results are consistent with the final conclusion of this report.

Based on the above design review, it is concluded that the intake/intermediate and exhaust rocker shaft assemblies are acceptable for their intended design function at Comanche Peak.

V REFERENCES

1. FaAA Report No. 84-6-2(a). "TDI Owners Group for Shoreham Nuclear Power Station - Unit 1--Intake/Intermediate and Exhaust Rocker Shaft Assemblies - Components Nos. 03-390A and 03-390B," 06/29/84.

2. "Rocker Shaft Assembly Support Package," SP-84-6-2(a).

3. "Emergency Diesel Generator Crankshaft Failure Investigation - Shoreham Nuclear Power Station," FaAA report #83-10-2.1.

4. "Evaluation of Emergency Diesel Generator Crankshaft at Shoreham Nuclear Power Station," FaAA report #84-3-16.

Appendix A

COMPONENT DESIGN REVIEW CHECKLIST
TEXAS UTILITIES

COMPONENT Rocker Arms and Pushrods Intake/Intermediate Exhaust Rocker Shaft Assemblies

CLASSIFICATION TYPE B

COMPONENT PART NUMBER 02-390A&B
(SNPS PART NUMBER 03-390A&B)

TASK DESCRIPTION NO: DR-10-02-390A&B-1

TASK DESCRIPTIONS:

Evaluate rocker shaft assembly stresses.

Review pushrod socket installation.

Review information provided on TERs.

PRIMARY FUNCTION:

Actuate intake valves, exhaust valves, and intermediate pushrods.

ATTRIBUTES TO BE VERIFIED:

Review loads, rocker arm assembly and pushrod cups

SPECIFIED STANDARDS:

None.

REFERENCES:

None.

Appendix A

DOCUMENTATION REQUIRED:

Valve and pushrod loading, installation drawings.

GROUP CHAIRPERSON: W. E. Patterson PROGRAM MANAGER: J. C. Kammeyer

Appendix B

COMPONENT QUALITY REVALIDATION CHECKLIST

COMPONENT: Rocker Arms & Pushrods - Intake and Intermediate Rocker Shaft Assembly

UTILITY: Texas Utilities Generating Co., Comanche Peak Station

GPL NO. 02-390A

REV. NO. 2

SNPS GPL NO. 03-390A

TASK DESCRIPTIONS

D.G. CP1-MEDGEE-01

1. Assemble and review existing documentation.
2. Perform a visual inspection of the intake and intermediate rocker arm assembly for signs of distress, linear indications and chipped pieces in the outer lips of the pushrod cups.
3. Determine the material of one rocker arm assembly.

D.G. CP1-MEDGEE-02

1. Assemble and review existing documentation.
2. Perform a visual inspection of the intake and intermediate rocker arm assembly for signs of distress, linear indications, and chipped pieces in the outer lips of the pushrod cups.

ATTRIBUTES TO BE VERIFIED

D.G. CP1-MEDGEE-01

1. Quality status of Component Document Package
2. Surface integrity of the rocker arm assembly
3. Material of rocker arm assembly

D.G. CP1-MEDGEE-02

1. Quality status of Component Document Package
2. Surface integrity of the rocker arm assembly

COMPONENT QUALITY REVALIDATION CHECKLIST

ACCEPTANCE CRITERIA

D.G. CP1-MEDGEE-01

1. Satisfactory Document Package
2. No linear indications/chipped pieces in the outer lips of the pushrod cups
3. Material to be AISI-4142

D.G. CP1-MEDGEE-02

1. Satisfactory Document Package
2. No linear indications/chipped pieces in the outer lips of the pushrod cups.

REFERENCES

D.G. CP1-MEDGEE-01

1. QCI-FSI-F11.1-020

2-3. Approved Site NDE Procedures

D.G. CP1-MEDGEE-02

1. QCI-FSI-F11.1-020
2. Approved Site NDE Procedures

DOCUMENTATION REQUIRED

D.G. CP1-MEDGEE-01

1. Document Summary Sheet

2-3. Inspection Report

D.G. CP1-MEDGEE-02

1. Document Summary Sheet
2. Inspection Report

COMPONENT QUALITY REVALIDATION CHECKLIST

GROUP CHAIRPERSON _____ PROGRAM MANAGER _____ for JCK

COMPONENT REVIEW

D.G. CP1-MEDGEE-01

1. No EDGCTS site experience documents are in evidence.

2. A visual inspection was performed with unsatisfactory results. This was reported by TER# 10-006.

3. The material was determined by use of a material comparitor test. This was reported by TER# 10-005.

D.G. CP1-MEDGEE-02

1. No EDGCTS site experience documents are in evidence

2. A visual inspection was performed with satisfactory results. This was reported by TER# 10-097.

RESULTS AND CONCLUSION

D.G. CP1-MEDGEE-01

The Quality Revalidation effort with respect to this component, as outlined above, is complete. The results have been forwarded to the Design Review Group for their evaluation and conclusions in support of the final report.

D.G. CP1-MEDGEE-02

Same as D.G. CP1-MEDGEE-01

GROUP CHAIRPERSON Victor A Sabata PROGRAM MANAGER _____ for JCK

Appendix B

COMPONENT QUALITY REVALIDATION CHECKLIST

COMPONENT Rocker Arms & Pushrods - Exhaust Rocker - Shaft Assembly

UTIILITY Texas Utilities Generating Co., Comanche Peak Station

GPL NO. 02-390B

REV. NO. 2

SNPS GPL NO. 03-390B

TASK DESCRIPTIONS

D.G. CP1-MEDGEE-01

1. Assemble and review existing documentation.
2. Perform a visual inspection of the intake and intermediate rocker arm assembly for signs of distress, linear indications, and chipped pieces in the outer lips of the pushrod cups.
3. Determine the material of one rocker arm assembly.

D.G. CP1-MEDGEE-02

1. Assemble and review existing documentation.
2. Perform a visual inspection of the intake and intermediate rocker arm assembly for signs of distress, linear indications, and chipped pieces in the outer lips of the pushrod cups.

ATTRIBUTES TO BE VERIFIED

D.G. CP1-MEDGEE-01

1. Quality status of Component Document Package
2. Surface integrity of the rocker arm assembly
3. Material of rocker arm assembly

COMPONENT QUALITY REVALIDATION CHECKLIST

ATTRIBUTES TO BE VERIFIED (continued)

D.G. CP1-MEDGEE-02

1. Quality status of Component Document Package
2. Surface integrity of rocker arm assembly

ACCEPTANCE CRITERIA

D.G. CP1-MEDGEE-01

1. Satisfactory Document Package
2. No linear indications/chipped pieces in the outer lips of the pushrod cups.
3. Material to be AISI-4142

D.G. CP1-MEDGEE-02

1. Satisfactory Document Package
2. No linear indications/chipped pieces in the outer lips of the pushrod cups.

REFERENCES

D.G. CP1-MEDGEE-01

1. QCI-FSI-F11.1-020

2-3. Approved Site NDE Procedures

D.G. CP1-MEDGEE-02

1. QCI-FSI-F11.1-020
2. Approved Site NDE Procedures

COMPONENT QUALITY REVALIDATION CHECKLIST

DOCUMENTATION REQUIRED

D.G. CP1-MEDGEE-01

1. Document Summary Sheet

2-3. Inspection Report

D.G. CP1-MEDGEE-02

1. Document Summary Sheet

2. Inspection Report

GROUP CHAIRPERSON [signature] PROGRAM MANAGER [signature]

COMPONENT REVIEW

D.G. CP1-MEDGEE-01

1. No EDGCTS site experience documents are in evidence.

2. A visual inspection was performed with satisfactory results as reported by TER# 10-055.

3. The material was determined by use of a material comparator test. This was reported by TER# 10-005.

D.G. CP1-MEDGEE-02

1. No EDGCTS site experience documents are in evidence.

2. A visual inspection was performad with satisfactory results as reported by TER# 10-097.

RESULTS AND CONCLUSION

D.G. CP1-MEDGEE-01

The Quality Revalidation effort with respect to this component, as outlined above, is complete. The results have been forwarded to the Design Review Group for their evaluation and conclusions in support of the final report.

COMPONENT QUALITY REVALIDATION CHECKLIST

RESULTS AND CONCLUSION (continued)

D.G. CP1-MEDGEE-02

Same as D.G. CP1-MEDGEE-01

GROUP CHAIRPERSON Victor A. Sabeta PROGRAM MANAGER D Kammeyer

TDI OWNERS GROUP

for

SHOREHAM NUCLEAR POWER STATION - UNIT 1

INTAKE/INTERMEDIATE AND EXHAUST
ROCKER SHAFT ASSEMBLIES
COMPONENT PART NO. 03-390-A and B

I INTRODUCTION

The TDI Emergency Diesel Generator Owners Group Program for the Shoreham Nuclear Power Station requires Design and Quality Revalidation reviews to determine the adequacy of the intake/intermediate and exhaust rocker shaft assemblies for their intended use at Shoreham. The primary function of the intake/intermediate and exhaust rocker shaft assemblies is to actuate the intake valves and connecting pushrod to pen the exhaust valves by transmitting and changing the direction of motion from the camshaft. The part numbers for both rocker shaft assemblies as assigned by the manufacturer, TDI, are 1A-5446 and 1A-5465.

II OBJECTIVE

The objective of this review is to evaluate the adequacy of the rocker shaft assemblies for their intended use at Shoreham. Specifically, the following tasks were performed:

- Review of nuclear, non-nuclear, and Shoreham site experience.
- Evaluation of state of stress in rocker shaft assemblies.
- Evaluation of resistance to bending and fatigue.
- Review of pushrod socket installation.
- Evaluation of load in rocker arm assembly and pushrod sockets.
- Evaluation of rocker shaft supports.
- Evaluation of the Quality Revalidation Checklist results for acceptability.

III METHODOLOGY

The Emergency Diesel Generator Component Tracking System records for Shoreham were reviewed to determine the nuclear, non-nuclear, and specific Shoreham experience of the rocker shaft assemblies.

A theoretical model was developed to compute the dynamic response of the valve systems, and to estimate the pushrod rocker arm, and shaft forces. These forces were used to conduct a stress analysis of the rocker shaft assemblies and to evaluate the resistance to fatigue.

The bearing stresses on the rocker shaft support were calculated in order to verify that resistance to lateral loads on the rocker arms is provided by 1) the friction forces between the rocker support and shaft assembly, and 2) the rocker shaft and support dowel and not by bearing between the rocker shaft bolt and the support.

IV RESULTS AND CONCLUSIONS

The maximum pushrod and rocker arm forces were computed (Ref. 1). These forces were used to compute the peak shear and bending stresses in the rocker shaft assemblies. The maximum shear stress was found to be 8.1 ksi, and the maximum bending stress was found to be 15.2 ksi. These are both below the endurance limit stress of 40 ksi (Ref. 1).

Conservative stress analysis of the intake, intermediate, and exhaust rocker arms indicate a minimum factor of safety against failure of 1.1 (Ref. 1). The forces acting on the pushrod sockets induce stresses in the sockets (8.8 ksi max, Ref. 1) which are below the allowable of 50 ksi.

The capscrew (P/N 02-390-01-0J) connecting the rocker shaft to the rocker support is torqued to 365 ft-lb (Ref. 1), which develops a tensile preload of 21.9 kips (Ref. 1). This is sufficient to provide frictional resistance to lateral forces on the intake rocker-side of both rocker shaft assemblies. On the other side (intermediate rocker), the support dowel (P/N 03-362-02-0B) is engaged by the rocker shaft end, and transfers the shear from the rocker shaft to the sub-base assembly boss. The shear resistance supplied by friction at this end is minimal, due to the uplift forces on the rocker shaft by the main exhaust and intermediate pushrods (Ref. 1), and calculations indicate that these shear stresses exceed the endurance limit stress for the dowel (Ref. 1). However, there is no evidence (nuclear or non-nuclear) indicating dowel failures. Specifically, Shoreham experience indicates that approximately 400 hours (Ref. 2 and 3) have been logged on these dowels at full engine load, which exceeds the endurance limit for this material.

Quality Revalidation Inspection results identified in Appendix B have been reviewed and considered in the performance of this design review and the results are consistent with the final conclusions of this report.

Based on the above review, it is concluded that the intake/intermediate and exhaust rocker shaft assemblies are acceptable for their intended design function at Shoreham.

V REFERENCES

1. "Rocker Shaft Assembly Support Package," SP-84-6-2(a).

2. "Emergency Diesel Generator Crankshaft Failure Investigation - Shoreham Nuclear Power Station," FaAA Report #83-10-2.1.

3. "Evaluation of Emergency Diesel Generator Crankshaft at Shoreham Nuclear Power Station," FaAA Report #84-3-16.

Appendix A

COMPONENT DESIGN REVIEW CHECKLIST

COMPONENT Rocker Arms and Pushrods Intake/Intermediate Exhaust Rocker Shaft Assemblies

CLASSIFICATION TYPE B

PART NUMBER 03-390-A and 03-390-B

TASK DESCRIPTION:

Evaluate rocker shaft assembly stresses.

Review pushrod socket installation.

Review information provided on TERs: Q-43, Q-44, Q-70, Q-79, Q-126, Q-127, Q-131, Q-132, Q-133, Q-147, Q-148, Q-151, Q-175, Q-197, Q-199, Q-200, Q-201, Q-270, Q-278, Q-279, Q-280, Q-281, Q-295, Q-296, Q-297, Q-319, Q-346, Q-444, Q-481, Q-515, Q-516, DR-1, DR-24, DR-88, DR-170, DR-176, DR-195, DR-196, DR-197, DR-198, DR-215, DR-224.

PRIMARY FUNCTION:

Actuate intake valves, exhaust valves, and intermediate pushrods

---

ATTRIBUTE TO BE VERIFIED:

Review loads rocker arm assembly and pushrod sockets.

SPECIFIED STANDARDS:

None

REFERENCES:

"Seismic Qualification Review, TDI Emergency Diesel Generators at Shoreham Nuclear Power Station," Stone & Webster Engineering Corp., Shoreham Project Job Book No. 244.7.

DOCUMENTATION REQUIRED:

Valve and pushrod loading, installation drawings.

GROUP CHAIRPERSON: A.H. Wells for G.E.S. Hogans PROGRAM MANAGER J.F. Powers for JCK

COMPONENT REVIEW:

Review of nuclear, non-nuclear and Shoreham site experience.

Evaluation of state of stress in rocker shaft assemblies.

Evaluation of resistance to bending and fatigue.

Review of pushrod socket installation.

Evaluation of load in rocker arm assembly and pushrod sockets.

Evaluation of rocker shaft supports.

Evaluation of the Quality Revalidation Checklist results for acceptability.

RESULTS AND CONCLUSIONS:

The intake/intermediate/exhaust rocker shaft assemblies are acceptable for their intended design function at Shoreham.

Seismic qualification for the intake/intermediate/exhaust is addressed in "Seismic Qualification Review, TDI Emergency Diesel Generators at Shoreham Nuclear Power Station," Stone & Webster Engineering Corp., Shoreham Project Job Book No. 244.7.

GROUP CHAIRPERSON A.H. Wells for G.E.S. Hogans PROGRAM MANAGER J.F. Powers for JCK

Appendix B

COMPONENT REVALIDATION CHECKLIST

COMPONENT Rocker Arms & Pushrods - Intake & Intermediate Rocker Shaft Assembly including Capscrews

DOCUMENT NO. QR-03-390A

PART NO. 03-390A

INCORPORATES DOC. NOS. QR-1, Rev. 1; QR-2, Rev. 1

TASK DESCRIPTIONS

ENGINE 101

1. Assemble and review existing documentation.
2. Review the pushrod cup installation documentation and ensure the overhang is properly ground flush (TDI P/N 08-390-01-0F) for cylinders 5, 7 and 8.
3. Perform visual inspections of cylinders 5, 7 and 8 intake and intermediate rocker arm assemblies for signs of debris, chipping, loose metal and damaged parts prior to subcover removal. Document with photographs.
4. Determine the material and the hardness of both the shaft (TDI P/N 03-390-01-0A) and the capscrews (TDI P/N 02-390-01-0J) for cylinders 5, 7, and 8.
5. Perform visual inspections of intake and intermediate rocker arm assemblies for signs of wear & distress, cylinders 5, 7, 8.
6. Perform a dimensional inspection of the rocker arm bushing bore, cylinders 5, 7, 8.

ENGINE 102

1. Assemble and review existing documentation.
2. Review the pushrod cup installation documentation and ensure the overhang is properly ground flush. (TDI P/N 08-390-01-0F) for cylinders 5, 7 and 8.
3. Determine material and hardness of the shaft (TDI P/N 03-390-01-0A) for cylinder 7.
4. Perform visual inspections of intake and intermediate rocker arm assemblies for signs of wear & distress, cylinders 5, 7, 8.
5. Perform dimensional inspection of rocker arm bushing bore, cylinders 5, 7, 8.

ENGINE 103

Same as Engine 101

SPARES

1. Perform material analysis of rocker arm shaft

ATTRIBUTES TO BE VERIFIED

ENGINE 101

1. Quality status of Vendor Component Package
2. All sockets (TDI P/N 08-390-01-0F) ground in accordance with TDI Letter April 15, 1983. L. McHugh to N. Rudikoff.
3. Absence of debris, loose metal and damaged parts in the rocker arm assemblies.

COMPONENT REVALIDATION CHECKLIST

ATTRIBUTES TO BE VERIFIED (continued)

ENGINE 101 (continued)

4. Proper material and hardness of the shaft (TDI P/N 03-390-01-0A) and capscrews (TDI P/N 02-390-01-0J).
5. Visual integrity of the rocker arm assemblies
6. Dimensions of the rocker arm bushing bores

ENGINE 102

1. Quality status of Vendor Component Package
2. All sockets (TDI P/N 08-390-01-0F) ground in accordance with TDI Letter April 15, 1983. L. McHugh to N. Rudikoff.
3. Proper material and hardness of the shaft (TDI P/N 03-390-01-0A)
4. Visual integrity of the rocker arm assemblies
5. Dimensions of the rocker arm bushing bores

ENGINE 103

Same as Engine 101

SPARES

1. Materials of the rocker arm shaft

ACCEPTANCE CRITERIA

ENGINE 101

1. Satisfactory Document Package
2-6. Review Inspection Report by Design Group

ENGINE 102

1. Satisfactory Document Package
2-5. Review of Inspection Report by Design Group

ENGINE 103

Same as Engine 101

SPARES

1. Review of Inspection Report by Design Group

REFERENCES

ENGINE 101

1. QCI-FSI-F11.1-020
2. TER Q-91, LDRs 1851, 1252
3. LILCO approved inspection procedures, Q-126, Q-91
4. TERs Q-91, DR-33, Q-143, Q-16, DR-24

REFERENCES (continued)

ENGINE 101 (continued)

5. TERs DR-24, Q-91
6. LDRs 1235, 1245

ENGINE 102

1. QCI-FSI-F11.1-020
2. LDRs 1252 & 1851, QR-1 Rev.1
3. TERs DR-24, Q-16, DR-33, Q-143
4. TER DR-24
5. LDRs 1234, 1245

ENGINE 103

Same as Engine 101

DOCUMENTATION REQUIRED

ENGINE 101

1. Document Summary Sheet
2-6. Inspection Report

ENGINE 102

1. Document Summary Sheet
2-5. Inspection Report

ENGINE 103

Same as Engine 101

SPARES

1. Inspection Report

GROUP CHAIRPERSON _____ PROGRAM MANAGER _____

COMPONENT REVIEW

ENGINE 101

1. All preassembly EDGCTS Shoreham experience documents were assembled and reviewed with satisfactory results.
2. A visual inspection of the intake rocker arm push rod cups was performed for cup overhang. The findings were reported by TER Q-346 and dispositioned by LDR 2279. The visual inspection of the intermediate rocker arm pushrod cups was found to be satisfactory.

COMPONENT REVIEW (continued)

ENGINE 101 (continued)

3. A visual examination was performed for debris, chipping, loose metal, and damaged parts. The findings were reported by TER Q-270 and dispositioned by LDR 2241.
4. Material tests were accomplished with a Bausch & Lomb 3600 Mobile Metal Analyzer on the shaft and the (2) two capscrews for cylinders 5, 7 & 8. The results were reported by TER Q-295. Hardness Tests were performed with an Equotip hardness tester. The results of the hardness tests for shafts were reported by TER Q-319 and those for the capscrews were reported by TER Q-297.
5. A visual inspection was performed with findings reported by TER Q-280 and dispositioned by LDR 2246.
6. A dimensional inspection was performed as reported by TER Q-278.

ENGINE 102

1. All preassembly EDGCTS Shoreham experience documents were assembled and reviewed with satisfactory results.
2. Positive verification of cups being ground flush was reported by TER DR-170 for cylinder 5 only. Documentation to support inspection of 7 & 8 was reported by TER Q-44 and dispositioned by LDR 2070.
3. Visual inspections of 5, 7 & 8 rocker arm assemblies were accomplished. The results were reported by TER Q-44 and dispositioned by LDR 2070.
4. Materials were determined by Bausch & Lomb 3600 Mobile Metal Analyzer for cylinder 7. The results were reported by TER DR-197 for the intake and intermediate shafts. Hardness tests were performed on the shafts for cylinder 7 by use of an Equotip hardness tester as reported by TER DR-215.
5. A dimensional inspection was performed as reported by TER DR-170.

ENGINE 103

1. All preassembly EDGCTS Shoreham experience documents were assembled and reviewed as were done for Engine 101.
2. A visual inspection of the pushrod cups for overhang was satisfactory. The results of the inspection of intermediate for cylinders 5, 7 & 8 were reported by TER Q-131.
3. A visual inspection was performed for evidence of damaged parts. The results are reported by TER Q-147 and dispositioned on LDR 2194.
4. Materials were determined by Bausch & Lomb 3600 Mobile Metal Analyzer. The results of the tests performed the on shafts were reported by TER Q-200. The test results for the capscrews were reported by TER Q-199. An Equotip hardness test was performed on the shafts and the capscrews for cylinders 5, 7 & 8. The results were reported by TER Q-175.
5. A visual inspection was performed with findings reported by TER Q-147 and dispositioned by LDR 2194.
6. A dimensional inspection was performed as reported by TER Q-133.

SPARES

1. Material analysis was performed on rocker arm shaft as reported by TER Q-505.

COMPONENT REVALIDATION CHECKLIST

RESULTS AND CONCLUSIONS

ENGINE 101

The Quality Revalidation effort with respect to this component, as outlined above, is complete. The results have been forwarded to the Design Review Group for their evaluation and conclusions in support of the final report.

ENGINE 102

Same as Engine 101

ENGINE 103

Same as Engine 101

SPARES

Same as Engine 101

GROUP CHAIRPERSON _____ PROGRAM MANAGER _____

Appendix B

COMPONENT REVALIDATION CHECKLIST

COMPONENT Rocker Arm & Pushrods Exhaust Rocker Shaft Assembly

DOCUMENT NO. QR-03-390B

PART NO. 03-390B

INCORPORATES DOC. NOS. QR-1

TASK DESCRIPTIONS

ENGINE 101

1. Assemble and review existing documentation.
2. Review the pushrod cup installation documentation and perform a visual inspection to verify the overhang is properly ground flush (TDI P/N 08-390-01-0F) for cylinders 5, 7, and 8.
3. Visually inspect the rocker arm shaft assembly for any signs of wear, scoring and pitting on cylinders 5, 7, and 8.
4. Measure rocker arm bushing bore on cylinders 5, 7, and 8.
5. Determine the material and hardness of the shaft (TDI P/N 03-390-01-0A) for cylinders 5, 7, and 8.

ENGINE 102

1. Assemble and review existing documentation.
2. Review the pushrod cup installation documentation and perform a visual inspection to ensure the overhang is properly ground flush (TDI P/N 08-390-01-0F) for cylinders 5, 6, 7, and 8.
3. Visually inspect the rocker arm shaft assembly for any signs of wear, scoring and pitting on cylinders 5, 6, 7, and 8.
4. Measure rocker arm bushing bore on cylinders 5, 6, 7, and 8.
5. Determine the material and hardness of the shaft (TDI P/N 03-390-01-0A) for cylinder 7.

ENGINE 103

Same as Engine 101

ATTRIBUTES TO BE VERIFIED

ENGINE 101

1. Quality status of Component Document Package
2. Pushrod cup overhang properly ground flush
3. Absence of wear, scoring and pitting on the rocker arm shaft
4. Proper rocker arm bushing bore dimension
5. Proper material and hardness of the shaft (TDI P/N 03-390-01-0A)

ENGINE 102

Same as Engine 101

ENGINE 103

Same as Engine 101

ACCEPTANCE CRITERIA

ENGINE 101

1. Satisfactory Document Package
2-5. Review of Inspection Report by Design Group

ENGINE 102

Same as Engine 101

ENGINE 103

Same as Engine 101

REFERENCES

ENGINE 101

1. QCI-FSI-F11.1-020
2. TERs Q-91, Q-444, Letter from W. Lenny McHugh (TDI) to Neil Rudikoff (LILCO) date 4/15/83 (LDR 1252)
3. TERs Q-91, DR-88, DR-481
4. TERs Q-91, DR-88, DR-481
5. TERs Q-91, Q-143, Q-16, DR-88

ENGINE 102

1. QCI-FSI-F11.1-020
2. TERs Q-444, Q-481, Letter from W. Lenny McHugh (TDI) to Neil Rudikoff (LILCO) dated 4/15/83 (LDR 1252)
3. TER DR-88
4. TERs DR-88, Q-481
5. TERs DR-88, Q-16, Q-143, Q-481

ENGINE 103

Same as Engine 101

DOCUMENTATION REQUIRED

ENGINE 101

1. Document Summary Sheet
2-5. Inspection Report

ENGINE 102

Same as Engine 101

DOCUMENTATION REQUIRED (continued)

ENGINE 103

Same as Engine 101

GROUP CHAIRPERSON _____ PROGRAM MANAGER _____

COMPONENT REVIEW

ENGINE 101

1. All preassembly EDGCTS Shoreham experience documents were assembled and reviewed with satisfactory results.
2. A review of pushrod cup installation documentation showed the overhang to be ground flush satisfactorily.
3. The rocker arm shaft assembly was visually inspected. The results were reported by TER Q-281 and dispositioned by LDR 2247.
4. The rocker arm bushing bore was measured. The results were reported by TER Q-279
5. Materials were determined by use of a Bausch & Lomb 3600 Mobile Metal Analyzer. Results for cylinders 5, 7 and 8 reported by TER Q-296. Equotip hardness tests were performed on the shaft for cylinders 5, 7, and 8 and reported by TER Q-319. The report was documented by TER Q-297.

ENGINE 102

1. All preassembly EDGCTS Shoreham experience documents were assembled and reviewed with satisfactory results.
2. The pushrod cup overhang was inspected. The results were documented by TER DR-198.
3. A visual inspection of rocker arm shaft assembly was performed. The results were reported by TER DR-176.
4. The rocker arm bushing bores were measured. The results were reported by TER DR-198.
5. The material of the shaft was determined by use of the Technicorp Model 850/950 wt Alloy Seperator. This was reported by TER Q-79 (cylinder 7). An Equotip hardness test was performed. The results were reported by TER Q-79 (cylinder 7).

ENGINE 103

1. All preassembly EDGCTS Shoreham experience documents were assembled and reviewed with satisfactory results.
2. A visual inspection was performed on cylinders 5, 7 and 8 to ensure that the overhang is properly ground flush. Cylinders 7 and 8 were found satisfactory as reported by TER Q-132. Cylinder 5 was found unsatisfactory. This was reported by TER Q-132 and dispositioned by LDR 2184.
3. A visual inspection of the rocker arm shaft assembly was accomplished. Unsatisfactory results for cylinder areas 5, 7 and 8 were reported by TER Q-148 and dispositioned by LDR 2195.
4. Rocker arm bushing bore dimensions were taken and reported by TER Q-151.
5. Materials were determined by use of a Baush and Lomb 3600 Mobile Metal Analyzer or the shafts for cylinders 5, 7 and 8. The results of this test are reported by TER Q-201. Equotip hardness tests were performed on the shafts for cylinders 5, 7 and 8 and reported by TER Q-175.

COMPONENT REVALIDATION CHECKLIST

RESULTS AND CONCLUSIONS

ENGINE 101

The Quality Revalidation effort with respect to this component, as outlined above, is complete. The results have been forwarded to the Design Review Group for their evaluation and conclusions in support of the final report.

ENGINE 102

Same as Engine 101

ENGINE 103

Same as Engine 101

GROUP CHAIRPERSON _____ PROGRAM MANAGER _____

March 1985

KAMMEYER, JOHN C.

ENGINEER
POWER DIVISION

EDUCATION

Ohio State University - Bachelor of Science, Mechanical Engineering, 1979

Various U.S. Navy Electronic Technician and Nuclear Power Courses

Various Stone & Webster Career Development and Continuing Education Courses

EXPERIENCE SUMMARY

Mr. Kammeyer has six years of experience on nuclear power plant projects and six years experience on U.S. Navy Nuclear Submarines. As an Engineer, assigned to the Transamerica Delaval, Inc. (TDI) Owners Group, as the Design Review and Quality Revalidation Program Manager, he was responsible for the technical direction and management of the TDI emergency standby diesel engine requalification effort for twelve utilities.

Since joining Stone & Webster Engineering Corporation (SWEC) in June 1979, he has also been assigned to the Site Engineering Office of the Shoreham Nuclear Power Station. In addition, he has completed the Career Development Program including assignments to the 850 MWe boiling water reactor Shoreham Nuclear Power Station as a Site Engineer and as a Systems Engineer, and to a 938 MWe pressurized water reactor North Anna Power Station project as a Systems Engineer.

Prior to college, Mr. Kammeyer spent six years in the Navy's Nuclear Power Program; the final three years as a Reactor Operator aboard a nuclear submarine.

PROFESSIONAL AFFILIATIONS

American Society of Mechanical Engineers - Associate Member

DETAILED EXPERIENCE RECORD
KAMMEYER, JOHN C. 47182

STONE & WEBSTER ENGINEERING CORPORATION, BOSTON, MA
(June 1979 to Present)

Appointments:

Engineer, Power Division - Feb 1981
Career Development Engineer, Power Division - June 1979

As **ENGINEER** (March 1985 to Present) assigned to the Site Engineering Office (SEO) in the capacity of Assistant Head-SEO. Responsible to the Head-SEO for the management of the SEO Engineering Staff. In addition, as the SWEC contact to the TDI Owners Group Executive Committee, responsible for SWEC's continuing support to the nuclear utility owners of TDI diesel engines, specifically: response to NRC questions, maintenance program development, special testing, engine startup consulting, and support for modification implementation.

As **ENGINEER** (Apr 1984 to Feb 1985) on special assignment to the Transamerica Delaval, Inc. (TDI) Owners Group in the capacity of Program Manager of the Design Review and Quality Revalidation effort for TDI diesel generators utilized at 13 different nuclear power plants. Responsible for directing Engineers and Quality Inspectors in the resolution of generic TDI diesel engine problems, and the design review/quality revalidation of selected engine components. In addition, participating in meetings with the Nuclear Regulatory Commission and its technical staff to present the overall program and provide briefings on problem component analyses. Successfully completed the generic Owners Group effort and closed out the Technical Program in February 1985.

As **ENGINEER** (Aug 1982 to Mar 1984) assigned to the Site Engineering Office (SEO) in the capacity of Power Engineer and Assistant Head-SEO, responsible to the Head-SEO for the Power Division effort. During the construction and startup testing phase of the plant, responsible for directing Engineers and Designers in the resolution of problems dealing with fluid systems and related components, such as piping, valves, mechanical equipment, and equipment erection. Provided engineering and coordination support to the client for the emergency diesel generator design revalidation program ASLB qualification effort. Plant preoperational phase responsibilties include developmental support of the station modification programs and engineering the specific modification packages for the upgrade of mechanical systems and equipment.

As **ENGINEER** (May 1981 to July 1982), assigned to the Site Engineering Office, responsible for resolving various engineering related construction problems, principally with piping and mechanical components, requiring an immediate solution to support the construction schedule. In addition, working directly with the client's start-up organization to resolve system operation deficiencies.

As **ENGINEER** and **CAREER DEVELOPMENT ENGINEER** (Nov 1979 to Apr 1981) in the Nuclear Engineering Group, responsible for preparing reactor plant flow diagrams, specifications, and FSAR sections. As a Career Development Engineer, spent four months at the Site Engineering Office, responsibilities included maintainability study of the 850 MWe power plant.