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James L. Kelley, Chairman
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dr. Paul W. Purdom
Administrative Judge
235 Columbia Drive
Decatur, GA 30030

Dr. Richard F. Foster
Administrative Judge
7 Stag Lane
Sunriver, Oregon 97702

In the Matter of
DUKE POWER COMPANY, ET AL.
(Catawba Nuclear Station, Units 1 and 2)
Docket Nos. 50-413 and 50-414

Dear Administrative Judges:

You will find enclosed, a copy of "NRC Staff Testimony of Carl H. Berlinger, B. J. Kirkwood, Paul J. Louzecky, and John F. Nesbitt on the Operability/Reliability of Catawba Emergency Diesel Generators."

Sincerely,

George E. Johnson
Counsel for NRC Staff

Enclosure: As stated

cc w/ enclosure: Service list

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
DUKE POWER COMPANY, ET AL.	)	Docket Nos. 50-413
	)	50-414
(Catawba Nuclear Station, Units 1 and 2)	)	

NRC STAFF TESTIMONY OF CARL H. BERLINGER, B. J. KIRKWOOD, PAUL J. LOUZECKY AND JOHN F. NESBITT ON THE OPERABILITY/RELIABILITY OF CATAWBA EMERGENCY DIESEL GENERATORS

Q1. Please state your names, your business addresses and your professional qualifications.

A1. My name is John F. Nesbitt. I am employed by Battelle Memorial Institute at the Pacific Northwest Laboratory in Richland, Washington. My professional qualifications are appended.

My name is B. J. Kirkwood. I am self-employed, under the firm name of Covenant Engineering. My principal office is in Buena Vista, Colorado. My general professional qualifications are appended.

My name is Paul J. Louzecky. I am self-employed, under the firm name of Engineered Applications, Corporation. My principal office is in Troy, Michigan. My general professional qualifications are appended.

My name is Carl H. Berlinger. I work at 7920 Norfolk Avenue, Bethesda, MD. I am Program Manager of the TDI Project Group, Division of Licensing, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission. My professional qualifications are attached.

Q2. Could you summarize briefly your specific qualifications to address issues dealing with reliability/operability of TDI emergency diesel generators?

A2. (Nesbitt) I have been responsible for the design and installation of various mechanical components and safety systems for nuclear reactors. I have also been involved in the operation and maintenance of nuclear reactors as well as nuclear fuel processing facilities. Details of my experience, education and affiliations are set forth in the attached professional qualifications.

(Kirkwood) My experience reflects nearly 30 years of service as a consulting engineer, during which time a significant portion of my engineering work was done in relation to diesel engine installations--preliminary evaluation and planning, selection and application, facility design, oversight of construction, startup testing and acceptance procedures. They all were for municipally-owned, central-station generating plants; none were for nuclear standby service. Most were intended for "base-load" service: some were for only peaking

and stand-by use. The majority, however, involved engines in the slow and medium speed category like these at Catawba, and of similar ratings. This did not include design of engine components, nor resolution of specific problems therewith. However, it was not uncommon that any particular engine might evidence some functional problems as it was first put into service. These I would pursue on behalf of my client until resolved. And, on occasion, I was asked by clients whose existing engine might be suffering troubles to pursue the cause and appropriate correction thereof. My work, though, did not get into analyses of metallurgy, component stresses, and the like.

In projects where I was in charge, or otherwise involved, there were several where Delaval engines were selected by the owners. But, there also were other makes of engines, such as Cooper-Bessemer, Colt-Fairbanks, Worthington and Nordberg. So, I am familiar with a wide variety of engines and engine manufacturers, how their engines were rated, and what performance, in general, to expect from such engines.

My qualifications also cite involvement with a committee which drafted the current ANSI/ASME code for engine testing. That pertains to performance testing of any reciprocating, internal-combustion engines. As such, it pertains to engines such as those at Catawba. It covers principally the tests to

determine that such an engine can achieve its contractual power rating, and to determine if it meets its contractual guarantees on fuel consumption.

(Louzecky) My interests and experience have been in engines, their problems, solutions and applications--from very small engines to engines with crankshafts over 50 feet long. My work has also included the control of engines, the burning of special fuels and engines' many lubrication problems.

Presently I am involved in consulting work on engines and their related problems. I have worked on a number of automotive and truck, gasoline and diesel engines, and on aircraft engines. My work has also included some road machinery and fuel injection problems. Details of my experience, education, and professional activities are covered in the attached professional qualifications.

(Berlinger) My educational background includes a B.S., M.S. and Ph.D. in mechanical engineering. I have teaching experience in a power laboratory which included diesel engines. I have previously been employed by Pratt and Whitney Aircraft Company where I worked on gas turbine engines, including the design of an experimental engine. I also have experience in manufacturing, production, and equipment and hardware from my employment at Pratt and Whitney. I have been employed by the Nuclear

Regulatory Commission for eleven years in a variety of technical and managerial positions. Since January of this year I have been the manager of the TDI Project Group, during which time I have participated in engine inspections, toured two diesel engine manufacturing plants, including TDI, reviewed Owners Group generic reports and attended Owners Group and plant-specific meetings.

Q3. Are you familiar with the contention in this case challenging "whether there is a reasonable assurance that the TDI emergency diesel generators at Catawba can perform their function and provide reliable service because of problems that have arisen in the course of testing and inspection . . .?"

A3. (Nesbitt, Kirkwood, Louzecky) In general, yes. As noted in Section 2.2 of the TER entitled Review and Evaluation of Transamerica Delaval, Inc., Diesel Engine Reliability and Operability - Catawba Nuclear Station Unit 1, PNL 5211, we have had access to considerable correspondence and documentation pertaining to the performance of the TDI diesel engines at Catawba Nuclear Station Unit 1. It is understood that the specific problems encountered during the tests and inspections at Catawba must be addressed while considering whether the subject engines can perform their functions and provide reliable service.

(Berlinger) I am familiar with the contention. I am also familiar with the Applicants' February 17 and June 25, 1984,

letters to the ASLB, in addition to the Applicants' March 21, 1984 meeting with the staff, all of which discussed diesel generator problems experienced at Catawba and which are the subject of this contention.

Q4. Please describe your role in the review and evaluation of the operability/reliability of the Catawba diesel generators.

A4. (Nesbitt) Pacific Northwest Laboratory (PNL) is supporting the Nuclear Regulatory Commission (NRC) Staff in their efforts of assessing and evaluating the operability and reliability of Transamerica Delaval, Inc., (TDI) diesel generators that are installed at a number of nuclear utilities. PNL has established a project management team for the NRC program and has secured the services of several recognized authorities on diesel engine technology. These diesel engine specialists provide a variety of background and expertise in engine design, research and development, manufacturing, application and installation engineering, field service and operations. As a team of experts they have provided PNL and NRC comprehensive and competent knowledge and judgment on the numerous issues that have been raised on these TDI engines, not only in regard to the generic-issue components, but also in regard to the various specific engine installations.

I am one of several senior members of the PNL technical staff assigned to the program and am assisting the Project Manager

with the technical coordination of project-related activities. I have been assigned the responsibility of overseeing endeavors relative to Catawba. B. J. Kirkwood, Covenant Engineering, and Paul J. Louzecky of Engineered Applications Corporation are two of the diesel experts under PNL contract who are providing technical consultation on diesel engine technology; they have been working on Catawba licensing matters in relation to the EDGs.

I contributed to the development and implementation of PNL's Project Plan for "Assessment of Diesel Engine Reliability and Operability". I also participated in the review of the TDI Owners' Group (OG) Program Plan and made contributions to its evaluation (PNL-5161), primarily in the areas of tests and inspections. I have been responsible for the coordination of the technical reviews of the OG reports on several generic engine components (e.g., connecting rod bearing shells, engine mounted electrical cable). Additionally, I have recently assumed the technical direction and coordination of the review and audit of the Design Review/Quality Revalidation (DR/QR) reports that are being developed as part of the TDI OG Program. In addition to the technical coordination of the project-related activities noted, I have reviewed reports of site-specific investigations, Owners' Group meetings and generic engine components.

I made two visits to the Catawba site in conjunction with the disassembly and inspection of the 1A engine and the disassembly and inspection of the 1B engine along with the reassembly and return-to-service testing of the 1A engine. I also reviewed or am familiar with the Catawba site inspection reports and documentation noted in Section 2.2 of the Catawba TER.

(Kirkwood) My involvement has been as a consultant to PNL, under whose auspices all these review services have been performed. To date I have participated in three general stages: 1) a review of the Owners' Group Program Plan for investigating these engines and their operability and reliability; 2) a series of technical reviews of certain generic issues on selected engine components; and 3) a series of reviews of site-specific engines - such as at Catawba - wherein I have observed components (as disassembled for inspection), evaluated certain functional test results, and helped prepare reports evaluating the component problems and their resolution and the owners' actions and plans for dealing with present or potential problems. In doing so, I have worked with other consultants on PNL's team.

In addition to relevant considerations within the review of the Program Plan and the generic issues, I have participated in site-specific investigations relative to Grand Gulf, Shoreham, Comanche Peak and, of course, Catawba. This included a visit

to the Catawba plant during the time of the inspection of Unit 1B, where I observed conditions in general and specifically on various components. I have met on various occasions with Duke personnel, in company with NRC and PNL staff members. I have reviewed Duke inspection reports and other documents, as available to this date (as listed in Section 2.2 of the Catawba TER).

(Louzecky) As a consultant to PNL, I have been involved in the reviews of various aspects of the TDI diesel engine program. I have participated in the review of the Owners' Group Program Plan, in a series of technical reviews of certain generic issues on selected engine components; and in a series of reviews and inspections of engines at various sites, including Catawba. In conjunction with other consultants, as well as independently, I have observed components of disassembled engines, evaluated test results, and prepared reports evaluating component problems and their resolution.

I have also participated in site-specific investigations relative to Catawba, Grand Gulf, and Shoreham. These included three visits to the Catawba plant--one during the disassembly of the 1A engine, one while it was being reassembled, and one while the 1B engine was being disassembled and inspected. I have reviewed Duke inspection reports and other documents, as

available to this date (as listed in Section 2.2 of the Catawba TER).

(Berlinger) As Manager of the TDI Project Group, I have overall responsibility for the review and evaluation of the operability/reliability of the Catawba diesel generators. As part of this responsibility I have visited the Catawba site twice to view the disassembled 1A diesel engine. I have attended meetings between the Staff and Applicants to discuss the review of Catawba diesels, and participated in the Staff's evaluation of the Catawba diesels. In addition, I provide an oversight of the Catawba review and as such have been keeping informed of developments as they relate to Catawba.

Q5. Specifically with respect to the PNL Technical Evaluation Report, what was your role in its creation?

A5. (Nesbitt, Kirkwood) The Catawba Technical Evaluation Report (TER), entitled Review and Evaluation of Transamerica Delaval, Inc., Diesel Engine Reliability and Operability - Catawba Nuclear Station Unit 1, PNL-5211, August 1984, was transmitted to the NRC on August 4, 1984. This TER was compiled and written by us jointly. It is based on data and information obtained from or provided by NRC, the TDI Owners' Group, and Duke Power Company (Duke). It is also based on observations made or data obtained by PNL staff or consultants during three visits to Catawba, attendance at Owners' Group meetings and/or

visits to other sites with TDI diesel engines. It also reflects knowledge gained by us and the rest of the PNL staff/consultant team in addressing both the OG Program Plan and the various generic component issues. While we were the principal authors, D. A. Dingee, and A. J. Currie, as members of the PNL Project Team, gave oversight and editorial assistance, respectively.

Others who have participated in various field inspections have been Adam J. Henriksen, J. E. Horner, P. J. Louzecky, Arthur Sarsten and J. C. Spanner. Each has, as appropriate, contributed comments during the course of this review of the Catawba engines and Duke's actions relevant thereto. Mr. Louzecky and Mr. Horner also contributed specific input for preparing the TER and reviewed it in its final form.

(Berlinger) I provided some comments on the first draft of the TER to PNL before finalization of the document.

Q6. Do you adopt the Technical Evaluation Report and hereby incorporate that document as part of this testimony?

A6. (Nesbitt, Kirkwood, Louzecky) We adopt by reference the TER as prepared under the auspices of PNL, Review and Evaluation of Transamerica Delaval, Inc., Diesel Engine Reliability and Operability - Catawba Nuclear Station Unit 1, as part of this testimony. We do so with the following proviso: that insofar

as the consequences of the final OG Program Plan, as accepted by NRC, or any other relevant action by NRC, might require actions, operations or limitations more stringent than proposed in the TER, the more stringent requirements should prevail over the TER recommendations.

Q7. Do you adopt the Safety Evaluation Report and hereby incorporate that document as part of this testimony?

A7. (Berlinger) Yes. However, the following clarifications are necessary. First, in discussing the jacket water pump nut inspection required at first refueling on the 1B diesel, we should be referring to the spline nut rather than the impeller nut as indicated in the SER. Secondly, confirmation is required from the Applicants indicating implementation of SIM No. 361 which recommends replacement of the engine mounted electrical cable with qualified cable. Additionally, in Section 3.2.1 of the SER, which discusses the 1A diesel inspection results, two cylinder leaks are mentioned. Only one of these applies to the 1A engine. The other was found in the 1B engine. Finally, the SER requires an operating restriction of

185 psig BMEP for the Catawba Unit 1 diesels. This restriction in not intended to be a permanent one, but rather a temporary one until the Applicants or the Owners Group can provide data or perform lead engine testing which demonstrates the ability of TDI engines to operate reliably above 185 psig BMEP.

Q8. Are you familiar with the function of the diesel generators as a standby power source for safety related equipment?

A8. (Nesbitt, Kirkwood, Louzecky) Yes, in general, we are familiar with the role and intended functions of EDG's as the most common source of onsite standby electrical power used to comply with the relevant requirements of 10 CFR 50 (including Appendix A - GDC 17) and its referenced standards, related codes and regulatory guides.

(Berlinger) Yes. As manager of the TDI Project Group, I routinely assess diesel generators as a standby power source.

Q9. As stated on page 9 of the Technical Evaluation Report, 18 components were noted to have experienced some sort of problem during the extended operational tests and inspections of the diesel generators. Four of these are noted to be components which have been the subject of generic TDI engine component reviews. With respect to each of these four items, would you state whether, in your opinion, the problem identified with the component at Catawba would prevent the EDGs from reliably performing their intended safety function in the event of an anticipated operational occurrence (AOO) or postulated accident (PA) at Catawba over the expected life of the plant?

A9. (Nesbitt, Kirkwood, Louzecky) The four "generic" components referenced are: piston skirts, cylinder heads, turbocharger bearings, and the pushrods. The two cylinder heads which

leaked cooling water (externally, not within the cylinders) were replaced (to the best of our knowledge), as were some others which had not leaked but which, due to manufacturing processes, had potential for similar leaks. The turbocharger bearings of EDG 1A which exhibited excessive wear also have been replaced, and those of 1B will also be replaced during the current inspection and reassembly process. Duke proposes to install an enhanced lubrication system which, if similar to that used elsewhere, would improve pre-lubrication for these bearings in manually-initiated starts. All of the original AN piston skirts of Unit 1A reportedly were replaced with AE skirts (not only the four with evidence of cracks, but all 12 others). We understand that the same replacement will be made on EDG 1B. With regard to these three components, we are of the opinion that the corrective actions cited, when coupled with the load limitations given in the Catawba TER, page 5, are of a nature to allow these engines to reliably perform their intended safety function, in the event of an AOO or PA, at least until the first refueling outage of the reactor.

The original pushrods at Catawba were of a design which has been supplanted by the engine manufacturer. Pushrods of this latest known design were installed in engine 1A; run for some 400 hours under generally high engine loads; removed, inspected and reinstalled in 1B; run for over 500 hours therein, also under generally high operating loads; removed and reinspected;

and now reportedly will be reinstalled in 1B. We are of the opinion that this pushrod design will operate reliably until at least the first reactor refueling outage, and quite possibly for the normal life of the engines (predicated on the evidence of their apparently successful operation for over 900 hours, or more than 10,000,000 operating cycles).

We want to emphasize, as was done in Section 1.2, page 3, of the Catawba TER, that the qualifying reference to "until the first refueling of the reactor" is not intended to infer that these components or the engines themselves are therefore inherently unreliable or inoperable for their intended use over their normally expected service lives. The qualification is stated only in recognition of the need for full completion of all OG Program Plan and Duke DR/QR programs and implementation of their findings.

Q10. With respect to the items referred to above, as to which you believe some information or action is still needed before you could conclude that the component would not prevent the EDGs from reliably performing their intended safety function over the expected life of the plant, what information and/or actions need to be completed in order for you to reach such a conclusion?

A10. (Nesbitt, Kirkwood, Louzecky) As noted in the TER on Catawba Nuclear Station Unit 1, there are a number of ongoing studies

and activities concerning the operability and reliability of the TDI engines in general, and some of these pertain to the piston skirts, cylinder heads and turbocharger components. In our opinion, all of the studies and activities, as noted in the TER on the Catawba Nuclear Station Unit 1 that pertain to the diesel engine components of piston skirts, cylinder heads and turbocharger, will have to be completed and/or implemented satisfactorily before we could reach a final, unqualified conclusion as to whether or not these components would prevent the EDGs from reliably performing their intended safety function for the normally expected life of the EDGs.

Q11. Is there a reasonable assurance that the above information can be obtained or the above measures and/or corrective actions be taken by the first refueling outage?

A11. (Kirkwood, Louzecky, Nesbitt) We understand that this represents an approximate 18 month time frame, from initial reactor operation. Some of the required actions or information are to be accomplished or developed solely by Duke; Duke should be able to accomplish them by that time. Other aspects are dependent upon completion of certain OG investigations, with relevant reviews and responses by NRC and PNL. While we have no bases for forecasting the speed of those OG endeavors, nor the adequacy thereof, nor the consequential actions then determined to be necessary, it is our present opinion that 18

months is a reasonable time frame for finally identifying and implementing appropriate actions.

Q12. With the implementation of the above measures, is it your conclusion that the component can be expected to perform reliably such that it would not prevent the EDGs from reliably performing their intended safety function over the expected life of the plant?

A12. (Kirkwood, Louzecky) It would presently appear (subject to final Catawba inspections on 1B) that the pushrod problem is resolved. Final, acceptable and reasonably proven resolutions of problems (both generic and site-specific at Catawba) on the piston skirts, cylinder heads and turbocharger bearings have not been achieved, but in our judgement (at this point) are not unresolvable, and actions already taken or proposed may well prove totally adequate as relevant studies and inspections are completed. Hence, in our judgement, with the satisfactory completion and/or implementation of the ongoing studies and activities pertaining to the diesel engine components of piston skirts, cylinder heads and turbochargers, these components are expected to perform reliably such that they would not prevent the EDGs from properly performing their intended safety functions through the normal expected life of that individual component.

Q13. With respect to the other 14 (site-specific) items listed on page 9 of the Technical Evaluation Report, have, in your opinion, Applicants adequately identified the cause of the problem, identified appropriate corrective actions, and committed to, or taken, those corrective actions such that the component will not prevent the EDGs from reliably performing their intended safety function in the event of an AOO or PA over the expected life of the plants?

A13. (Kirkwood, Louzecky) We are of the opinion that the Applicants have adequately identified the cause of the problems, identified appropriate corrective actions and committed to, or taken, those corrective actions such that the components as listed below will not prevent the EDGs from reliably performing their intended safety function in the event of an AOO or PA over the expected or normal life of these particular engine components. This presumes, of course, that the Applicants will conduct both normal and appropriate enhanced surveillance and maintenance thereon. The 13 components to which these remarks apply are:

- o fuel line fittings
- o fuel oil injection pump valve holder
- o turbocharger lube oil drain line
- o turbocharger prelube oil lines
- o turbocharger exhaust gas inlet bolts

- o crankcase and camshaft cover capscrews
- o triple-clamp bolts
- o lube oil and jacket water thermocouples
- o rocker box (subcover) assemblies
- o intermediate rocker arm sockets
- o exhaust valve tappet (rocker arm adjusting screw swivel pad)
- o intake and exhaust valves
- o spring retaining nut and roll pin on air start valve

Q14. Please identify, as to any component not listed above, the specific additional information, actions, or other measures which need to be addressed or accomplished in order for you to reach a conclusion that the operability/reliability of the component would not prevent the EDGs from reliably performing their intended safety function over the expected life of the plant.

A14. (Kirkwood, Louzecky) It is also our opinion that the Applicants have identified the problem with the right bank turbocharger-to-intercooler adapters (the remaining item listed on page 9 of the TER). However, to our knowledge, adequate corrective actions have not been implemented at this time. Therefore, these components cannot presently be considered to be fully adequate to support the EDGs in reliably performing their intended safety function at Catawba Nuclear Station Unit 1. However, these components appear to be amenable to acceptable corrective actions for long-term reliability. Furthermore, as

expressed in the TER, it is our opinion, that, even with a cracked weld (if proposed correction were not completed immediately), an engine could operate a number of hours without deleterous consequences or forced immediate shutdown.

Q15. With respect to the adapters, described above, is there a reasonable assurance that the needed information can be obtained, and the necessary measures and/or corrective actions be accomplished before ascension beyond 5% power?

A15. (Kirkwood, Louzecky) In the SER, the NRC has stipulated that the Applicants shall install a flexible joint arrangement on the right turbocharger bank on both diesel engines at Catawba Nuclear Station Unit 1 prior to operating the nuclear reactor above 5% power. It is our opinion that such corrective action can and should be successful, and can be functionally accomplished as required by NRC. The time requirements of the component qualification process remains uncertain to us, but certainly should be possible. Ultimate proof of success and durability will only come through operation, but this is not a component of immediate impact on engine operability and reliability.

Q16. With the implementation of the above measures, is it your conclusion that the component can be expected to perform reliably such that it would not prevent the EDGs from reliably

performing their intended safety functions over the expected life of the plant?

A16. (Kirkwood, Louzecky) In our opinion, upon the installation of an adequate joint arrangement on the right bank of the turbochargers, these components can be expected to perform reliably such that they would not prevent the EDGs from reliably performing their intended safety functions at Catawba Nuclear Station Unit 1 over their normally expected service lives.

Q17. On page 10 of the Technical Evaluation Report, twelve other components are listed as having been classified in the generic problem category by the TDI Owners' Group. Have any significant safety concerns arisen with respect to any of these components as a result of the extended operational testing and inspection program for the Catawba EDGs?

A17. (Kirkwood, Louzecky) Out of the twelve engine components classified in the generic problem category by the TDI Owners' Group and listed on page 10 of the Catawba Nuclear Station Unit 1 TER, it is our opinion that only two (connecting rod bearing shells and connecting rods) have evidenced any signs of safety concern or limited life as a result of the extended operational testing and inspection programs on the Catawba EDGs. One additional concern relates to the cylinder block, but is not reflective of Catawba experience.

Q18. For the items raised in your previous answer, please describe the component and the problem identified.

A18. (Kirkwood, Louzecky) In our opinion, the connecting rod bearing shells that have been exposed to over 800 hours of operation on the Catawba 1A engine, and over 750 hours of operation on the Catawba 1B engine show indications of "limited" life. The problem observed is a pattern of bearing surface erosion reflective of normal wear and, possibly, low oil pressure. But, in our opinion, that "limited" life expectancy is measureable in terms of several years at the rate of operation expected for the Catawba EDGs.

The connecting rods (specifically the link-rod box) showed no evidence of the generic concern identified in some of the broader population of TDI engines. In fact, the inspection of the 1A rod mating surfaces showed no pronounced fretting and reportedly were re-mated with contact levels within the manufacturer's specifications. The only "problem" to deal with at Catawba is the inherent potential for the problems identified by the OG.

Likewise, in the case of the cylinder block, there is only the inferred concern arising from of the OG generic report on blocks, as cited in the Catawba TER, pages 51 to 52. Because of the conclusions in the OG report, it remains hypothetically possible that the Catawba blocks would develop cracks.

Q19. As to the component problems identified in the previous answer, please describe any information, measures or corrective actions which need to be acquired or taken to assure reliable performance.

A19. (Kirkwood, Louzecky) In our opinion, the information, measures or corrective actions required to assure the continued reliable operation of the connecting rod bearing shells and the connecting rods are those as identified or outlined in the TER for Catawba Nuclear Station Unit 1. A sufficient surveillance and maintenance (S/M) program, rigidly followed, is the heart of the required actions.

The potential for cracking of the cylinder block will be reduced if engine operation at high firing pressures is avoided. Hence, it has been suggested in the TER that loads be limited to levels equivalent to 185 psig brake mean effective pressure (BMEP). Along with enhanced S/M programs, this should, in the opinion of PNL's consultants, keep the engines both operable and reliable for their intended function, at least until the time of the first reactor refueling outage. By that time agreement should be possible on causes and corrective actions (or ultimate operational limitations).

Q20. Do you have confidence that these matters can be addressed by the first refueling outage?

A20. (Nesbitt, Kirkwood, Louzecky) Surveillance and maintenance are the key responses required of Duke for the Catawba engines, and this will be an ongoing responsibility (like all proper preventive maintenance) unless and until a more permanent resolution is derived by the OG and/or TDI. Any such matters should be able to be addressed by the first refueling outage.

Q21. With the implementation of the above measures, is it your conclusion that the components can be expected to perform reliably such that it would not prevent the EDGs from reliably performing their intended safety function over the expected life of the plant?

A21. (Kirkwood, Louzecky, Nesbitt) It is our opinion that, with the implementation of the measures noted in the Catawba Nuclear Station Unit 1 TER for the connecting rods, the connecting rod bearing shells and the cylinder blocks, these components can be expected to function such that they will not prevent the EDGs at Catawba from reliably performing their intended safety function up to the normal or expected life of any of the said components. However, this is necessarily conditioned upon the ultimate conclusion and disposition of the generic issue report thereon.

Q22. The Staff, pursuant to recommendations by PNL, has placed an operating limitation on the EDGs at Catawba that the sustained kW output not be in excess of that corresponding to a

brake mean effective pressure (BMEP) of 185 psig. (See TER, p. 5, SER, p. 6.) Please explain the reason for this limitation.

A22. (Kirkwood, Louzecky) In the review of the OG Program Plan on generic component issues (see PNL-5161, entitled Review and Evaluation of TDI Diesel Generator Owners' Group Program Plan), the project team from PNL and the diesel consultants serving PNL concluded that there were various key components pertinent to the family of TDI model R4 engines which were particularly sensitive to the firing pressures within the cylinders. These included the piston/piston skirt assemblies and the crankshaft. These items are not readily accessible for periodic inspection for signs of possible distress. Other generic-issue items also impacted by firing pressures include the cylinder heads and studs, cylinder blocks, liners, connecting rods, wrist pin bushings and main and connecting rod bearings, most of which also are not readily observable; but the skirts and crankshaft were deemed at the time to be of particular concern within that group of generic-issue components.

Firing pressures (peak pressures within the cylinder during the combustion stroke) are influenced by a number of factors. But they are approximately proportional to the average pressure within the cylinder during the power stroke, which is known as the brake mean effective pressure (BMEP), expressed in psig.

That, itself, is computed from the engine shaft (or brake) horsepower.

Pending ultimate, satisfactory resolution of the alleged problems, it was the opinion of PNL's diesel consultants that it would be inappropriate to conclude at this time that there is full operability and reliability of these key components at their manufacturer's rated capacity, in which we fully concur. (In the case of Catawba's engines, that is 7,000 kW, at 225 psig BMEP.) However, there was deemed to be some body of evidence of satisfactory, reliable operability of skirts and shafts of engines which had been operating at 185 psig BMEP (equivalent to 5756 kW). Hence for this and other reasons, as expressed in both PNL-5161 (the OG Program Plan Review) and PNL-5211 (the Catawba TER), PNL suggested a temporary limit be placed on these engines at 185 BMEP, to allow for interim licensing (if otherwise appropriate) pending final component resolution.

In the case of Catawba, the 185 psig BMEP limit computes to 5756 kW; the AOO and PA (i.e., LOOP and LOCA) conditions are understood to be 5714 and 5256 kW, respectively.

Q23. Is there a possibility or likelihood of needing to exceed that limitation in order for the EDGs to perform their intended safety function? How would this be accounted for?

A23. (Kirkwood, Louzecky) It is our understanding that the referenced emergency loads at Catawba, for LOOP and LOCA events, have been determined by Applicants, and accepted by NRC, as realistic calculations of the maximum emergency power loads which the engines might have to carry for a short, initial period. In fact, load/time descriptions referenced by the Applicants indicate the actual loads would, within relatively few minutes, begin to decrease therefrom. It is possible, of course, that actual loads might exceed the established levels, but only actual synthesized tests would show this at this point. And, it could well be that momentary motor in-rush currents could briefly exceed these levels and, as a consequence, the 5756 kW operating limit established for sustained operations. Note, though, that this level is only 82.2% of the engines' nameplate ratings, loads at which they have proven to be operable for many hours in past functional tests at Catawba (and, in fact, were operated at 10% above nameplate ratings at times to prove overload capability).

Q24. What would be the safety significance, with respect to operability/reliability (O/R) of the EDGs at Catawba, of exceeding the 185 psig?

A24. (Kirkwood, Louzecky) In our judgement, there would be an insignificant safety impact in operating these engines briefly at levels modestly exceeding 185 BMEP. The incipient problems with these load-impacted components are basically load/duration

related, so excursions of modest BMEP and/or duration should be of no meaningful consequence on their long-term O/R. Furthermore, it must be remembered that the 185 BMEP temporary ceiling is a nominative figure, related to what is believed to be conservatively successful operating conditions elsewhere; it is not actually a functional barrier per se.

Q25. Is there an adequate margin for safety, given the possible loads during emergencies, while at the same time maintaining the above operating limitation?

A25. (Kirkwood, Louzecky) Yes. We refer to our immediately preceding answers for our reasoning.

Q26. What will be the Staff mechanisms for assuring that the various confirmatory actions (such as inspections and tests), replacement of components, surveillance and maintenance schedules, procedure revisions, and OGPP corrective recommendations will be implemented in the time and as specified in the SER or TER?

A26. (Berlinger) Prior to operation above 5% power, the Applicants must either complete the required actions or provide a commitment to do so. The Staff will follow up on completed actions and commitments to ensure that they are accomplished. This follow-up will be accomplished through Staff review and inspections. Where appropriate, the Staff may require

commitments to be incorporated into plant Technical Specifications to ensure that implementation is occurring over a period of time. Similarly, to ensure future implementation of Staff requirements, the Staff may condition the license so that follow-through of an Applicants' commitment is necessary to maintain the license.

Q27. Is there anything unusual about the Staff approving the EDGs when it is contemplated that various requirements placed on the Applicants/Licensees, or commitments made by them, are to be implemented in the future?

A27. (Berlinger) The Staff typically finds licensee proposals acceptable based on commitments to carry out Staff requirements. If there is a time lag involved between commitment and completion during which the plant operates, the Staff evaluates this interim operation in terms of how it affects safe operation of the plant. This process is being employed in the Staff's review of TDI diesel generators at Catawba. It is not an unusual procedure.

Q28. Given that the Staff's finding of compliance with GDC-17 is based, in part, on actions which Applicants/Licensees will take in the future, what is the basis for the Staff's assurance that the EDGs will meet all regulatory requirements?

A28. (Berlinger) Based on the expertise and evaluation of the Staff and its consultants, the Catawba Unit 1 diesel generators

have been found to be in conformance with GDC-17 until the first refueling outage. The Staff believes that the Owners Group Program Plan will be complete by the Catawba Unit 1 first refueling outage, at which time the Owners Group recommendations approved by the Staff will be implemented. Implementation of the Staff-approved OGPP recommendations will ensure that the Catawba Unit 1 diesels will continue to meet GDC-17.

Q29. Applicants reported, in a letter of July 17, 1984, the history of starts and operations on both Unit 1 EDGs. Are the difficulties experienced in starting, referenced therein, of additional valid concern relating to the operability/reliability of any component the EDGs?

A29. (Kirkwood, Louzecky) The Duke Power Company letter showed the two engines to have a combined total of 361 attempts to start, of which there have been 7 "valid failures to start" (2%). One-hundred twenty of these starts were on the 1A engine while the remaining 241 starts were on the 1B engine. Two of the 7 valid failures to start (as defined by U.S.N.R.C. Regulatory Guide 1.108) were on the 1A engine and the other 5 were experienced during the operation of the 1B engine.

Each of the seven valid failures to start is addressed in detail by the letter noted above. Items noted are start number and purpose, indication of failure or trip, the factors that

contributed to the trip or failure, as well as the action(s) taken to correct the fault or problem.

It is our opinion that Duke Power Company has adequately identified the cause of each valid failure to start, that the company worked on each problem until its cause was identified and that appropriate corrective actions were taken or proposed on each. Also, in our opinion, the types of problems or failures experienced to date in the operation of the Catawba Unit 1 EDGs are quite similar in nature to those that might be experienced or found during the startup and preliminary operation of any complex, remote-controlled and operated electrical/mechanical system.

These types of problems or failures tend to decrease as operating time and experience are achieved on the system in question. As such, we do not consider the difficulties experienced in the starting of the Catawba Unit 1 EDGs to date to be of a magnitude sufficient for additional concern pertaining to the reliability of the emergency diesel generator system. This is said with the proviso that customary surveillance and maintenance be conducted (as described in Duke's responses to the problems), and that an adequate supply of spare parts be maintained. The need for the latter is highlighted by the failures of the VR/SCR components (identified re: start #58,

Unit 1B), which items can sometimes be difficult to obtain on short notice.

Q30. To the best of your knowledge, has any pre-operational testing been conducted on the Catawba Unit 2 emergency diesel generators?

A30. (Berlinger) To the best of my knowledge, no pre-operational testing has been conducted on the Catawba Unit 2 emergency diesel generators.

Q31. Have any problems been detected in the Unit 2 EDGs of the sort discovered in testing the Unit 1 EDGs?

A31. (Berlinger) To the best of my knowledge, the Unit 2 EDGs have not been tested or inspected. Therefore, problems have not yet been identified.

Q32. When do you anticipate that pre-operational testing of the Unit 2 EDGs will commence?

A32. (Berlinger) I anticipate that pre-operational testing of the Unit 2 EDGs will commence in December 1984 or January 1985.

Q33. Upon implementation of the OGPP, would you conclude that the O/R of the Unit 2 EDGs would be established?

A33. (Nesbitt, Kirkwood, Louzecky, Berlinger) If all pertinent aspects of the OG plan have been completed with satisfactory results on the EDGs at Catawba Unit 2, then, in our opinion,

these EDGs would be adequate to perform their intended design and operational functions.

Q34. Does the Staff intend to require a showing by Applicants of operability/reliability of the EDGs for Unit 2 similar to that undertaken for the Unit 1 EDGs?

A34. (Berlinger) If the OGPP is not accepted by the Staff and implemented by the TDI Owners, including the Applicants, by the time of Catawba Unit 2 licensing, the Applicants will be required to show the operability/reliability for Unit 2 EDGs similar to that done for the Unit 1 EDGs.

Q35. Does the Staff believe that Applicants will, at the appropriate time, be able to demonstrate the operability/reliability of the Unit 2 EDGs for their intended safety functions?

A35. (Berlinger) Based on the information learned through Applicants' Unit 1 extended operational testing, inspections, and return-to-service testing program, the OGPP analyses and recommendations, and the review of Unit 1 diesels by PNL and the Staff, the Staff believes that appropriate measures, whether in terms of parts replacement, procedure changes, enhanced maintenance and surveillance, or other steps determined to be appropriate, can be taken.

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 goals 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.

JOHN F. NESBITT

Senior Research Engineer
Materials & Manufacturing Technology Section
Pacific Northwest Laboratory
Battelle Memorial Institute

Education

B.S., Mechanical Engineering, University of Idaho, 1950
Company Management Courses, 1952-1984

Experience

Mr. Nesbitt is currently a member of the group organized to review and assess the reliability and operability of emergency diesel generators at specified commercial reactor sites for the NRC. In addition, he is project manager for the Federal Interim Storage Deployment portion of DOE's Commercial Spent Fuel Management Program.

Since joining PNL in 1975, Mr. Nesbitt developed and implemented a department quality assurance program. He was responsible for the procurement of special instrument systems, equipment, and vessels installed in hot cells to process nuclear fuels and to vitrify their wastes. He was also principal author of documentation identifying the ramifications and requirements of various remote processes to solidify high-level nuclear wastes. Mr. Nesbitt conducted studies and developed plans for N-Reactor fuel fabrication and for reducing N-Reactor charge/discharge-time requirements. He contributed to facility studies on monitored retrieval storage for spent fuel and nuclear wastes. Mr. Nesbitt also served as principal investigator for an NRC program on the QA problems related to nuclear reactor design, construction, and operation.

From 1971 to 1975, Mr. Nesbitt was Director of Engineering for the International Snow-mobile Industry Association, Washington, D.C., and Minneapolis, Minnesota. His responsibilities pertained to vehicle standards, design, manufacture, operations, and use.

From 1964 through 1970, Mr. Nesbitt was with AMF, Inc., York, Pennsylvania. Initially he was project engineer responsible for equipment to handle and process irradiated fuel. Later he worked on the research, development, and testing of snowmobiles and was responsible for the design of the new models.

Mr. Nesbitt was employed by General Electric Company, Richland, Washington, for 14 years. He worked on the design of four nuclear reactor plants and directed the design, procurement, and installation of systems for the reactors and their facilities. He also directed operational and startup tests on reactor components and systems. He served as shop engineer in Hanford's central maintenance shops and also worked as maintenance engineer in a fuel reprocessing facility.

Professional Affiliations

Licensed Professional Engineer in Washington, Pennsylvania, Minnesota
Member, Society of Automotive Engineers
Member, American Society of Mechanical Engineers
Member, National Society of Professional Engineers

PROFESSIONAL QUALIFICATIONS

B. J. KIRKWOOD, P.E.

Consulting Engineer
Covenant Engineering Co.
Buena Vista, Colorado

Education

B.S.	Mechanical Engineering, Massachusetts Institute of Technology, 1950
M.S.	Economics and Engineering, Massachusetts Institute of Technology, 1950

Experience

Mr. Kirkwood is currently a self-employed consulting engineer (semi-retired) doing business as Covenant Engineering. Services include studies and consultation on power supply planning; utility rates and economics; diesel engine applications; project administration and financing; and utility coordination.

From 1982 to 1984, Mr. Kirkwood provided the same consulting engineering services from his office in Prairie Village, Kansas.

From 1954 to 1982, Mr. Kirkwood was with A. C. Kirkwood & Assoc., Kansas City, Missouri. During that time, the firm was responsible for engine-generator installation designs embracing 13 basic models of seven engine manufacturers, ranging in size from 600 to 7000 kW, and speeds of 200 to 900 rpm. Mr. Kirkwood was responsible for 15 diesel projects for 10 different clients involving 19 engines of 5 different makes. He also directed study of present and future engine utilization for the Electric Power Research Institute.

He retired from the firm in January 1982 as one of three senior partners. At that time, he was responsible for quality assurance and procedure for all specifications, studies and reports; directed all and performed many economic and rate studies; was project sponsor for the majority of engine-generator project designs; was director of long-range planning and business analyses for the firm.

Professional Affiliations

Registered Professional Engineer - Colorado, Missouri, and Kansas.

Member: American Society of Mechanical Engineers
Associate - Diesel and Gas Engine Power Divn
Secretary (1967-1973) Performance Test Code Com. #17,
Reciprocating Internal Combustion Engines
Accreditation Board for Engineering and Technology (ME)
American Solar Energy Society
National Society of Professional Engineers
Colorado Engineering Society (ex - MoSPE and KsES)
Pi Tau Sigma (national honorary ME fraternity)

Publications and Presentations

Several articles for Diesel and Gas Turbine Progress magazine; papers and presentations for Energy Technology Conference, Diesel Engine Manufacturers Association, Kansas Municipal Utilities, and Iowa Association of Municipal Utilities.

Professional Qualifications

Paul J. Louzecky

Consulting Engineer
Engineered Applications Corporation
1674 Witherbee Road
Troy, Michigan 48084

Education

B.S.	Mechanical Engineering, Case Western Reserve University 1932
M.S.	Mechanical Engineering, Case Western Reserve University 1933

Experience

For the past 9 years, Mr. Louzecky has been self-employed as a consulting engineer under the firm name Engineered Applications Corporation. He applies his expertise to client problems with diesel and gasoline engines for aircraft, automotive, and truck applications.

From 1970 through 1975, Mr. Louzecky was with the Detroit Diesel Engine Division, General Motors Corporation, in Detroit, Michigan. His work encompassed design and development of various diesel engine configurations and components, including an 8-cylinder vee 4-cycle diesel truck engine and three rotary combustion diesel engines. In addition, he designed a high-pressure, high-speed fuel injection pump for use on a rotary combustion diesel engine, as well as a stratified-charge automotive gasoline. He was also Executive Engineer on the MBT-70 Main Battle Tank Program.

From 1963 to 1970, Mr Louzecky conducted research projects involving a variety of novel engine concepts for the General Motors Research Laboratories in Warren, Michigan. As a consulting engineer to the Waukeska Bearing Company, Waukeska, Wisconsin, Mr. Louzecky analyzed the potential market for internal combustion engine bearings.

As chief engineer for the Engine Division of Nordberg Manufacturing Company from 1958 through 1963, Mr. Louzecky provided engineering and administrative oversight for three departments. He was responsible for all design, research, development, and testing of new engines, as well as improvements to all production 2- and 4-cycle diesel, duafuel, trifuel, sparkignition, and propane engines.

From 1935 through 1958, Mr. Louzecky was with the Cleveland Diesel Engine Division of General Motors. As head of the analytical design section, his responsibilities included all stress analysis work on engine design, vibrations, governing, engine performance, and electrical power plant systems.

During the 2 years immediately following receipt of his M.S. degree, Mr. Louzecky designed and developed a variety of automotive and aircraft components for two Cleveland firms.

Professional Affiliations

Registered Professional Engineer in Ohio
American Society of Mechanical Engineers
Society of Automotive Engineers
Sigma Xi

Patents

Mr. Louzecky holds 8 U.S. Patents.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
DUKE POWER COMPANY, ET AL.	)	Docket Nos. 50-413
	)	50-414
(Catawba Nuclear Station, Units 1 and 2)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "NRC STAFF TESTIMONY OF CARL H. BERLINGER, B. J. KIRKWOOD, PAUL J. LOUZECKY AND JOHN F. NESBITT ON THE OPERABILITY/ RELIABILITY OF CATAWBA EMERGENCY DIESEL GENERATORS" in the above-captioned proceeding have been served on the following by express mail, or, as indicated by an asterisk, by deposit in the United States mail, first class, or, as indicated by double asterisks, by deposit in the Nuclear Regulatory Commission's internal mail system, or, as indicated by triple asterisks, by messenger, this 20th day of August, 1984:

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