UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
GEORGIA POWER CO.	)	Docket Nos. 50-424
et al.	)	50-425
	)	(OL)
(Vogtle Electric Generating Plant,	)	
Units 1 and 2)	)	

AFFIDAVIT OF CARL H. BERLINGER IN SUPPORT
OF NRC STAFF RESPONSE TO APPLICANTS'
MOTION FOR SUMMARY DISPOSITION OF CONTENTION 14

I, Carl H. Berlinger, being duly sworn, state as follows:

1. I am employed by the U.S. Nuclear Regulatory Commission and I am currently designated as the Manager of the Transamerica Delaval, Inc. (TDI) Project Group in the Division of Licensing. A copy of my professional qualifications is enclosed as Exhibit 1.

2. The purpose of this affidavit is to respond to the Applicant's Motion for Summary Disposition of Contention 14, concerning the adequacy of the TDI Emergency Diesel Generators (EDGs) at Vogtle.

Joint Intervenors in this proceeding have alleged that inadequate design, manufacture, and QA/QC have resulted in substandard TDI diesel engines

which prevent the Vogtle emergency diesel generators from meeting the requirements of 10CFR Part 50, Appendix A, General Design Criterion 17. As a specific basis for this contention, the Joint Intervenors have cited past TDI diesel generator problems with the governor lube oil cooler assembly, air valve assembly, piston skirts, and engine mounted electrical cables.

3. Concerns regarding the reliability of large bore, medium speed diesel generators manufactured by TDI for application at domestic nuclear plants were first prompted by a crankshaft failure at the Shoreham Nuclear Power Station in August 1983. However, a broad pattern of deficiencies in critical engine components have become evident at Shoreham and at other nuclear and non-nuclear facilities employing TDI diesel generators. These deficiencies stem from inadequacies in design, manufacture and QA/QC at TDI.

4. The NRC staff has formed a TDI Project Group to specifically address and evaluate TDI EDG problems. The staff has engaged the Battelle Pacific Northwest Laboratory (PNL) as a consultant for this effort.

5. In response to the TDI engine problems, thirteen U.S. nuclear utility owners formed a TDI diesel generator Owners Group to address reliability, operability, and quality assurance issues relative to diesel generators used for standby emergency power. The Owners Group was initiated on October 25, 1983. On March 2, 1984, the Owners Group submitted their plan to the U.S. Nuclear Regulatory Commission. The Owners Group program embodies three major efforts as follows:

1. Phase 1: Resolution of 16 known generic problem areas intended by the Owners Group to serve as a basis for the licensing of plants during the period prior to completion and implementation of the Owners Group program.

2. Phase 2: A design review/quality revalidation (DR/QR) of a larger set of important engine components to assure their design and manufacture, including specifications, quality control and quality assurance, and operational surveillance and maintenance, are adequate.

3. Identification of any needed additional engine testing or inspections based on findings from Phases 1 and 2.

6. A more detailed description of the program is given in the staff's Safety Evaluation Report on the TDI Diesel Generator Owners Group Program Plan dated August 13, 1984. In that SER, the staff concluded 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 in nuclear service. With the implementation of an enhanced maintenance and surveillance program, the staff concluded that the TDI diesel engines would comply with GDC 1 and GDC 17 throughout the life of the plant.

7. The Owners Group has completed its generic reviews of the 16 Phase 1 generic components and has submitted these reports to the staff. The

applicant has committed to follow all Phase I recommendations from the Owners Group program.

8. The staff, with assistance from PNL, is in the process of completing its review of the Phase 1 component analyses. To date, the staff has completed and issued its evaluation of the following components:

1) EDG and Auxiliary Module Wiring and Terminations
2) Air Start Valve Capscrews
3) Rocker Arm Capscrews
4) Engine Base and Bearing Caps.

Reports 1 and 2 above (Enclosures 1 and 2) address the Joint Intervenors' specific concerns about the reliability of the air start valve assemblies and the engine mounted electrical cables, and resolve these issues.

Preliminary conclusions about the remaining Phase I items have been made by PNL and were presented at an Owners Group meeting with the staff on February 11, 1985. These preliminary results were favorable. The staff expects to issue a report on all of the Phase I components this fall, and this final report will confirm the staff's belief that these components are satisfactory for their intended purpose.

9. The Owners Group has completed the DR/QR (Phase II Owners Group Report) for Vogtle. The applicant submitted the Vogtle DR/QR report to the staff on January 18, 1985. The Vogtle DR/QR is based on the Comanche Peak DR/QR using Comanche Peak Unit 1 as the "lead" engine in the V-16

category. The Comanche Peak and Vogtle engines are similar V-16 units. By letter dated April 26, 1985, the applicant committed to implement the recommendations from the DR/QR. It has taken exceptions to two of the recommendations pertaining to the addition of a Dresser coupling on the engine-driven lube oil pump suction line, and the replacement of certain slip-on joints on the exhaust manifolds with slip-on flanges. These exceptions are not significant, but the staff will review and evaluate them to ensure that they do not adversely affect EDG reliability. Staff consultant PNL has completed but has not formally issued its final evaluation of the DR/QR programs at Comanche Peak Unit 1 and Shoreham. The review of the Comanche Peak Unit 1 DR/QR has not revealed any programmatic deficiencies. All suggestions and recommendations identified in the PNL/staff Phase II reports for Shoreham and Comanche Peak will be resolved to the satisfaction of the staff upon finalization of these reports.

10. Vogtle, Perry, Comanche Peak Unit 1, Grand Gulf Unit 1, and Catawba all have DSRV-16-4 engines. They consist of 16 cylinders arranged in a "vee." The staff has performed reviews of EDG adequacy for Comanche Peak Unit 1, Perry(in NUREG-0887, Supplement No. 6, Section 9.5.5.1, dated April, 1985), Grand Gulf Unit 1(in NUREG-0831, Supplement No. 6, Section 8.3.1, dated August, 1984) and Catawba(in NUREG-0954, Supplement 4, Section 8.3.1.1, December, 1984) and has issued interim SERs for each.

The SERs were "interim" in that they were issued prior to completion of the entire Owners Group Program and staff review of Owners Group findings. The staff SER on the Owners Group Program Plan dated August

13, 1984, specified considerations which must be addressed by individual utility owners requesting a full power license prior to completing the Owners Group Program and prior to completion of staff review and approval of Owners Group findings.

11. The plant-specific SERs already issued by the staff for all of the above named plants addressed the actions taken by the applicants to implement the recommendations and conclusions put forth by the Owners Group and the staff. These actions included the replacement of parts as a result of Phase I and Phase II component inspections, design modifications, preoperational testing, and proposed maintenance and surveillance programs.

The staff SER on the Owners Group Program Plan (August 13, 1984) reflected the information available at that time and identified concerns regarding the acceptability of AE piston skirts at operating engine loads greater than those corresponding to a brake mean effective pressure (BMEP) of 185 psig. In addition, at that time some concerns regarding crankshaft design adequacy were identified. However, the staff concluded that the 185 psig BMEP load restriction would be sufficiently conservative during the "interim" period while those concerns were being evaluated. Therefore, each of the staff SERs noted above restricted EDG loads to limit engine BMEP to a maximum of 185 psig. This corresponds to an engine electrical output of 5740 kW.

12. Subsequent to imposing the engine load restrictions (due to AE piston concerns), operating experience obtained from both the TDI R-5 engine tests and from the Shoreham EDG-103 confirmatory "qualified" load testing led PNL and the staff to conclude that AE pistons skirts (which are installed at Vogtle) are adequate for service at the full design rating of 225 psig BMEP. This corresponds to an engine electrical output of 7000 kW. The staff will remove the 185 psig BMEP limitation with the publication of its Phase I final report to be issued this fall. The Phase I final report will also resolve the concerns mentioned above regarding the crankshaft design adequacy, and will present the bases for operating the V-16 engines at their full design rating.

13. Consistent with the actions taken at Grand Gulf, Perry, Comanche Peak, and Catawba, the applicants have committed to perform the major actions the staff considers necessary for licensing. These actions consist of a teardown and inspection(now completed at Vogtle), and implementation of Owners Group Phase I and Phase II recommendations including the implementation of an enhanced maintenance and surveillance program.

14. In addition, consistent with the requirements established by the staff during the Grand Gulf, Perry, Catawba, and Comanche Peak reviews, the applicants have committed to perform torsiograph tests on the Vogtle engines as recommended by the Owners Group. These tests will confirm the

adequacy of both Unit 1 crankshafts. The staff will review the results of these tests.

15. Although the staff will not perform a detailed review of the Vogtle DR/QR report, or any other DR/QR reports for non-"lead" engines, the staff believes that the Owners Group program plan which will be followed by the applicants provides the requisite assurance of the reliability of the TDI EDGs to perform their intended function. Because of the similarity between the Vogtle and Comanche Peak diesels, and the degree of reliance of Vogtle on the Comanche Peak DR/QR report, the staff believes, based on its Comanche Peak review, that no open items of sufficient concern would be identified which would require resolution prior to licensing.

The staff believes that no substantive concerns about the governor lube oil coolers remain, based on the similarity of the Vogtle and Comanche Peak engines, and the preliminary results of the Comanche Peak DR/QR review. The staff will confirm this belief prior to the licensing of Vogtle.

16. The staff believes that the applicants' preoperational testing program for Vogtle will be adequate to demonstrate engine operability by detecting any abnormal engine behavior during the tests. The applicants have proposed to perform all tests recommended by the Owners Group. The staff approved the Owners Group test program in its August 13, 1984 Program Plan SER.

17. The applicants have agreed to implement the maintenance and surveillance recommendations of the Owners Group, with minor exceptions not here germane. The Owners Group maintenance and surveillance plan, as amended by Comanche Peak in a letter from J. George of Texas Utilities Generating Company dated June 27, 1985 (TXX-4501), will be confirmed this fall to be acceptable for generic application to all V-16 engines, including Vogtle, for the life of the plant. Since the maintenance and surveillance plan for Vogtle will be implemented consistent with a staff-approved generic plan for all V-16 engines, we believe that an adequate maintenance and surveillance plan will be in effect at Vogtle prior to licensing.

18. The staff disagrees with the conclusions set forth in Joint Intervenors' Contention 14. The staff believes that the Vogtle TDI engines will be reliable at the time Vogtle is licensed, based on: 1) the Owners Group Program to resolve reliability issues on the TDI engines, 2) staff review of the adequacy of certain Phase 1 components, 3) the Phase 2 DR/QR review conducted for Comanche Peak Unit 1 and the similarity of the Vogtle diesels to those at Comanche Peak, 4) previous staff conclusions on similar engines at Comanche Peak, Perry, Grand Gulf and Catawba, 5) preliminary findings by PNL on the remainder of the Phase 1 generic components, 6) the commitment by the applicants to implement a maintenance/surveillance program at Vogtle recommended by the Owners Group which will be reviewed by the staff, 7) preoperational testing at Vogtle to be conducted as proposed by the applicants, and 8) the applicants' commitment to perform a torsiograph test and submit the results to the staff for approval.

Carl H. Berlinger

Carl H. Berlinger

Subscribed and sworn to before me this 23rd day of September, 1985

Melinda L. McDonald

Notary Public

My commission expires: 7/1/86

Professional Qualifications of

Carl H. Berlinger

Division of Licensing

Office of Nuclear Reactor Regulation

United States Nuclear Regulatory Commission

My name is Carl H. Berlinger, I am the Group Manager of the TDI Project Group. In this position I manage the activities of the Project Group staff and coordinate the efforts of NRR and other offices, interface with industry and licensees and as appropriate keep the ACRS, hearing boards and the Commission informed regarding the status and resolution of this issue. I have held this position since January 16, 1984.

I received a Ph.D in Mechnical Engineering from the University of Connecticut in 1971, and a Bachelor of Science and a Master of Science degrees in Mechanical Engineering from Clarkson College of Technology in 1960 and 1962, respectively.

Detailed Experience Record

Carl H. Berlinger

September 1981
to
January 1984

UNITED STATES NUCLEAR REGULATORY COMMISSION

Division of Systems Integration - Core Performance Branch

Branch Chief -

Duties included:

1. Management of the activities of a branch engaged in the review, analysis and evaluation of calculational methods used by applicants for the licensing of nuclear power plants in the fuel and core design areas of reactor plant engineering.

2. Responsible for development and application, in conjunction with consultants, of independent calculational methods including complex computer codes for the analysis of fuel and reactor core performance during steady-state, transient, and accident conditions.

3. Participates as a technical specialist on various NRC committees, subcommittees, panels, task force assignments, and on technical, industrial and professional society committees.

4. Represents the Commission in dealings with other governmental departments and agencies, national laboratories, industry and industry organizations in discussion of complex technical matters in the areas of new or proposed reactor systems.

November 1980
to
September 1981

USNRC

Division of Licensing - Systematic Evaluation Program Branch

Section Leader - Systems Engineering

Duties included:

1. Supervised senior technical staff in the Systems Engineering section.

2. Responsible for the analysis, evaluation and safety reviews in the areas of thermal hydraulics, physics, site hazards, and safety analyses aspects of the reactor core, primary and secondary plant systems, electrical and auxiliary systems.

January 1980
to
November 1980

USNRC

Division of Licensing - Operating Experience Evaluation Branch

Branch Chief -

Duties included:

1. Organized newly formed branch; formulated goa's and objectives.

2. Established procedures and significance criteria for systematic screening and technical review of domestic and foreign licensee event reports and operating experience reports, respectively.

3. Initiated staff reviews of significant licensee events.

4. Developed licensee event reporting requirements.

5. Managed and participated in the investigation of plant operating problems and identified generic reactor operating problems.

April 1976
to
January 1980

USNRC

Division of Operating Reactors - Reactor Safety Branch

Section Leader -

Duties included:

1. Provided technical supervision and review of senior technical staff in the Reactor Safety Branch.

2. Planned, coordinated and reviewed safety design evaluations of reactor cores, reactor systems, and engineerined safety features, and in accident analysis evaluations.

3. Acted as contract coordinator.

4. Served on the initial on-site response team sent to TMI.

5. Served as the team leader of the on-site response team sent to Oyster Creek following the 1979 plant transient.

6. Served as a reactor systems expert detailed to the Office of the Executive Director.

September 1973 to April 1976

USNRC (AEC)

Division of Operating Reactors - Reactor Systems Branch

Senior Nuclear Engineer - Reactor Systems Section

Duties included:

1. Served as a senior reactor systems specialist.

2. Responsible for analyzing and evaluating proposed nuclear reactor designs in the areas of thermal hydraulics, nuclear and reactor system performance.

3. Represented the AEC before ACRS, licensee and industry meetings.

4. Responsible for making technical recommendations and formulating technical positions regarding standards, regulatory guides and codes as related to reactor safety.

August 1970 to September 1973

COMBUSTION ENGINEERING CORPORATION

Nuclear Power Division - Accident Analysis Department

Principal Safety Engineer -

Duties included:

1. Responsible for the development of analytical tools for analysis of LMFBR maximum hypothetical accidents.

2. Performed quality assurance of complex computer codes and plant safety analysis (including LOCA and plant transients).

3. Presented testimony before ACRS regarding the San Onofre Units 2 and 3 plants.

4. Developed a transient steam generator/superheater model for the once through steam generator with integral economizer.

February 1969 to August 1970

UNIVERSITY OF CONNECTICUT

Mechanical Engineering Department

Graduate Teaching Assistant -

Duties included:

1. Taught undergraduate heat transfer course.

2. Designed, procurred, constructed and operated all equipment and instrumentation required for Ph.D dissertation.

3. Administered a research budget of $20,000.

August 1961 to February 1969

PRATT AND WHITNEY AIRCRAFT

Advanced Power Systems

Senior Analytical Engineer -

Duties included:

1. Planning and coordinating research and development of advance engineering products.

2. Analyzed heat transfer, thermodynamic and aerodynamic problems.

3. Supervised the design, manufacture, testing and evaluation of new design concepts.

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

June 25, 1985

Docket Nos.: 50-322/416-417/206/312/458-459/400-401/413-414/440-441
50-438-439/445-446/424-425/329-330/460

Mr. J. B. George, Chairman
Transamerica Delaval, Inc.
Owners Group
Texas Utilities Generating Company
Post Office Box 1002
Glen Rose, Texas 76043

Dear Mr. George:

SUBJECT: SAFETY EVALUATION REPORT, TRANSAMERICA DELAVAL, INC. DIESEL GENERATOR OWNERS GROUP ANALYSIS OF THE R-4 AND RV-4 SERIES EMERGENCY DIESEL GENERATOR ENGINE AND AUXILIARY MODULE WIRING AND TERMINATIONS

Enclosed is the staff's evaluation of the Owners Group analysis of the Engine and Auxiliary Module Wiring and Terminations being used by the Transamerica Delaval, Inc. on the Series R-4 and RV-4 diesel engines. The staff found that wiring and termination at the plants listed below are adequately designed for their intended use:

Comanche Peak Steam Electric Station Unit 1
Grand Gulf Nuclear Station Unit 1
Perry Nuclear Power Plant Unit 1
Rancho Seco Nuclear Power Station Unit 1
River Bend Nuclear Power Station Unit 1
San Onofre Nuclear Generating Station Unit 1, Engine No. 1 and 2
Shearon Harris Nuclear Power Plant Unit 1
Shoreham Nuclear Power Station

Also, the staff found that wiring and terminations at Catawba and Midland were adequately designed for their intended use subject to the following actions being completed:

1. Catawba

   a. The period of manufacture of States-Type NT sliding link terminal blocks should be verified in accordance with NRC IE Information Notice No. 80-08 of March 7, 1980.

b. Certain Kyner-insulated, 14 AWG wire should be replaced with wire qualified to IEEE-383-1974.

2. Midland

Construction on the Midland Plant was suspended, but if it resumes, TDI SIM 361 should be implemented and the period of manufacture of States-Type link terminal blocks should be verified.

The Owners Group did not address the wiring and terminations for Vogtle-1, Bellefonte-1, and WNP-1 as part of their Phase I reports. Instead, these items were to be addressed during the plant-specific Phase II (DR/QR) reviews. The Owners Group, which has completed all of the DR/QR reviews, has used the same approach to verify the adequacy of the wiring and terminations for these three plants. On that basis, the staff finds that the wiring and terminations at Vogtle-1, Bellefonte-1, and WNP-1 are adequately designed for their intended use, provided that the licensee implements the Owners Group recommendations reached in the DR/QR reports issued by the Owners Group for these plants. Any exceptions to the Owners Group recommendations will have to be submitted by the licensee to the NRC for review.

Hugh L. Thompson, Jr., Director
Division of Licensing

Enclosure:
As stated

cc w/enclosure:
C. Ray, TDI

SAFETY EVALUATION REPORT (SER)

TRANSAMERICA DELAVAL INC. (TDI) DIESEL GENERATOR OWNERS GROUP
ANALYSIS OF THE R-4 AND RV-4 SERIES EMERGENCY DIESEL
GENERATOR ENGINE AND AUXILIARY MODULE WIRING AND TERMINATION

Introduction and Background

Concerns regarding the reliability of large bore, medium speed diesel generators of the type supplied by Transamerica Delaval, Inc. (TDI) at 16 domestic nuclear plants were first prompted by a crankshaft failure at Shoreham in August 1983. However, a broad pattern of deficiencies in critical engine components later became evident at Shoreham, Grand Gulf Unit 1, and at other nuclear and non-nuclear facilities employing TDI diesel generators. These deficiencies stem from inadequacies in design, manufacture and QA/QC by TDI.

In response to these problems, 13 U.S. nuclear utility owners formed a TDI Diesel Generator Owners Group to address operational and regulatory issues relative to diesel generator sets used to provide standby emergency power. The Owners Group program, which was initiated in October 1983, embodies three major efforts:

1. Resolution of 16 known generic problem areas (Phase I program);

2. Design review of important engine components and quality revalidation of important attributes for selected engine components (Phase II program); and

3. Identification of any needed additional engine testing or inspections, based on findings stemming from the Phase I and II programs.

The Owners Group program plan, submitted on March 2, 1984, was reviewed by the U.S. Nuclear Regulatory Commission (NRC) in a Safety Evaluation Report (SER) on August 13, 1984.

The Owners Group has performed design analysis and considered surveillance requirements for the 16 components in Phase I to ascertain whether their design would be acceptable for application to specific engine designs. The components are as follows: Air Start Valve Capscrews, Connecting Rods, Connecting Rod Bearing Shells, Crankshaft, Cylinder Block, Cylinder Heads, Cylinder Head Studs, Cylinder Liner, Engine Base and Bearing Caps, Engine Mounted Electrical Cable, High Pressure Fuel Oil Tubing, Jacket Water Pumps, Piston Skirts, Push Rods, Rocker Arm Capscrews and Turbochargers. The engines considered were the DSR-48 (in-line 8), DSRV-12, DSRV-16, and DSRV-20.

The wiring and terminations reviewed in this SER apply to the following plants: Catawba Nuclear Station Unit 1, Comanche Peak Steam Electric Station Unit 1, Grand Gulf Nuclear Station Unit 1, Midland Nuclear Power Plant, Perry Nuclear Power Plant Unit 1, Rancho Seco Nuclear Power Station Unit 1, River Bend Nuclear Power Station Unit 1, San Onofre Nuclear Generating Station Unit 1, Engine No. 1 and 2, Shearon Harris Nuclear Power Plant Unit 1, Shoreham Nuclear Power Station, Vogtle-1, Bellefonte-1, and WNP-1.

Phase I reports on wiring and terminations were issued by the Owners Group for all but the last 3 plants, i.e., Vogtle-1, Bellefonte-1, and WNP-1. The latter three were reviewed by the Owners Group to the same criteria as the former 10, but specific Phase I reports were not developed; the results of the review were included in the Phase II DR/QR reports because of the plant specific nature of this component and because Phase II reports were being developed at the time.

Evaluation

The enclosure to this SER is a Technical Evaluation Report (TER), entitled "Review of Emergency Diesel Generator Engine and Auxiliary Module Wiring and Terminations." This TER was prepared by Pacific Northwest Laboratory (PNL) which 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. PNL has retained the services of several expert diesel consultants as part of its review staff.

The staff, PNL and its consultants reviewed the Owners Group submittals listed in the references and have performed onsite inspections of the wiring and terminations at several nuclear plants. The staff has reviewed the enclosed TER, and adopts the TER as part of this safety evaluation by reference.

The Stone and Webster Engineering Company (SWEC), a consultant to the Owners Group, performed a survey at each of the plants listed previously to review the following:

- Identify all wiring and terminations supplied with the diesel engines from TDI manuals (or, in the case of Shoreham, from SWEC design documents).

- Review the wiring insulation for compatibility with circuit requirements.

- Determine if the insulating material is known to have generic fire-retardant characteristics and is qualified to selected industry standards.

- Review the wiring installation routing to determine the physical environment for each cable.

- Evaluate circuit requirements to determine if special cable is required.

- Compare the termination types, materials, sizes, and insulation ratings as given in the manufacturer's specifications with the characteristics required for the particular circuit and environment.

The SWEC survey found that most plants had wiring and terminations that were properly rated. Some of the installations were deficient and SWEC recommended that wiring be replaced and that certain terminations be verified. The specific plant deficiencies in the first 10 plants are summarized in Section 2.2 of the PNL TER. Recommendations with regard to the other 3 plants are in the individual DR/QR reports for Vogtle-1, Bellefonte-1, and WNP-1.

The staff and PNL concur in the approach used to evaluate the class 1E auxiliary module wiring and terminations currently installed on TDI diesel generators at the nuclear power plants reviewed.

Conclusions

As a result of the review performed by the Owners Group and PNL and upgrades put in place by the licensee, the staff finds that the wiring and terminations at the plants listed below are adequately designed for their intended use:

Comanche Peak Steam Electric Station Unit 1
Grand Gulf Nuclear Station Unit 1
Perry Nuclear Power Plant Unit 1
Rancho Seco Nuclear Power Station Unit 1
River Bend Nuclear Power Station Unit 1
San Onofre Nuclear Generating Station Unit 1, Engine No. 1 and 2
Shearon Harris Nuclear Power Plant Unit 1
Shoreham Nuclear Power Station

Also, the staff found that wiring and terminations at Catawba and Midland were adequately designed for their intended use subject to the following actions being completed:

1. Catawba

   a. The period of manufacture of States-type NT sliding link terminal blocks should be verified in accordance with NRC IE Information Notice No. 80-08 of March 7, 1980.

   b. Certain Kyner-insulated, 14 AWG wire should be replaced with wire qualified to IEEE-383-1974.

2. Midland

Construction on the Midland Plant was suspended but if it resumes, TDI SIM 361 should be implemented and the period of manufacture of Stater-Type link terminal blocks should be verified.

The Owners Group did not address the wiring and terminations for Vogtle-1, Bellefonte-1, and WNP-1 as part of their Phase I reports. Instead, these items were to be addressed during the plant specific Phase II (DR/QR) reviews. The Owners Group, which has completed all of the DR/QR reviews, has used the same approach to verify the adequacy of the wiring and terminations for these three plants. On that basis, the staff finds that the wiring and terminations at Vogtle-1, Bellefonte-1, and WNP-1 are adequately designed for their intended use provided that the licensee implements the Owners Group recommendations reached in the DR/QR reports issued by the Owners Group for these plants. Any exceptions to the Owners Group recommendations will have to be submitted by the licensee to the NRC for review.

REFERENCES

1. Letter, D. G. Eisenhut (NRC) to J. B. George (TUGCo), "Safety Evaluation Report, Transamerica Delaval, Inc., Diesel Generator Owners Group Program Plan" dated August 13, 1984.

2. Battelle Pacific Northwest Laboratory May 1985 Technical Evaluation Report, "Review of Emergency Diesel Generator Engine and Auxiliary Module Wiring and Terminations," PNL-5200-3.

Technical Evaluation Report

Review of Emergency Diesel Generator Engine and Auxiliary Module Wiring and Terminations

May 1985

Prepared for
the U.S. Nuclear Regulatory Commission
Division of Licensing
Office of Nuclear Reactor Regulation
under Contract DE-AC06-76RLO 1830
NRC FIN B2952

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

Battelle

PNL-5200-3

Technical Evaluation Report

REVIEW OF EMERGENCY DIESEL GENERATOR ENGINE AND AUXILIARY MODULE WIRING AND TERMINATIONS

May 1985

Prepared for
the U.S. Nuclear Regulatory Commission
Division of Licensing
Office of Nuclear Reactor Regulation
under Contract DE-AC06-76RL0 1830
NRC FIN B2952

Project Title: Assessment of Diesel Engine Reliability/Operability

NRC Lead Engineer: C. H. Berlinger

Pacific Northwest Laboratory
Richland, Washington 99352

FOREWORD

This report is supplied as part of the Technical Assistance Project, Assessment of Diesel Engine Reliability/Operability, being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Licensing, by the Pacific Northwest Laboratory. The U.S. Nuclear Regulatory Commission funded this work under authorization B&R 20-19-40-42-1 FIN No. B2952.

PACIFIC NORTHWEST LABORATORY

PROJECT APPROVALS

W. W. Laity

W. W. Laity, Project Manager
Pacific Northwest Laboratory

Date May 9, 1985

W. D. Richmond

W. D. Richmond, Chairman
Senior Review Panel
Pacific Northwest Laboratory

Date 5-17-85

ACKNOWLEDGMENTS

This report was compiled by PNL project team members J. F. Nesbitt and F. R. Zaloudek based on technical contributions provided by PNL staff member C. L. Wilson and consultants E. Loftus, P. J. Louzecky, W. R. McSpadden, J. E. Horner, and N. M. Rivera.

ABSTRACT

This report documents the review performed by the Pacific Northwest Laboratory (PNL) of action taken by the Transamerica Delaval, Inc. (TDI) Diesel Generator Owners' Group to evaluate wiring and terminations for TDI engines at 10 nuclear power plants. In response to TDI Service Information Memo (SIM) 361, Rev. 1, concerning potentially defective engine-mounted cables for the Woodward governor/actuator and the Air-Pax magnetic pickup, the Owners' Group authorized Stone & Webster Engineering Corporation (SWEC) to evaluate all class IE auxiliary module wiring and terminations installed on the engines. The evaluations are described in five SWEC reports.

In field surveys of the engine installations, SWEC investigated the compatibility of the wiring and terminations on the diesel engines with the electrical and environmental service characteristics of the applications. SWEC conclusions and recommendations are as follows:

- The existing wiring and terminations are acceptable for service at the following installations:
  - Comanche Peak
  - Grand Gulf
  - Perry
  - Rancho Seco
  - River Bend
  - San Onofre Engine No. 2
  - Shearon Harris
- The following recommendations should be implemented at the installations noted:
  - Catawba: TDI SIM 361 should be implemented, the period of manufacture of the States-type sliding link terminal blocks should be verified, and certain Kyner-insulated wire should be replaced.

- Midland: TDI SIM 361 should be implemented, and the period of manufacture of the States-type sliding link terminal blocks should be verified. (Construction of this power plant was subsequently suspended.)
- San Onofre Engine No. 1: TDI SIM 361 should be implemented.
- Shoreham: Wiring with type MTW insulation should be replaced in the circuits for the crankcase vacuum fans and the starting air supply solenoid valves.

PNL concurs with the conclusions and recommendations described in the SWEC reports.

CONTENTS

REVIEW OF
EMERGENCY DIESEL GENERATOR ENGINE AND AUXILIARY MODULE WIRING AND TERMINATIONS

1.0 INTRODUCTION

The Pacific Northwest Laboratory (PNL) is supporting the U.S. Nuclear Regulatory Commission (NRC) staff in addressing questions of the reliability, operability, and quality assurance of Transamerica Delaval, Inc. (TDI) diesel engines used to provide standby power in some nuclear power plants. These questions were raised because of a major failure in one TDI diesel at the Shoreham Nuclear Power Station in August 1983 and other problems encountered with TDI diesels. One of the principal tasks in PNL's effort is to evaluate the resolution by the TDI Owners' Group of known problems with potential generic applicability.

This report documents PNL's evaluation of the Owners' Group review of the electrical wiring and terminations supplied with the TDI emergency diesel generators at the Catawba, Comanche Peak, Grand Gulf, Midland, Perry, Rancho Seco, River Bend, San Onofre, Shearon Harris, and Shoreham nuclear power stations. The details of the Owners' Group review were presented in five reports prepared by Stone & Webster Engineering Corporation (SWEC):

- Emergency Diesel Generator Engine and Auxiliary Module Wiring and Termination Qualification to IEEE-383-1974, April 1984
- Supplement To The Emergency Diesel Generator Auxiliary Module Control Wiring and Termination Qualification Review, DR4-210-013, May 4, 1984
- Supplement to the Emergency Diesel Generator Auxiliary Module Control Wiring and Termination Qualification Review, B2-1160060-2, June 1984
- Supplement to the Emergency Diesel Generator Auxiliary Module Control Wiring and Termination Qualification Review, B2-1160060-4, June 1984
- Emergency Diesel Generator Auxiliary Module Control Wiring and Termination Qualification Review, TDI0287, July 1984.

1.1 ISSUE ADDRESSED BY OWNERS' GROUP

TDI's Service Information Memo (SIM) 361, Rev. 1, notified the engine owners of potentially defective engine-mounted cables associated with the Woodward governor/actuator and the Air-Pax magnetic pickup. This memo led the Owners' Group to question the suitability of all class IE auxiliary module wiring and terminations currently installed on the diesel engines. Of special interest was the suitability of this wiring with respect to flame-retardancy of the insulation, qualification to industry standards, routing of conduit, compatibility with circuit requirements, and the need for special requirements such as shielding.

1.2 DESCRIPTION OF INSTALLATIONS

All cable/wire associated with the engines is generally routed in either electrical metallic tubing (EMT), rigid galvanized steel conduit, or flexible conduit. A variety of wire and insulation types is used, depending on the characteristics of the circuit. These include types SIS, MTW, XLPE, and XHHW. The conduits installed on the skid and supported away from the engine are potentially subject to the maximum room temperature (120°F to 140°F). The junction boxes, conduits, and cables attached to the engine block are potentially subject to at least engine cooling jacket/lubricating oil temperature (180°F).

2.0 OWNERS' GROUP STUDY

This issue was addressed by SWEC, a consultant to the Owners' Group. The objectives of the SWEC effort were to examine the functional attributes of the electrical wiring and terminations supplied with the diesel engines and to determine their suitability for the intended purpose.

2.1 SCOPE OF INVESTIGATION

The scope of SWEC's investigation encompassed the following activities:

- Identify all wiring and terminations supplied with the diesel engines from TDI manuals (or, in the case of Shoreham, from the SWEC design documents).
- Review the wiring insulation for compatibility with circuit requirements.
- Determine if the insulating material is known to have generic fire-retardant characteristics and is qualified to selected industry standards.
- Review the wiring installation routing to determine the physical environment for each cable.
- Evaluate circuit requirements to determine if special cable is required.
- Compare the termination types, materials, sizes, and insulation ratings as given in the manufacturer's specifications with the characteristics required for the particular circuit and environment.

2.2 SUMMARY OF RESULTS

2.2.1 Shoreham Nuclear Power Station

SWEC surveyed the class IE auxiliary module wiring and terminations currently installed on the TDI diesel engines at Shoreham. Each circuit's service characteristics were identified and compared to the service ratings of the cable and termination types used. IEEE-383-1974 was used as the basis for this review.

As reported in Emergency Diesel Generator Engine and Auxiliary Module Wiring and Termination Qualification to IEEE-383-1974 (April 1984), SWEC reached the following conclusions for the Shoreham engines:

- Qualified replacement cable was provided by TDI and installed on the diesel engines in accordance with SIM 361, Rev. 1.

- The module wiring, cable, and terminations are compatible with the circuit characteristics and the operating environment, except for the wiring with type MTW insulation used in the circuits for the crankcase vacuum fans and the starting air supply solenoid valves. Type MTW insulation is not compatible with expected ambient temperatures in these circuits. The selected replacement cable, Okonite 1/C#12-19X Black Okozel (Tefzel insulation), type ZW, rated at 125°C, is acceptable for the expected operating temperature (87.2°C). When this replacement is accomplished, all functional attributes established for the design review of the wiring and terminations will be satisfied.

2.2.2 Comanche Peak Steam Electric Station Unit 1

Taking into consideration the same attributes and qualifications as those applied at Shoreham, SWEC conducted a field survey of the class IE auxiliary module wiring and terminations currently installed on the TDI diesel engines at Comanche Peak. SWEC reported in the Supplement to the Emergency Diesel Generator Auxiliary Module Wiring and Termination Qualification Review (May 1984) that all wiring and terminations are acceptable for their intended service.

2.2.3 Grand Gulf Nuclear Station Unit 1

In the Supplement to the Emergency Diesel Generator Auxiliary Module Control Wiring and Termination Qualification Review (B2-1160060-2, June 1984), SWEC concluded from a field survey of the TDI diesel engines at Grand Gulf that qualified replacement cable had been installed in accordance with SIM 361, Rev. 1, and that all wiring and terminations are acceptable for their intended service.

2.2.4 Catawba Nuclear Station Unit 1

The results of the field survey conducted by SWEC on the TDI engines at Catawba are reported in the Supplement to the Emergency Diesel Generator Auxiliary Module Control Wiring and Termination Qualification Review

(B2-1160060-4, June 1984). SWEC found the wiring and terminations acceptable for their intended service, subject to implementation of the following recommendations:

- TDI SIM 361 should be implemented.
- In accordance with NRC IE Information Notice No. 80-08 of March 7, 1980, the period of manufacture of States-type NT sliding link terminal blocks (item 5 in Table A of the SWEC report) should be checked to verify that the blocks were produced in a time period other than 1974 through 1976.
- The Kyner-insulated, 14 AWG wire identified as item 2 in Table A of the SWEC report should be replaced with wire qualified to IEEE-383-1974.

2.2.5 Other Nuclear Power Stations

The results of the field surveys conducted on class IE auxiliary module wiring and terminations installed on TDI diesel engines at six other nuclear power stations were reported by SWEC in Emergency Diesel Generator Auxiliary Module Control Wiring and Termination Qualification Review (July 1984). SWEC found the existing wiring, cable, and terminations acceptable for their intended service on the TDI engines at the following installations:

- Perry Nuclear Power Plant Unit 1
- Rancho Seco Nuclear Power Station Unit 1
- River Bend Nuclear Power Station Unit 1
- San Onofre Nuclear Generating Station Unit 1, Engine No. 2
- Shearon Harris Nuclear Power Plant Unit 1.

SWEC also found the wiring and terminations acceptable for the intended service at the following installations, subject to implementation of certain recommendations:

- Midland Nuclear Power Plant - TDI SIM 361 should be implemented, and the period of manufacture of the States-type sliding link terminal blocks should be verified.

- San Onofre Nuclear Generating Station Unit 1, Engine No. 1 - TDI SIM 361 should be implemented.

2.3 REVIEWS DEFERRED TO PHASE II OF OWNERS' GROUP PROGRAM

SWEC commented in the above-mentioned report of July 1984 that wiring and terminations on engines not reviewed during Phase I of the Owners' Group Program will be reviewed as part of the Phase II Design Review/Quality Revalidation Program.

3.0 PNL'S EVALUATION

The following PNL staff and consultants participated in the reviews of the reports prepared by Stone & Webster Engineering Corporation on engine and auxiliary module wiring and terminations:

- J. F. Nesbitt, PNL project team
- E. Loftus, electrical engineer, Kaiser Engineers Hanford Co.
- P. J. Louzecky, consultant, Engineered Applications Corporation
- W. R. McSpadden, Ph.D., engineering consultant
- J. E. Horner, consultant, Seaworthy Systems, Inc.
- N. M. Rivera, consultant, Designers and Planners, Inc. (TRACOR Hydronautics, Inc.)
- C. L. Wilson, PNL staff.

PNL's reviews focused on the following areas:

- Were the methods of analysis and approaches taken in the studies satisfactory?
- Are the information and data collected in the studies adequate for proper evaluation?
- Are the conclusions and recommendations supportable?
- Have the objectives of the study been met?

PNL's reviews focused on the SWEC reports. Some use was made of specific references and written and oral information requested from and provided by the Owners' Group.

4.0 CONCLUSIONS AND RECOMMENDATIONS

PNL concurs with the approach used to evaluate the class IE auxiliary module wiring and terminations currently installed on TDI diesel generators at 10 nuclear power plants owned by the TDI Diesel Generator Owners' Group. PNL also concurs with the conclusions and recommendations in the five SWEC reports on the field surveys of the wiring and terminations. SWEC's conclusions and recommendations, and the references for them, are discussed in Section 2.2 of this report. They are categorized under the two subheadings that follow according to those found to be satisfactory during the field surveys and those for which SWEC recommended that certain actions by taken.

4.1 INSTALLATIONS FOR WHICH NO FURTHER ACTION IS NECESSARY

SWEC concluded that the existing class IE auxiliary module wiring and terminations are acceptable for service on TDI diesel engines at the installations listed below. On the basis of the field surveys reported by SWEC, PNL concurs that no further action to upgrade the engine-mounted wiring and terminations at these installations is necessary:

- Comanche Peak Steam Electric Station Unit 1
- Grand Gulf Nuclear Station Unit 1
- Perry Nuclear Power Plant Unit 1
- Rancho Seco Nuclear Power Station Unit 1
- River Bend Nuclear Power Station Unit 1
- San Onofre Nuclear Generating Station Unit 1, Engine No. 2
- Shearon Harris Nuclear Power Plant Unit 1.

4.2 INSTALLATIONS RECOMMENDED FOR FURTHER ACTION

SWEC concluded that the wiring and terminations on TDI diesel engines are acceptable for service at three other installations, subject to implementation of certain recommendations. These recommendations, and the status of action on each at the time this PNL report was written, are as follows.

4.2.1 Action Completed

- San Onofre Nuclear Generating Station Unit 1, Engine No. 1
  - SWEC Recommendation: TDI SIM 361 should be implemented.
  - Status: In a letter to NRC (C. H. Berlinger) dated April 3, 1985, the Owners' Group (A. M. Segrest) confirmed that SIM 361 has been implemented on this engine. (TDI SIM 361 had previously been implemented on Engine No. 2.)
- Shoreham Nuclear Power Station
  - SWEC Recommendation: Wiring with type MTW insulation should be replaced in three circuits for the crankcase vacuum fans and the starting air supply solenoid valves. The selected replacement cable, Okonite 1/C#12-19X Black Okozel (Tefzel insulation), is acceptable for the expected operating temperature.
  - Status: In a letter to NRC (C. H. Berlinger) dated May 7, 1985, Duke Power Company (A. M. Segrest) confirmed on behalf of the Owners' Group that this recommendation has been implemented.

4.2.2 Action Pending

- Catawba Nuclear Station Unit 1
  - SWEC Recommendations:
    a. TDI SIM 361 should be implemented.
    b. The period of manufacture of States-type NT sliding link terminal blocks should be verified in accordance with NRC IE Information Notice No. 80-08 of March 7, 1980.

c. Certain Kyner-insulated, 14 AWG wire should be replaced with wire qualified to IEEE-383-1974.

- Status: In a letter to NRC (C. H. Berlinger) dated April 3, 1985, Duke Power Company (A. M. Segrest) confirmed on behalf of the Owners' Group that SIM 361 has been implemented (recommendation a., above), but that the verification of the sliding link terminal blocks has not been performed to date (recommendation b.). Duke Power (A. M. Segrest) stated in a letter to NRC (C. H. Berlinger) dated May 7, 1985 that the Kyner-insulated wire has not yet been replaced (recommendation c.)

- PNL Recommendation: SWEC recommendations b. and c., above, should be implemented by Duke Power Company in a timely manner and no later than the first outage for power plant refueling.

4.2.3 Action Deferred

- Midland Nuclear Power Plant

  - SWEC Recommendations: TDI SIM 361 should be implemented, and the period of manufacture of States-type link terminal blocks should be verified.

  - Status: Construction of the Midland plant was suspended, and the owner, Consumers Power Company, withdrew from the TDI Diesel Generator Owners' Group.

  - PNL Recommendation: The SWEC recommendations should be implemented if construction of the Midland plant is resumed.

2.3

4.3 REVIEWS DEFERRED TO PHASE II OF OWNERS' GROUP PROGRAM

As noted in Section 2.2.6 of this report, SWEC observed that wiring and terminations on engines not reviewed during Phase I of the Owners' Group Program will be reviewed as part of Phase II, the Design Review/Quality Revalidation Program. PNL recommends that these later reviews be conducted using the same approach and with the same thoroughness as was used in the reviews already completed.

REFERENCES

ANSI/IEEE STD 383-1974. IEEE Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations. The Institute of Electrical and Electronics Engineers, Inc., New York, New York.

Ray, C. L., Jr. August 13, 1984. Letter to NRC (C. H. Berlinger, "TDI Diesel Generator Owners' Group Response to PNL and NRC Questions."

Segrest, A. M. April 3, 1985. Letter to NRC (C. H. Berlinger) re Response of TDI Owners' Group to Questions on Engine Wiring and Terminations.

Segrest, A. M. May 7, 1985. Letter to NRC (C. H. Berlinger) re Response of TDI Owners' Group to Questions on Engine Wiring and Terminations.

Stone & Webster Engineering Corporation. April 1984. Emergency Diesel Generator Engine and Auxiliary Module Wiring and Termination Qualification to IEEE-383-1974. Boston, Massachusetts.

Stone & Webster Engineering Corporation. May 1984. Supplement To The Emergency Diesel Generator Auxiliary Module Control Wiring and Termination Qualification Review. DR4-210-013, Boston, Massachusetts.

Stone & Webster Engineering Corporation. June 1984. Supplement to the Emergency Diesel Generator Auxiliary Module Control Wiring and Termination Qualification Review. B2-1160060-2, Boston, Massachusetts.

Stone & Webster Engineering Corporation. June 1984. Supplement to the Emergency Diesel Generator Auxiliary Module Control Wiring and Termination Qualification Review. B2-1160060-4, Boston, Massachusetts.

Stone & Webster Engineering Corporation. July 1984. Emergency Diesel Generator Auxiliary Module Control Wiring and Termination Qualification Review. TDI0287, Boston, Massachusetts.

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

June 17, 1985

Docket Nos: 50-322/416-417/206/312/458-459/400-401/413-414/440-441
50-438-439/445-446/424-425/329-330/460

Mr. J.B. George, Chairman
Transamerica Delavel, Inc.
Owners Group
Texas Utilities Generating Company
Post Office Box 1002
Glen Rose, Texas 76043

Dear Mr. George:

SUBJECT: SAFETY EVALUATION REPORT, TRANSAMERICA DELAVAL, INC. DIESEL GENERATOR OWNERS GROUP ANALYSIS OF THE R-4 AND RV-4 SERIES EMERGENCY DIESEL GENERATOR AIR START VALVE CAPSCREWS

Enclosed is the staff's evaluation of the Owners Group analysis of the Air Start Valve capscrews being used by the Transamerica Delaval, Inc. on the Series R-4 and RV-4 diesel engines. The staff found that the shorter capscrews currently recommended are adequately designed for their intended use. Certain installation and maintenance requirements should be followed by the owners as outlined in the evaluation of the enclosure.

Sincerely,

Hugh L. Thompson, Jr., Director
Division of Licensing

Enclosure: As Stated

cc: w/enclosure
C. Ray, TDI

SAFETY EVALUATION REPORT (SER)

TRANSAMERICA DELAVAL INC. (TDI) DIESEL GENERATOR OWNERS GROUP
ANALYSIS OF THE R-4 AND RV-4 SERIES EMERGENCY DIESEL
GENERATOR AIR START VALVE CAPSCREWS

INTRODUCTION AND BACKGROUND

Concerns regarding the reliability of large bore, medium speed diesel generators of the type supplied by Transamerica Delaval, Inc. (TDI) at 16 domestic nuclear plants were first prompted by a crankshaft failure at Shoreham in August 1983. However, a broad pattern of deficiencies in critical engine components later became evident at Shoreham, Grand Gulf Unit 1 and at other nuclear and non-nuclear facilities employing TDI diesel generators. These deficiencies stem from inadequacies in design, manufacture, and QA/QC by TDI.

In response to these problems, 13 U.S. nuclear utility owners formed a TDI Diesel Generator Owners Group to address operational and regulatory issues relative to diesel generator sets used to provide standby emergency power. The Owners Group program, which was initiated in October 1983, embodies three major efforts:

1. Resolution of 16 known generic problem areas (Phase I program);

2. design review of important engine components and quality revalidation of important attributes for selected engine components (Phase II program); and

3. identification of any needed additional engine testing or inspections, based on findings stemming from the Phase I and II programs.

The Owners Group program plan, submitted on March 2, 1984, was reviewed by the U.S. Nuclear Regulatory Commission (NRC) in a Safety Evaluation Report (SER) on August 13, 1984.

The Owners Group has performed design analysis and considered surveillance requirements for the 16 components in Phase I to ascertain whether their design would be acceptable for application to specific engine designs. The components are as follows: Air Start Valve Capscrews, Connecting Rods, Connecting Rod Bearing Shells, Crankshaft, Cylinder Block, Cylinder Heads, Cylinder Head Studs, Cylinder Liner, Engine Base and Bearing Caps, Engine Mounted Electrical Cable, High Pressure Fuel Oil Tubing, Jacket Water Pumps, Piston Skirts, Push Rods, Rocker Arm Capscrews and Turbochargers. The engines considered were the DSR-48 (in-line 8), DSRV-12, DSRV-16, and DSRV-20.

The Air Start Valve capscrews reviewed in this SER are applicable to all four engine configurations.

EVALUATION

The enclosure to this SER is a Technical Evaluation Report (TER) entitled "Review of Emergency Diesel Generator Air Start Valve capscrews." This TER was prepared by Pacific Northwest Laboratory (PNL) which 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. PNL has retained the services of several expert diesel consultants as part of its review staff.

The staff, PNL and its consultants reviewed the Owners Group submittals listed in the references and have performed onsite inspections of this component at several nuclear plants. The staff has reviewed the enclosed TER, and adopts the TER as part of this safety evaluation by reference.

The Owners Group reviewed the Air Start Valve capscrew designs. The static strength and endurance strength have adequate margins over the static stress and cyclic stress. The shortened air start valve capscrews are fabricated from SAE grade 5 (min) material. Stone and Webster performed further analyses and provided information to the Owners Group which forms the basis for the PNL review.

PNL determined that the analytical methods used by Stone & Webster were consistent with standard engineering practice and were appropriately applied. All assumptions used in the analysis were found to be conservative. The Stone & Webster analysis indicated that 1) the new 2-3/4-inch capscrews would not bottom out, 2) their maximum stress is well below the yield stress, and 3) they are not subject to fatigue failure if installed with the specified preload. PNL concurred with these conclusions, provided that 1) there is sufficient assurance that the capscrews installed have the proper length and 2) the preload on the capscrews is properly established and maintained. The concern with the preload is that the copper gasket used in the installation of the air start valve would creep under the sustained loading from the capscrews, resulting in a diminution of the preload. Both these issues were addressed and it was recommended (1) that the capscrew length be measured, on a sample basis, as a part of DR/QR effort for each plant and 2) that an installation procedure be developed to ensure that the proper preload was imposed on the capscrews. The procedure as developed calls for the initial installation of these capscrews with 150 ft-lb torque followed by retorquing every 8 hours until no further change is noted in the torque. PNL concurs with the procedure; however, PNL recommends that the torque on these capscrews be checked following the first period of engine operation after a new gasket is installed, to ensure that no additional gasket creep occurs as a result of the additional thermal and mechanical stresses. In previous plant specific

TERs, PNL had recommended that a 100% preload check of the air start valve capscrews be performed at every refueling outage. The PNL conclusions in this TER regarding maintenance and surveillance reflect additional information presented by the Owners Group at a meeting held on February 11, 1985 (transcript available) and supersedes PNL's earlier recommendation.

CONCLUSIONS

The staff has reviewed the PNL Technical Evaluation Report, "Review of Emergency Diesel Generator Air Start Valve Capscrews" and is in agreement with the conclusions presented.

On the basis of the review of the referenced documents and calculations provided by the TDI Owners Group, the staff concurs with PNL's conclusion that the described design for the air start valve capscrew is acceptable for the intended service. This conclusion assumes that 1) a sampling procedure will be established as part of the DR/QR effort to ensure that the capscrews are of the specified length, 2) the capscrews will be installed as recommended by Stone & Webster, and 3) torque is checked following the first period of engine operation after gasket replacement.

REFERENCE

Battelle Pacific Northwest March 1985 Technical Evaluation Report, "Review of Emergency Diesel Generator Air Start Valve Capscrews", PNL-5200-21

PNL-5200-21

Technical Evaluation Report

Review of Emergency Diesel Generator Air Start Valve Capscrews

March 1985

Prepared for
the U.S. Nuclear Regulatory Commission
Division of Licensing
Office of Nuclear Reactor Regulation
Under Contract DE-AC06-
NRC FIN B2952

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

Battelle

Technical Evaluation Report

REVIEW OF EMERGENCY DIESEL GENERATOR AIR START VALVE CAPSCREWS

March 1985

Prepared for
the U.S. Nuclear Regulatory Commission
Division of licensing
Office of Nuclear Reactor Regulation
under Contract DE-AC06-76RLO 1830
NRC FIN B2952

Project Title: Assessment of Diesel Engine Reliability/Operability

NRC Lead Engineer: C. H. Berlinger

Pacific Northwest Laboratory
Richland, Washington 99352

FOREWORD

This report is supplied as part of the Technical Assistance Project, Assessment of Diesel Engine Reliability/Operability, being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Licensing, by the Pacific Northwest Laboratory. The U.S. Nuclear Regulatory Commission funded this work under authorization B&R 20-19-40-42-1 FIN No. B2952.

PACIFIC NORTHWEST LABORATORY

PROJECT APPROVALS

W. W. Laity Date March 25, 1985

W. W. Laity, Project Manager
Pacific Northwest Laboratory

W D Richmond Date 3-26-85

W. D. Richmond, Chairman
Senior Review Panel
Pacific Northwest Laboratory

ACKNOWLEDGMENTS

This report was compiled by PNL project team members F. R. Zaloudek, R. E. Dodge, and M. Clement based on technical contributions provided by PNL consultants S. H. Bush, A. J. Henriksen, and B. J. Kirkwood.

ABSTRACT

This report documents Pacific Northwest Laboratory's (PNL) review of the Owners' Group resolution of a known problem with air start valve capscrews used on Transamerica Delaval, Inc. (TDI), emergency diesel generators installed in nuclear power plants. The Owners' Group efforts are described in the Stone & Webster Engineering Corporation report, Emergency Diesel Generator Air Start Valve Capscrew Dimension and Stress Analysis (March 1984), and its supplement (April 1984).

The Stone & Webster report and supporting calculations were reviewed by PNL and its consultants. Based on this review, PNL concurs with the Owners' Group that the air start valve capscrew design is adequate for the intended service when installed and torqued as specified by the Owners' Group and when the torque is rechecked after the first period of operation following installation of a new gasket.

CONTENTS

REVIEW OF
EMERGENCY DIESEL GENERATOR AIR START VALVE CAPSCREWS

1.0 INTRODUCTION

The Pacific Northwest Laboratory (PNL) is supporting the U.S. Nuclear Regulatory Commission (NRC) staff in addressing questions of the reliability, operability, and quality assurance of Transamerica Delaval, Inc. (TDI) diesel engines used to provide standby power in some nuclear power plants. These questions were raised because of a major failure in one TDI diesel at the Shoreham Nuclear Power Station in August 1983 and other problems encountered with TDI diesels. One of the principal tasks in PNL's effort is to evaluate the resolution by the TDI Diesel Generator Owners' Group of known problems with potential generic applicability.

This report documents PNL's evaluation of the Owners' Group resolution of problems identified with the air start valve capscrews installed in all TDI nuclear service engines used by the Owners' Group. The details of the resolution of this problem were described in the report, Emergency Diesel Generator Air Start Valve Capscrew Dimension and Stress Analysis (March 1984), by Stone & Webster Engineering Corporation, a consultant to the Owners' Group.

1.1 FAILURE HISTORY

To date, no failure of air start valve capscrews has occurred. However, at Shoreham and Grand Gulf the air start valve capscrews have loosened during operation because of a "bottoming out" in the cylinder head tapped hole during torquing. This problem was corrected by replacing the original 3-inch-long capscrews with new, slightly shorter, 2-3/4-inch capscrews.

1.2 COMPONENT DESCRIPTION

The shortened air start valve capscrews are fabricated from SAE grade 5 (min.) material, 2.75 inches long, with 3/4-inch 10N-3A type threads. Figure 1 illustrates the dimensions and installation of the capscrews.

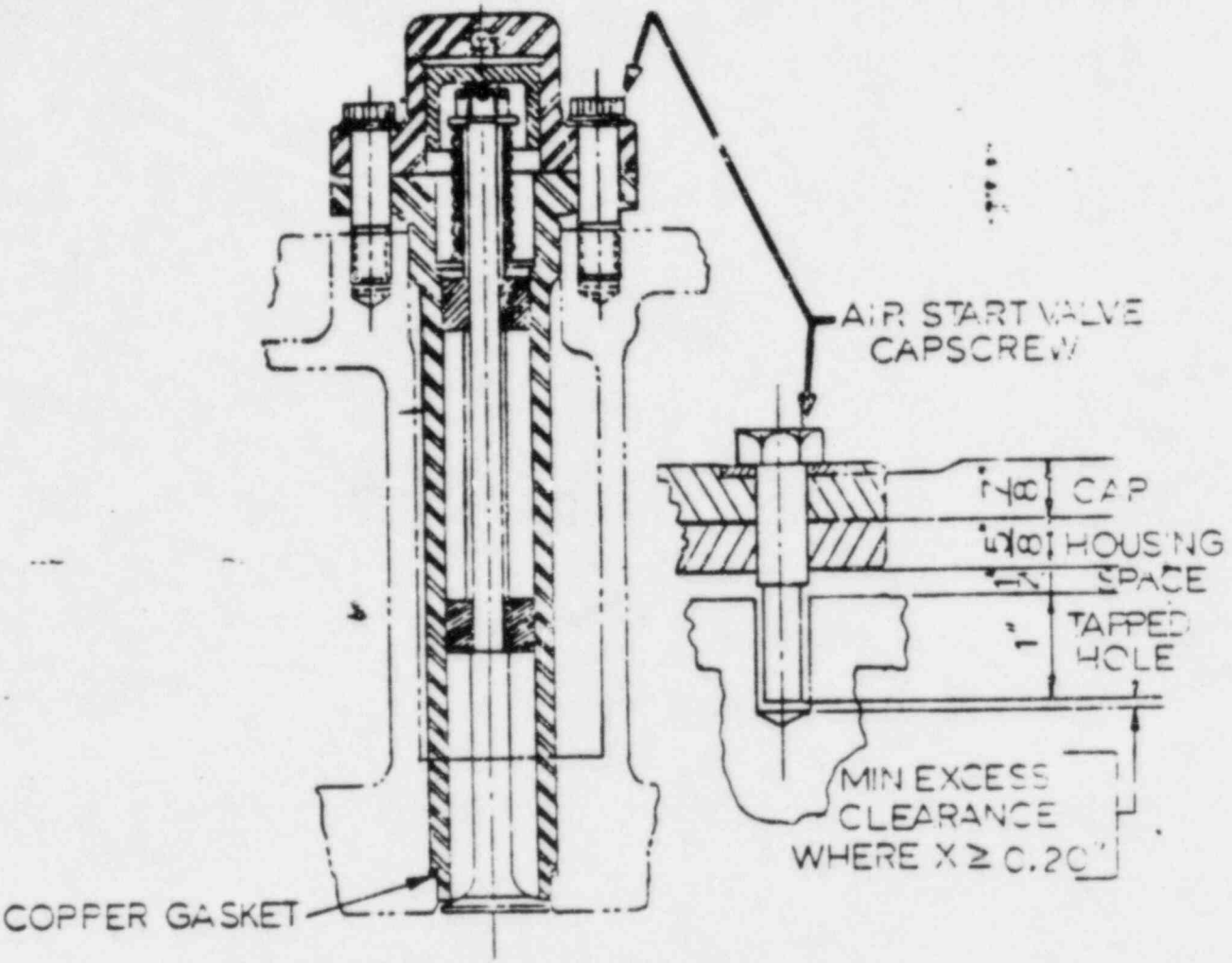

FIGURE 1. Air Start Valve Assembly

Source: Stone & Webster Engineering Corporation (March 1984)

2.0 OWNERS' GROUP RESOLUTION OF PROBLEM

This problem area was addressed by Stone & Webster Engineering Corporation, a consultant to the Owners' Group. The objective of their review was to evaluate the functional attributes of the shorter TDI air start valve capscrews.

2.1 SCOPE OF EFFORT

Stone & Webster completed the following specific tasks as part of their review:

- performed a dimensional check on the air start valve capscrews to determine if adequate clearance exists within the cylinder head tapped hole
- determined if the specified torque value ensures adequate capscrew preload
- determined the total resultant bolt stress
- evaluated TDI's recommended retorquing requirements.

The details of this analysis are provided in Stone & Webster calculation number 11600.60-245.1-M3.

2.2 SUMMARY OF RESULTS

The Stone & Webster report concluded that the 2-3/4-inch-long air start valve capscrew design is adequate for the given service conditions.

In addition, Stone & Webster's report concluded the following:

- A dimensional check indicates that a 0.2-inch minimum clearance exists within the cylinder head tapped hole. As a result, the air start valve capscrew will not "bottom out" upon torquing.
- Fatigue failure in capscrews is avoided if two criteria are met: 1) the total applied mean stress (S_t) is below the yield point (S_y) for the component material and 2) the endurance strength exceeds the cyclic stress by an acceptable margin. The total applied mean stress

(S_t) taken at the minimum cross-sectional area A(min.) is 37.5 ksi. The yield strength for the capscrew material is 92 ksi minimum. As a result, the first criterion for a fatigue-resistant design, namely, $S_t < S_y$, is satisfied. The endurance stress is 9.0 ksi and the cyclic stress is $\pm$1.6 ksi. Accordingly, the second criterion for a fatigue-resistant design is also satisfied. The recommended preload serves to reduce the range of stress cycling and subsequent fatigue effects on the capscrews. As a result, the specified torque that provides the preload is acceptable.

- During engine startup, a stress is imposed on the capscrews due to starting air pressure within the air start valve assembly. This stress is insignificant compared to the greater alternating stress induced by cylinder firing pressures.

- During engine operation, the valve assembly copper gasket is subjected to elevated temperatures. As a result of the temperature rise and preload, creep occurs within the gasket, which will decrease the total capscrew preload. To compensate, the existing diesel engine maintenance procedures require retorquing at specified intervals until no change is detected. At this time the gasket is fully compressed at its operating temperature by the required preload. Hence, capscrew preload is maintained during the full range of engine operation.

3.0 PNL'S EVALUATION

The Stone & Webster report, Emergency Diesel Generator Air Start Valve Capscrew Dimension and Stress Analysis, was evaluated by:

- M. Clement, PNL project team
- S. H. Bush, consultant, Review and Synthesis Associates
- A. J. Henriksen, consultant
- B. J. Kirkwood, consultant, Covenant Engineering.

As a result of the initial review, the PNL reviewers requested additional information and supporting calculations (Laity April 23, 1984). Handwritten calculations (Stone & Webster calculation 245.1-M3) and additional information were received in reply (Ray June 20, 1984). The Stone & Webster report, the supplemental handwritten calculations, and written responses to PNL's questions formed the basis for the review of the Owners' Group resolution of the air start valve capscrew problem.

PNL reviewed the details of the Stone & Webster analysis, including:

- the review of dimensions of the shorter capscrew and the threaded hole showing that it would not be possible for the capscrew to "bottom out"
- the calculation of the factor of safety for yield of the capscrew under the maximum imposed non-operating load
- the comparison of the maximum operating capscrew stress to the yield strength of the capscrew material
- the fatigue analysis of the capscrew using a Goodman diagram.

PNL determined that the analytical methods used by Stone & Webster were consistent with standard engineering practice and were appropriately applied. All assumptions used in the analysis were found to be conservative.

The Stone & Webster analysis indicated that 1) the new 2-3/4-inch capscrews would not bottom out, 2) their maximum stress is well below the yield stress, and 3) they are not subject to fatigue failure if installed with the specified preload. PNL concurs with these conclusions, provided that 1) there is sufficient assurance that the capscrews installed have the proper length and 2) the preload on the capscrews is properly established and maintained. The concern with the preload is that the copper gasket used in the installation of the air start valve would creep under the sustained loading from the capscrews, resulting in a diminution of the preload.

Both these issues were addressed in the Stone & Webster report, Supplement to the Emergency Diesel Generator Air Start Valve Capscrew Dimension and Stress Analysis (April 1984). In this report, it was recommended that the capscrew

length be measured, on a sample basis, as a part of the DR/QR effort for each plant. Also, an installation procedure was recommended to ensure that the proper preload was imposed on the capscrews. The procedure calls for the initial installation of these capscrews with 150 ft-lb torque followed by retorquing every 8 hours until no further change is noted in the torque. PNL concurs with the procedure; however, PNL recommends that the torque on these capscrews be checked following the first period of engine operation after a new gasket is installed, to ensure that no additional gasket creep occurs as a result of the additional thermal and mechanical stresses.

4.0 CONCLUSIONS AND RECOMMENDATIONS

On the basis of the review of the referenced documents and calculations provided by the TDI Owners' Group, PNL concurs that the described design for the air start valve capscrew is acceptable for the intended service. This conclusion assumes that 1) a sampling procedure will be established as part of the DR/QR effort to ensure that the capscrews are of the specified length, 2) the capscrews will be installed as recommended by Stone & Webster, and 3) torque is checked following the first period of engine operation after gasket replacement.

REFERENCES

Laity, W. W. April 23, 1984. Letter to Mr. Carl Berlinger, "Preliminary PNL Review of Report, Emergency Diesel Generator Air Start Valve Capscrew Dimension and Stress Analysis, Stone & Webster Engineering Corporation, Boston, Massachusetts, March 1984."

Ray, C. L., Jr. June 20, 1984. Letter OGTP-85 to C. Berlinger transmitting answers to PNL's previous questions.

Stone & Webster Engineering Corporation. March 1984. Emergency Diesel Generator Air Start Valve Capscrew Dimension and Stress Analysis. Boston, Massachusetts.

Stone & Webster Engineering Corporation. April 1984. "Air Start Valve Capscrew Dimension and Stress Analysis." Calculation 11600.60-245.1-M3, Boston, Massachusetts.

Stone & Webster Engineering Corporation. April 1984. Supplement to the Emergency Diesel Generator Air Start Valve Capscrew Dimension and Stress Analysis. Boston, Massachusetts.

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
GEORGIA POWER COMPANY,	)	Docket Nos. 50-424
et al.	)	50-425
	)	(OL)
(Vogtle Electric Generating Plant,	)	
Units 1 and 2)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "STAFF"S RESPONSE TO APPLICANTS' MOTION FOR SUMMARY DISPOSITION OF JOINT INTERVENORS' CONTENTION 14 (TDI DIESEL GENERATORS)" and Supporting Documents in the above-captioned proceeding have been served on the following by deposit in the United States mail, first class or, as indicated by an asterisk, through deposit in the Nuclear Regulatory Commission's internal mial system, this 23rd day of September, 1985.

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