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

MAR 9 1984

MEMORANDUM FOR: Carl Berlinger
TDI Project Group Manager
Division of Licensing

FROM: Vincent S. Noonan, Chief
Equipment Qualification Branch
Division of Engineering

SUBJECT: DIVISION OF ENGINEERING COMMENTS ON THE FRANKLIN RESEARCH CENTER DRAFT TER

As you requested in your memorandum of February 28, 1984 the Materials Engineering Branch, MCET (D. Sellers), the Mechanical Engineering Branch, CSE (H. Shaw) and the Equipment Qualification Branch, CSE (R. Wright) of the Division of Engineering have reviewed the Franklin Research Center (FRC) Draft Technical Evaluation Report titled Evaluation of Diesel Generator Failure at Shoreham Unit 1, Interim Report on Phase 2, Failure Cause Evaluation. Our comments are attached. By way of this memorandum we are transmitting our comments to R. Giardina, the Lead NRC Engineer for the FRC work.

Vincent S. Noonan, Chief
Equipment Qualification Branch
Division of Engineering

Attachment: As stated

cc: M. Miller
E. Murphy
[redacted]
R. Giardina
R. Wright
H. Shaw
D. Sellers
G. Bagchi
H. Brammer
W. Hazelton

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Specific Comments

Page	Comment
1	Second paragraph, line 6, add DG 101 and DG 103, after word generators
19	Second paragraph, line 14, the word appears is not appropriate. Fa AA either did or did not use this method. What prevents the reviewer from saying this.
22	Footnote indicated by * references an informal communication. More specifics are required, such as, the name of all parties, their respective organizations, whether the communications was a telephone call, a meeting or written correspondence and on what date.
30	Sentence in parenthesis is not appropriate. Firsty the data should be made available. Secondly, the comment with regard to page 29 applies.
31	First line, the word appears should be replaced by the reviewer's opinions and the bases for the opinion. If an opinion cannot be reached than say so.
35	For Sections 3.3.2.3 there is no conclusion. Is it acceptable, is it not acceptable and the bases.
37	For Sections 3.4.1 line 2 the comment for page 29 applies.
39	Last paragraph of Section 3.4.2.1 should relate the significance of the information sought. The implication is that the reviewer would be satisfied if the learning reactions had been considered and found negligible. What is the documentation and justification suppose to address.
39	First paragraph of Sections 3.4.2.3 should relate what the reviewer expects to see in the model loading method and the significance of not having this information.
39	First paragraph of Sections 3.4.2.3 refers to good agreement. The agreement is between what and what and a definition of good needs to be provided, i.e., within 10% or 100% or what.
42	Second paragraph, end of line 1, the comment for page 29 applies.
42	Last paragraph of Sections 3.5.2.2 should indicate why the method of loading is critical and what the reviewer wants from the discussion by Fa AA.
43	Section 3.54 indicates additional information is required before the evaluation can be completed. Thus, we cannot issue this as a final TER.

COMMENTS ON FRI EVALUATION OF FaAA REPORT ON TDI

Although, as is pointed out in various places in the report, there cannot be a code for all diesel types. It is apparent that there can and should be a better definition of nuclear EDG requirements. Such definition should define material specification, design rules, and qualification testing for nuclear EDG. Therefore, the endorsement of the first bullet item for longer range action of Section 5 Recommendations is to be encouraged.

From the materials engineering standpoint, the first bullet item of Section 5 is also endorsed. The effect of the shot peening should indeed be evaluated.

1. What are the DEMA specified mechanical properties for crank shaft materials?

2. What are the impact on stress analysis if 3900 kw is used as the full load in the F_a AA model instead of 3500 kw?

3. Has the crankshaft new design also reduce the high ratio of cyclic torque to steady torque = What is the interpretation of the high ratio number?

H.K. Shaw

Central files

April 11, 1984

Docket Nos.: See Enclosure 1

Mr. J. P. McGaughy, Chairman
Vice President - Nuclear Production
Mississippi Power & Light Company
Post Office Box 1640
Jackson, Mississippi 39205

14

Dear Mr. McGaughy:

SUBJECT: PRELIMINARY ASSESSMENT OF TWO REPORTS SUBMITTED TO THE NRC BY THE TRANSAMERICA DELAVAL, INC. (TDI) OWNERS GROUP

References: (1) "Design Review of Connecting Rod Bearing Shells for Transamerica Delaval Enterprise Engines," prepared by Failure Analysis Associates, March 12, 1984.

(2) "Emergency Diesel Generator Rocker Arm Capscrew Stress Analysis," prepared by Stone and Webster Engineering Corporation, March 1984.

The TDI Owners Group has submitted the referenced reports to the NRC for review for which the staff and its consultants have generated initial comments. Staff comments on the report referenced in item (1) above are contained in Enclosure 2. In general, the subject report in itself does not appear to present sufficient data and backup details to support the predicted bearing life or to verify that aluminum bearings will have adequate operating life.

Initial staff comments on the report referenced in item (2) above are contained in Enclosure 3. The comments indicate that additional information is required in such areas as the failure mechanisms, the referenced calculations, and the quality of the materials before our assessment of the capscrews can be completed.

A preliminary version of these initial comments were transmitted previously to the Owners Group and were discussed at the last meeting with the NRC staff on March 22, 1984. The staff is reviewing the meeting transcripts to determine whether the Owners Group responses to the staff comments are satisfactory. We will inform you of any additional information needed by the staff to complete its review.

Sincerely,

Original signed by/

Carl H. Berlinger
TDI Project Group Manager
Division of Licensing

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PDR ADOCK 05000416
A PDR

cc: W. Museler, LILCo
W. Laity, PNL

*PREVIOUS CONCURRENCES OBTAINED

TDI:PG*	TDI:PG	TDI:PG	TDI:PG*
MMiller:dk	EMurphy	RCaruso	CBerlinger
4/6/84	4/11/84	4/ /84	4/6/84 4/11/84

RD-7-2A
RD-8-2
MP+L Co

Docket Nos.: See Enclosure 1

Mr. J. P. McGaughy, Chairman
Vice President - Nuclear Production
Mississippi Power & Light Company
Post Office Box 1640
Jackson, Mississippi 39205

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Most of these comments were transmitted previously to the Owners Group and were discussed at the last meeting with the NRC staff on March 22, 1984. Any additional answers or clarification should be provided within one week from the date of receipt of this letter. As we continue our review, additional questions may be identified which will require an Owners Group response.

Sincerely,

Carl H. Berlinger
TDI Project Group Manager
Division of Licensing

cc: W. Museler, LILCo
W. Laity, PNL

TDI:PG	TDI:PG	TDI:PG	TDI:PG
MMiller:dk	EMurphy	RCaruso	CBerlinger
4/6/84	4/ /84	4/ /84	4/10/84

Enclosure 1

TRANSAMERICA DELAVAL, INC.

EMERGENCY DIESEL GENERATOR DISTRIBUTION

Plant	Docket	Utility
Shoreham	50-322	Long Island Lighting
Grand Gulf 1, 2	50-416, 417	Middle South Energy
San Onofre 1	50-206	Southern California Edison
Rancho Seco	50-312	SMUD
River Bend	50-458, 459	Gulf States Utilities
Shearon Harris 1, 2	50-400, 401	Carolina Power and Light
Catawba 1, 2	50-413, 414	Duke Power
Perry 1, 2	50-440, 441	Cleveland Electric Illuminating
Bellefonte 1, 2	50-438, 439	TVA
Comanche Peak 1, 2	50-445, 446	Texas Utilities Services
Vogtle 1, 2	50-424, 425	Georgia Power
Midland 1, 2	50-329, 330	Consumers Power
WNP-1	50-460	Washington Public Power

Enclosure 2

INITIAL STAFF COMMENTS AND QUESTIONS ON THE REPORT
"DESIGN REVIEW OF CONNECTING ROD BEARING SHELLS FOR
TDI ENTERPRISE ENGINES"

1) Included in the TDI Diesel Generator Owners Group Program Plan is a task description for the component design review of connecting rod bearing shells. Evaluations called for in the task description that are apparently not addressed in the subject report include:

   a) Item 12a - "Determine differences, if any, between DSRV-16-4 and DSRV-12-4, DSRV-20-4. Conduct necessary design review steps, issue final report covering all engines."

   b) Item 12b - "Evaluate possible preventive maintenance and monitoring procedures (i.e., oil sample particulate/chemical analysis, periodic visual inspection)."

2) The report examines the design aspects of the bearing shells, but related aspects that can affect the probability of cracking under operational conditions (e.g., tolerance limits, adequacy of material, heat treatment of the alumimum, fabrication, and assembly procedures) are not discussed. Does the Owners Group plan to address these?

3) The report's projected fatigue life of current bearings was based on past operating life of the 11-inch bearings. However, four of the 16-inch bearing shells were found to be fractured or to contain cracks after about 600 to 800 hours of operation, including about 250 hours of full-load operation. Should these fractures and cracks be construed to be failures of consequence, or are they acceptable failures? Since these failures occurred sometime during this period of operation, and the time of any one of the failures is not known or indicated, it is our opinion that the basis used in the report to extrapolate from (i.e., 250 hours) to predict the fatigue life of the larger bearing shells was not an adequate one. Because of this and the apparent lack of consideration of other factors that can and do impact the operating life of bearings, we do not believe the predicted life of 38,800 hours at full load is one that should be accepted as identifying a completely acceptable bearing. What is your basis for assuming that the bearing failed at 250 hours of full-load operation?

   Based on experience with diesel engines and their operations, we have reason to believe that the maximum bearing life that can be expected from aluminum bearings in engines of this size and under similar operating environments will not be above 10,000 to 15,000 hours. Also, this life can only be achieved if all conditions are optimum or perfect. Provide a detailed response.

4) The report as presented does not contain sufficient detail to determine in all cases the number of items that were examined by a certain process or the history of the item or part being examined. For example, what number of upper or lower 12-inch bearing shells were examined? How were they selected for this examination? Were examinations performed on each and every one of the 11-inch bearing shells to ascertain they did not contain cracks? Were tests conducted on the intact 11-inch bearing shells to determine if there were voids in the general areas that the other 11-inch shells failed in, and if so their size and concentration? Provide an inspection summary for all bearing shells.

5) Why were TDI specifications for tensile strength requirements changed? How do the old and new requirements compare to industry standards? Are there any test data to show the minimum tensile strength required to withstand the actual imposed loads occurring in the upper and lower bearing shell locations during full-load and start-up conditions?

6) The report assumes the polishing pattern found at the bearing ends was the result of journal axis and bearing surface misalignment. If so, what were the misalignments that resulted in these patterns? What limits have been placed on the subject misalignment to prevent an impact on bearing life? Were any tests conducted to determine if these polishing patterns may be the result of other aspects of the engine and its operation such as crank pin loading and deflection? Are there any test or examination data on these aspects that can be made available? What are the end loadings and why are they significant or not significant?

7) The report identifies the possible reasons for babbitt removal that were found in this evaluation such as cavitation, high loadings or weak adhesion to the substrate. However, it indicates the subject of a continuous babbitt overlay as not being significant to the performance or life of the bearing in question. If the babbitt overlay is not significant, why is it included in the design of the bearings?

   Based on preliminary comments, it is deemed that the babbitt overlay which has a different hardness than the alumimum base is very important. Also, the bearing to crank pin clearance is a crucial factor in bearing lubrication, cooling and load reversals. If this clearance is opened up, say due to the removal of the overlay for any reason, one can expect the alumimum substrate will also fail usually in a relatively short period of time.

8) The report only addressed cracks that were assumed to have started from existing voids. Provide justification for your explanation for the cause of the voids. There was no indication if these bearing shells or others were examined for voids in areas where there are no cracks, or for other defects such as inclusions, etc. Address this comment. The development of such data could be very pertinent to the assumed void-crack relationship.

9) More information should be developed on the presence and the source of the voids, such as the size and concentration of voids in the present castings. Are they in all castings? Provide a better description on the determination and distribution of the voids. What can or should be done to eliminate, to reduce or to control the size and concentrations of voids? Some voids are a large percentage of specimen size. How does this affect elongation test results? The report indicates these are surface pores. Did any of these pores extend above the apparent surface of the alumimum? Do these pores only exist toward the ID of the bearing shell, or are they distributed throughout the total thickness?

10) Is there a specification or maximum permissible void size? What is the basis for a larger permitted void size as indicated on page 5-4 of the report? Is this void size a relaxation from the specification?

11) The report's recommendation for maximum bearing load (Tables 3 and 4) is for wrought alumimum Al-6% Sn. It is our preliminary consideration that its value is not applicable to the metallic form used in the subject bearing sleeves (cast). This area of concern will require additional evaluation that will be conducted as the assessment of the subject bearing shells continues.

12) In order to proceed with logical assessment of certain portions of the report, more materials characterization data are needed. In particular, measured yield strength at temperature and ranges of threshold stress intensity values are needed to confirm the design adequacy. Actual fatigue data would be helpful. Also, more data on the material chemistry specification are required to assure that the material tested was within specification. What is the effect of a corrosive atmosphere on threshold stress intensity?

13) No loading data were included in the report. Provide a copy of the journal orbit analysis and details of the loads applied to the bearings. These are required for the analysis and evaluation of the methods used in the report and to determine how close these expected loads are to the yield strength of the materials.

14) The replacement 12-inch bearing shells have a maximum film oil pressure of 26,800 psi as predicted by journal orbit analysis which exceeds the industry guideline used by TDI of 26,000 psi. Is the 26,000 psi guideline similar to that used by other diesel manufacturers? Justification for exceeding the guideline is that the more detailed fracture mechanics and finite element analysis support the predicted fatigue life of the bearing. Should not the fatigue life of the bearing be supported by journal orbit analysis also?

15) If the information listed in the Information Required section of Component Design Review Task Description in the Owners Program Plan, as well as copies of data pertinent to all of this report's references could be provided, the staff would be in a better position to perform an adequate analysis of this design review report.

Enclosure 3

INITIAL STAFF COMMENTS AND QUESTIONS ON THE REPORT
"EMERGENCY DIESEL GENERATOR ROCKER ARM CAPSCREW
STRESS ANALYSIS"

1) How did the capscrews fail? The report does not provide a description of the failures or a discussion of the cause. How will possible problems in fabrication, heat treatment or overtorquing be addressed? We need to know how many failed, why, how, etc. (We will check the computer listing to determine if any data were provided.) Also discuss solutions to the failures.

2) The summary analysis indicates that both designs are adequate. If so, why the redesign? Was the cause of failure identified and what is the anticipated effect of the change?

3) Much of the report was based on SWEC calculation 11600.60-245.1-M1. We need to see these calculations to evaluate the conclusions based on the calculations. May we obtain a copy of the calculations?

4) Currently, we can only assume how the capscrews fit into the engines. A picture or cross section of a drawing indicating how the capscrews are used would be useful. (The set of engineering drawings may be sufficient.)

5) The staff believes it is desirable to check at least some of the calculations performed by Stone and Webster. Before we can make these calculations, however, we need to know what forces act on the capscrews. May we obtain a listing of measured forces as well as the distribution of values relating to these forces? Explain how each was accounted for in the analysis.

6) Were the capscrews subjected to any bending moment? That is, what forces were included and excluded in the analysis by Stone and Webster?

7) Two capscrew designs are referenced but only one is illustrated. We need both designs with dimensions. May we obtain drawings for both designs?

8) Tables 1 and 2 are confusing and we need an explanation of each. For example, what is the basis for the numbers? Why is the endurance limit S_E different in Tables 1 and 2 (8.7 versus 37.6 KSI)? May we also have an explanation of Figures 2 and 3, especially as they relate to satisfying the criteria for a fatigue resistant design?

9) What values were used in Equation 3 on page 8 of the report and on what basis were they used?

10) We need more information to verify the analysis regarding the thread design, for example, are they rolled, turned, etc? Also what changes were made in the thread design?

11) We are concerned about the quality of the material used. For example, the material specified is AISI 4140 hardened to 25-30 (Rockwell). What was the quality of the material used and was it hardened to 25-30? How did Stone and Webster conclude that the specified material was used? We would like supporting data.

12) We need additional information about Figure No. 1. We believe that the total applied mean stress should be 2 S_B, not $S_B/2$ as stated. May we have an explanation of this figure?

13) Are any data available regarding confirmation testing of materials? Data for tensile tests, heat-treating, etc., is needed.

14) The conclusions provided on pages 10 and 11 of the report are not supported. May we have the data that led Stone and Webster to conclude that "the effects due to thermal stresses are negligible" and "effects due to creep and stress relaxation are also negligible"? Data for all other conclusions are also needed.

15) The statement on page 1 indicates this report applies only to the Shoreham Plant; i.e.,

> "This report is applicable to the TDI Nuclear Stand-by Service Diesel Generators utilized at the Shoreham Nuclear Power Station. Other TDI Nuclear Stand-by Service Diesel Engine Rocker Arm Capscrews, as part of the TDI Owners Group Design Review/Quality Revalidation effort, will be evaluated separately."

Does this mean that the staff should expect to receive additional reports on rocker arm capscrews? If so, how many reports will we receive and when?

16) No review of the TDI stress analysis has been done as indicated in the Task Description. Does the Owners Group plan to address this portion of the Task Description? When?