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

August 14, 1984

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Mr. Robert Guild, Esq.
c/o Palmetto Alliance
2135½ Devine Street
Columbia, SC 29205

Mr. Jesse L. Riley
Carolina Environmental Study Group
854 Henley Place
Charlotte, NC 28207

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

Dear Messrs. Guild and Riley:

I am forwarding herewith a copy of the Staff's Safety Evaluation Report concerning the Reliability of Diesel Generators at Catawba, which was approved by the Staff today. I have not included the TER, which the SER adopts, since you already have received that document.

Sincerely,

George E. Johnson
Counsel for NRC Staff

Enclosure: As stated

cc w/ enclosure: Service list

DS07

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

AUG 14 1984

Docket Nos.: 50-413
50-414

Mr. H. B. Tucker, Vice President
Nuclear Production Department
Duke Power Company
422 South Church Street
Charlotte, North Carolina 28242

Dear Mr. Tucker:

SUBJECT: STAFF SAFETY EVALUATION REPORT ON CATAWBA, UNIT 1 TRANSAMERICA DELAVAL, INC. (TDI) DIESEL GENERATORS

The staff and its consultants have reviewed your submittals dated February 22, April 5, June 1, June 29, July 6, July 16 and August 1, 1984, regarding Catawba Unit 1 TDI diesel generators. A July 17, 1984 report, from W. Hallman, Duke, to C. Ray, TDI Owners Group, was also reviewed. The staff's safety evaluation, which will be issued as a supplement to the Catawba Safety Evaluation Report at a later date, is enclosed. The evaluation incorporates, by reference, the Technical Evaluation Report (TER) prepared by the staff consultants from Pacific Northwest Laboratory (PNL). The staff concludes that the TDI diesel engines at Catawba Nuclear Station, Unit 1 will provide a reliable standby source of onsite power in accordance with General Design Criterion 17 through the first reactor refueling outage. This finding is based upon the NRC staff/PNL review of (1) the current status of the TDI Owners Group Program in resolving the TDI diesel engine issue; (2) actions taken by the licensee to enhance and verify the reliability of the 1A and 1B engines; (3) the enhanced maintenance and surveillance program as modified in the SER; and (4) changes to the Technical Specifications to limit future testing of the engines to 5750 KW (185 psig BMEP). In addition, this finding is subject to the license condition that Duke implement Owners Group recommendations by the first refueling which will assure that Catawba, Unit 1 will continue to meet GDC 17 beyond the first refueling outage. To implement the staff's findings regarding Technical Specification changes, you should request appropriate changes to the Technical Specifications within two weeks of receipt of this letter.

Sincerely,

Thomas M. Novak, Assistant Director
for Licensing
Division of Licensing

Enclosures: As stated

cc: See next page

SAFETY EVALUATION REPORT

CATAWBA NUCLEAR STATION UNIT 1

RELIABILITY OF DIESEL GENERATORS

MANUFACTURED BY TRANSAMERICA DELAVAL, INC.

TDI PROJECT GROUP

DIVISION OF LICENSING

1.0 INTRODUCTION

In support of its request for a full power license for Catawba Nuclear Station (Catawba), Unit 1, Duke Power Company (the licensee) submitted by letter dated June 29, 1984, a description of the inspection results of the 1A diesel generator. Further, on July 6, 1984, the licensee submitted its inspection plans for the 1B engine along with its proposed return-to-service testing of the 1A engine. The licensee submitted its enhanced maintenance and surveillance program for the diesels on July 16, 1984.

Both diesel generators at Catawba Unit 1 (designated 1A and 1B) have 16 cylinders in the vee configuration with a full load engine rating of 7000KW. The engine manufacturer is Transamerica Delaval, Inc. (TDI).

2.0 BACKGROUND

Concerns regarding the reliability of large bore, medium speed diesel generators of the type supplied by TDI at Catawba Unit 1 and at fifteen (15) other 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 have since become evident 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, thirteen (13) U.S. nuclear utility owners, including the licensee, formed a TDI Diesel Generator Owners Group to address operational and regulatory issues relative to diesel generator sets used for 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) intended by the Owners Group to serve as an interim basis for the licensing of plants.

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

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

3.0 EVALUATION

Enclosure 1 to this SER is a Technical Evaluation Report (TER) entitled, "Review and Evaluation of Transamerica Delaval, Inc. Diesel Engine Reliability and Operability - Catawba Nuclear Station, Unit 1." 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's 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.

In addition to the submittals listed in Section 1.0 above, PNL and its consultants also reviewed other licensee submittals (identified in Section 2.0 of the enclosed TER) and performed onsite inspections of key engine components in April and July, 1984, while the 1A and 1B engines were disassembled, respectively. PNL and its consultants also considered the status of the generic Owners Group program relative to the actions taken by the licensee to establish the reliability of the diesels.

The staff has reviewed the enclosed TER, and adopts the TER as part of this Safety Evaluation by reference. The remainder of the SER provides clarification of the TER and indicates items required of the licensee.

3.1 Extended Operational Tests

In an April 5, 1984 letter to the NRC, Duke Power Company described their extended operational tests on the 1A engine. The 1A engine had been operated to over 810 hours with about 76% of those hours at operating levels greater than required for emergency power. The licensee's intent in operating the 1A engine (and subsequently the 1B engine) for this amount of time was to establish the reliability and operability of the engine. The 1B engine has also been tested to greater than 750 hours with more than 75% of the tests conducted at full load or above and approximately 80% of the tests conducted at operating levels greater than required for emergency power.

3.2 Inspections Following Extended Operational Tests

3.2.1 1A Engine

Following the extended operational tests, the licensee conducted an extensive teardown and inspection of the 1A engine which presently is almost complete. The inspection of key engine components, including those identified by the Owners Group as known potential problem areas, indicates that these components are acceptable for nuclear service for the interim period extending to the first refueling of Catawba Unit 1. This finding is subject to (1) operating restrictions as identified in Section 3.5 of this SER, and (2) completion of licensee actions pertaining to confirmatory issues as identified in Section 4.0 below.

The most significant findings as a result of this inspection include cracks in four of the AN type piston skirts (all pistons in both engines have been replaced with the later model AE skirts), wear on the turbocharger thrust bearings, cracks in two intake rocker arm pedestals, small jacket water leaks in two cylinders, and three minor indications on the crankshaft which were polished out.

In a June 29, 1984 submittal, Duke Power discussed their inspections and their evaluation and final disposition of findings. For the most part, the staff has concurred with Duke Power's assessment and resolution of inspection results. However, the staff has no basis to find that Duke Power's solution to preventing weld cracking on the right bank at the turbocharger adapter to the intercooler interface, i.e., providing stiffeners to span the weld area, is adequate considering the amount of surging and vibration that this interface is likely to experience. The staff believes a solution which would alleviate this problem involves installation of a flexible joint at this juncture. Because of the potential impact to operation that failure at the adapter could have, the staff requires Duke Power to install a flexible joint arrangement at the turbocharger right bank of both engines prior to operation above 5% power.

Additionally, Duke Power must install an improved turbocharger prelubrication system by first refueling, or in lieu of installation, must fully inspect the turbocharger thrust bearings of one engine at the first refueling. Duke Power has committed to install an improved system by September 1984. In addition, prior to operation above 5% power, Duke Power must commit to perform such an inspection if an improved prelubrication system is not installed.

Duke Power has indicated in their June 29, 1984 inspection report that #6L cylinder head will be replaced. The staff requires that this head be replaced prior to operation above 5% power with either a new cylinder head or one obtained from another engine such as those at Catawba Unit 2.

There remains several plant-specific and generic problem areas where Duke Power has not yet completed the inspection or where investigation is continuing. Satisfactory completion and resolution of these areas must be confirmed to the staff prior to full power licensing of Catawba. Confirmation is required of the following:

- Satisfactory reassembly and walkdown results for the fuel line fittings,
- Satisfactory inspection results, including necessary replacement of fuel injection pump valve holders,
- Replacement of turbocharger gas inlet bolts,
- Satisfactory results of eddy-current testing of high pressure tubing, and
- Installation of the jacket water pump impeller nut within the recommended torque range.

3.2.2 1B Engine

The inspections performed on the 1B engine are identified in a July 6, 1984 letter to the NRC and are also quite thorough and extensive. They are very similar in scope to those performed on the 1A engine. The justification for reduced inspection of some components is based on satisfactory results on the

1A engine. By letter dated August 1, 1984, Duke Power has committed to perform examinations of the 1B engine's link rod bushings for any damage.

As resolution to the problem of chrome peeling on the intake and exhaust valves, Duke Power has replaced the affected valve stems where found, on both engines. The staff and its consultants agree with the licensee's approach. It is not the consultant's intent in the enclosed TER to suggest that all valves need to be replaced.

The staff concludes that the licensee's proposed 1B inspection plan, as contained in the July 6 and August 1, 1984 submittals, is adequate with one modification. Prior to operation above 5% power, the staff requires that Duke Power commit to check the torque of the jacket water pump impeller nut at the time of the first refueling outage.

The staff concludes that the 1B diesel can reliably meet its intended design function based on the proposed inspection plan. The staff anticipates receipt of the 1B inspection results by October 31, 1984.

3.3 Return-to-Service Testing

The licensee proposed certain return-to-service tests for the engine in its July 6, 1984 submittal to the staff. The purpose of the tests is to demonstrate the engine's operability following reassembly. By letter dated August 1, 1984, Duke Power committed to install temporary thermocouples on the 1B engine to measure pre-turbine exhaust temperatures at 25%, 50%, 75% and 82% of full engine load during that engine's return-to-service testing program. In addition, Duke Power has committed to install permanent thermocouples on both engines by the first refueling outage. The staff and its consultants have reviewed the licensee's proposed testing and find it acceptable with the following modification:

- Duke Power must perform the tests within the operating restrictions outlined in Section 3.5 of this SER.

The staff concludes that the licensee's proposed testing plan, with the above modification is sufficient to establish the 1A engine's operability for return-to-service. If a test failure occurs during return-to-service testing, the problem must be corrected and that particular test sequence (e.g. endurance test or modified start tests) must be reperformed.

The staff understands that the testing program for the 1B engine will duplicate that of the 1A engine with the addition of the monitoring of the pre-turbine exhaust temperatures. As with the 1A engine, the staff concludes that successful completion of the 1B testing program will establish the 1B engine's operability for return to service.

3.4 Enhanced Maintenance and Surveillance Program

PNL concluded in the enclosed TER that modifications to the Enhanced Maintenance/Surveillance (M/S) Program proposed by the licensee in their July 16, 1984 submittal are needed to provide adequate assurance of engine reliability/operability. These modifications are discussed in detail in Section 7 of the enclosed TER.

The staff will require that the licensee commit to a modified M/S program as discussed in this section of the SER and in Section 7 of the enclosed TER as a prerequisite to a operation above 5% power. The connecting rod bearing shell inspection called for on page 50 of the enclosed TER should include a complete inspection (dimensional, visual and radiographic) of all bearing shells after 500 hours of operation. The bearing shell inspection discussed on page 92 should be a sample inspection of four bearing shells to evaluate their condition in relation to the 500 hour inspection interval.

Duke Power indicated in its inspection report dated June 29, 1984, that until the cause of the rocker box subassembly cracking was determined, the subassemblies would be inspected regularly. Duke Power must supply to the staff the planned surveillance activities and frequencies of inspections of the subassemblies prior to operation above 5% power. Increased surveillance activities should continue until identification and resolution of the cause of the failure is accomplished to the staff's satisfaction.

The TER specifies an inspection interval for the connecting rod bolting* of 200 hours or nine months, whichever comes first. Since issuance of the final TER, PNL has reevaluated the inspection interval in terms of the operating time expected in nine months which is on the order of 50 hours. Their reevaluation is contained in an August 10, 1984 letter to the staff provided as an enclosure to this SER. Because the operating time in nine months is not expected to approach 200 hours, inspection of the connecting rod bolts at the first refueling outage, rather than nine months, is deemed acceptable. The staff agrees with this assessment since the inspection time interval will now correspond more closely with the operating time inspection interval. Therefore, the connecting rod bolting should be inspected at 200 hours or first refueling, whichever comes first.

The licensee is required to check the lubricating oil of the engine for chemical and particulate contamination on a monthly basis for the first three months of operation at which time the results will be reviewed by the staff to determine a subsequent surveillance schedule.

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* The diesel engines at Catawba have 1½" connecting rod bolting rather than 1-7/8" bolting as identified in the TER.

3.5 Operating Restrictions

The staff recommendations and conclusions regarding TDI diesel engine reliability at Catawba Unit 1 are predicated on the following:

1. Engine operation and testing, including surveillance testing required by the plant Technical Specifications, will be limited to within ± 5% of the nominal engine load where the upper limit of this load range corresponds to a BMEP of 185 psig. The need for this is based on PNL and staff concerns regarding the acceptability of crankshaft stresses, and the lack of substantial AE piston operational data at higher BMEP loadings.

2. The emergency service requirements of Catawba Unit 1 do not exceed the engine load corresponding to a brake mean effective pressure (BMEP) of 185 psig.

3. At the first refueling, the licensee is required to implement all applicable recommendations of the Owners Group, as reviewed and accepted by the staff. This implementation will be a condition of the license.

With regard to item 1 above, the licensee must submit proposed Technical Specification changes incorporating this item prior to operation above 5% power. Specifically, the proposed changes would require that the monthly and 18 month surveillance tests be performed at a load greater than or equal to the maximum emergency service load, but not to exceed 5750KW (82% of rated load, 185 psig BMEP). This limit is greater than the auto-connected loads required for the loss of offsite power and post-LOCA conditions as described below in reference to item 2. Therefore, the staff finds these changes acceptable.

With regard to item 2 above, the 185 psig BMEP corresponds to a generator load of approximately 5750KW, slightly more than 82% of full rated load. This exceeds the maximum emergency service loads of 5714KW and 5256KW required to shut down the plant and maintain it in a safe condition for loss of offsite power and LOCA, respectively. Thus, there exists sufficient engine capacity at 185 psig BMEP to assure that the fuel design limits and design conditions of the reactor coolant system boundary are not exceeded, and that the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents as required by GDC-17.

The licensee must add, prior to full power licensing, a precautionary note to the Catawba Abnormal Procedure for Loss of Normal Power, and to any other applicable plant procedures, to ensure that loads will not be added unnecessarily to the engines in excess of 185 psig BMEP (5750KW). In addition, future training with respect to this procedure will explain both the basis for the note and the aspects to be taken into consideration in its application. The NRC will verify that these actions have been completed.

With regard to item 3, the full power license is being conditioned to require NRC review and approval of licensee actions pertaining to a final resolution of the TDI diesel generator issues at Catawba Unit 1.

4.0 CONCLUSIONS

The staff and its consultants have reviewed the licensee's extended operational test program, its post-operational inspection program, its return-to-service test plan and its maintenance/surveillance schedule. The staff believes that the licensee has adequately tested the engines prior to disassembly and inspection. The inspections performed by the licensee were sufficiently broad in scope to encompass both Catawba-specific occurrences as well as the significant generic problems identified by the Owners Group. Further, the staff concludes that upon satisfactory completion of return-to-service testing and implementation of the modified maintenance/surveillance program, the Unit 1 engines should be reliable to perform their design functions through the first reactor refueling outage.

Therefore, the NRC staff concludes that the TDI diesel engines at Catawba Unit 1 will provide a reliable standby source of onsite power in accordance with General Design Criterion 17. This finding is based upon the NRC staff/PNL review of (1) the current status of the TDI Owners Group Program in resolving the TDI diesel engine issue; (2) actions taken by the licensee to enhance and verify the reliability of the 1A and 1B engines (contingent upon satisfactory completion of the 1B engine inspections and the 1A and 1B engines' return-to-service testing); (3) the enhanced maintenance and surveillance program as described in Section 3.4 of this SER and in Section 7 of the TER which the licensee must commit to; and (4) changes to the Technical Specifications to limit future testing and operation of the engines to a BMEP of 185 psig. Furthermore, the Catawba license will be conditioned to require Duke Power to implement the Owners Group recommendations applicable to Catawba Unit 1, as reviewed and accepted by the staff, by the plant's first refueling outage.

As discussed in the SER, the following items are required of the licensee prior to operation above 5% power to support the staff's conclusions.

- Installation of a flexible joint arrangement at the turbocharger right bank of both engines.
- A commitment to inspect the turbocharger bearings of one engine if an improved prelubrication system is not installed.
- Replacement of the 6L cylinder head on the 1A engine.
- A commitment to inspect the 1B engine's jacket water pump impeller nut at the first refueling.
- A commitment to incorporate the modified maintenance and surveillance program as discussed in the SER and TER, including identification of the rocker box subassembly inspection frequency and cause of failure.
- Revised Technical Specifications limiting operation and testing to 185 psig BMEP (5750KW).

- Revised plant procedures incorporating a precautionary note to ensure that loads will not be unnecessarily added in excess of 185 psig BMEP (5750KW).

Confirmation of the following is required on the 1A inspection prior to operation above 5% power:

- Satisfactory reassembly and walkdown results for the fuel line fittings.
- Satisfactory inspection results, including necessary replacement of fuel injection pump valve holders.
- Replacement of turbocharger gas inlet bolts.
- Satisfactory results of eddy-current testing of high pressure tubing.
- Installation of the jacket water pump impeller nut within the recommended torque range.

Enclosure 2

Battelle
Pacific Northwest Laboratories
P.O. Box 999
Richland, Washington U.S.A. 99352
Telephone (509)
Telex 15-2874

August 10, 1984

Mr. Carl Berlinger
Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Berlinger:

SUBJECT: "REVIEW AND EVALUATION OF TRANSAMERICA DELAVAL, INC., DIESEL ENGINE RELIABILITY AND OPERABILITY - CATAWBA NUCLEAR STATION UNIT 1", PNL Report No. 5211, prepared for U.S. Nuclear Regulatory Commission by Pacific Northwest Laboratory, August 1984

In Section 7.1.3 of the subject document, PNL recommended a visual surface inspection and bolt preload check of the connecting rods at 200 hours of operation or 9 months, whichever occurs first. This is consistent with an earlier recommendation made by PNL for the diesel engines at Grand Gulf. However, the engines at Catawba are equipped with connecting rods of a later design than those at Grand Gulf. In a report on connecting rods prepared for the TDI Diesel Generator Owners' Group, Failure Analysis Associates concluded that the later design has an 8% to 9% higher margin of safety than the earlier design, because the rod box structure is more massive.

Accordingly, PNL has reconsidered its recommendation for surveillance of connecting rods in the engines at Catawba. PNL now recommends a visual surface inspection and bolt preload check of these connecting rods at 200 hours of operation or 18 months, whichever comes first. Per discussions with M. Miller of the NRC staff, we understand that this new recommendation has been incorporated into the Catawba SER.

PNL consultants B. J. Kirkwood, P. J. Louzecky, J. E. Horner, and A. J. Henriksen, who participated in the preparation of the subject report, concur with this new recommendation. If further clarification is needed, please give me a call at (509) 375-2332.

Sincerely,

J. F. Nesbitt

J. F. Nesbitt
PNL Diesel Engine O/R Project

Concurrence: W. W. Laity
W. W. Laity
PNL Project Manager

JFN:r1
cc: M. Miller, NRC
A. J. Henriksen
J. E. Horner
B. J. Kirkwood
P. J. Louzecky