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NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

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

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Dr. Richard F. Foster
Administrative Judge
P.O. Box 4263
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 OL

Dear Administrative Judges:

In accordance with the Board's order of July 20, 1984 establishing a schedule leading to hearing on August 27, 1984 of the diesel generator contention, and an up-to-two day extension granted to the Staff to file the consultant's technical evaluation report (TER), I am herewith enclosing a copy of said TER. I have also included several pertinent documents referenced therein which you may not have received.

Sincerely,

George E. Johnson
Counsel for NRC Staff

Enclosures: As stated

cc w/encl: Parties

cc w/o encl: Remainder of Service List

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REVIEW AND EVALUATION OF TRANSAMERICA DELAVAL, INC., DIESEL ENGINE RELIABILITY AND OPERABILITY - CATAWBA NUCLEAR STATION UNIT 1

August 1984

Prepared for
Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
under Contract DE-AC06-76RLO 1830
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Project Title: Assessment of Diesel Engine Reliability/Operability

NRC Lead Engineer: C. H. Berlinger

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PACIFIC NORTHWEST LABORATORY

PROJECT APPROVALS

for [signature] Date 8/2/84

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Pacific Northwest Laboratory

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Senior Review Panel
Pacific Northwest Laboratory

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REVIEW AND EVALUATION OF
TRANSAMERICA DELAVAL, INC., DIESEL ENGINE
RELIABILITY AND OPERABILITY -
CATAWBA NUCLEAR STATION UNIT 1

1.0 INTRODUCTION

Duke Power Company (Duke) has requested an operating license for its Catawba Nuclear Station Unit 1 (Catawba). One key matter before the U.S. Nuclear Regulatory Commission (NRC) in considering this request is the operability and reliability (O/R) of the station's standby emergency diesel-engine generators which have been brought into question by a number of circumstances (as described in Section 2.0). The subject engines were manufactured by Transamerica Delaval, Inc. (TDI).

To identify, evaluate, and correct these concerns, Duke has undertaken a number of industry-wide and plant-specific investigative, corrective, and administrative efforts. These have been addressed by Duke and its consultants in numerous documents and related meetings with NRC staff and NRC's consultant, Pacific Northwest Laboratory (PNL). PNL has been requested by NRC to review and evaluate these documents and Duke's underlying efforts and to prepare this technical evaluation report (TER) expressing its conclusions and recommendations.

Catawba Nuclear Station Unit 1 is served by two emergency standby engines to meet its ESF loads. Each engine is a TDI DSRV-16-4 engine, nameplate rated by TDI at 7000 kW, operating at 450 rpm with a brake mean effective pressure (a computed measure of the average cylinder pressure in the firing stroke) of 225 psig. These engine-generators are designated by Duke as 1A and 1B. The latest information in the Final Safety Analysis Report (FSAR) specifies the emergency loads for these engines as a maximum of 5256 kW for a loss of coolant accident (LOCA) and a maximum of 5714 kW for a blackout or loss of offsite power (LOOP).

1.1 SCOPE OF REPORT

This TER is organized as follows:

- Section 2.0 provides relevant background information on the known problems and efforts toward their resolution by both Duke and an ad hoc group of similar TDI engine owners (the TDI Owners' Group) who have united their efforts in regard to these mutual concerns.
- Section 3.0 presents a review and evaluation of specific problems experienced on the Catawba engines as well as of activities pertaining to the TDI Owners' Group generic components.
- Section 4.0 reviews Duke Power Company test and inspection activities on the 1A engine.
- Section 5.0 reviews the activities Duke has conducted or plans to perform on the 1B engine.
- Section 6.0 documents PNL's evaluation of Duke's post-inspection engine tests.
- Section 7.0 presents PNL's review of the utility's proposed maintenance and surveillance (M/S) program.
- Finally, Section 8.0 presents PNL's overall conclusions and recommendations regarding the suitability of the two diesel engines to perform their intended function as emergency standby power sources for the Catawba Nuclear Station Unit 1.

1.2 LIMITED APPLICABILITY OF CONCLUSIONS

PNL has reviewed the basic documents referred to in Section 2.0, has participated in various meetings with Duke and NRC, and has observed components of both engines as disassembled in Duke's inspection program. Concurrently, PNL also has reviewed various relevant Owners' Group documents and participated in their meetings with NRC, and has completed TERs on some elements of the Owners' Group Program Plan (OGPP). Because none of the various phases of the OGPP (as described in Section 2.1) has yet been finalized, PNL is not in a position to draw final conclusions on the overall extended operability and reliability of these TDI engines in general, nor extensions thereof to plant-specific engines such as those installed at Catawba.

This TER on the Catawba 1A and 1B engines' operability and reliability precedes completion of the OGPP and its appropriate implementation by Duke. This document also precedes full plant-specific DR/QR analyses of both the 1A and 1B engines. Therefore, PNL is constrained from reaching unlimited conclusions relative to the Catawba 1A and 1B engines' operability and reliability to perform indefinitely their expected design function. Any such conclusions, if supportive toward licensing, must necessarily be somewhat tentative, subject to full completion of all OGPP and Duke DR/QR programs and implementation of their findings (these actions should be a part of Duke's licensing authorization).

Hence, PNL has been constrained to evaluate all components in light of expected operating conditions and patterns at Catawba over a relatively short term. The term chosen, thought by PNL's diesel consultants to be reliably conservative, was until the first reactor refueling outage, which PNL understands to be approximately 18 months from initial plant startup. By that time, all phases of both the general OGPP evaluation and implementation and the plant-specific Catawba DR/QR program should be complete or ready to implement. In PNL's judgment, it would be more appropriate to decide long-term O/R at that time (near the first reactor refueling outage), rather than now.

The considerations and recommendations presented in this TER are sometimes expressed in terms of "until the first reactor refueling outage". However, in using this phrase, PNL does not intend to infer (unless specifically stated otherwise) that the engines or their components are therefore unreliable or inoperable for their intended use over their normally expected life.

1.3 REPORT PREPARATION

This TER was prepared by the following PNL staff and consultants:

- J. F. Nesbitt, PNL project staff
- B. J. Kirkwood, Covenant Engineering, diesel consultant to PNL
- J. E. Horner, Seaworthy Systems, Inc., diesel consultants to PNL

- P. J. Louzecky, Engineered Applications Corporation, diesel consultant to PNL.

Others whose contributions were considered in formulating the conclusions include PNL Assessment of Diesel Engine Reliability/Operability Project team members J. M. Alzheimer, M. Clement, S. D. Dahlgren, D. A. Dingee, R. E. Dodge, W. W. Laity, J. C. Spanner, and F. R. Zaloudek; and consultants S. H. Bush, A. J. Henriksen, and J. A. Webber (representing Ricardo Consulting Engineers plc).

2.0 BACKGROUND

This section presents background information on efforts undertaken by the TDI Diesel Generator Owners' Group and by Duke Power Company to resolve the problems identified in the TDI diesel engines.

2.1 OWNERS' GROUP PROGRAM PLAN

Thirteen nuclear utilities that own diesel generators manufactured by Transamerica Delaval, Inc. (TDI), have established an Owners' Group to address questions raised by a major failure in one TDI diesel engine (at the Shoreham Nuclear Power Station in August 1983), and other problems in TDI diesels reported in the nuclear and non-nuclear industry. On March 2, 1984, the Owners' Group submitted a plan to the U.S. Nuclear Regulatory Commission outlining a comprehensive program that included 1) an in-depth assessment of 16 known engine problems (Phase I), 2) a design review and quality revalidation (DR/QR) program that addresses other key engine components (Phase II), and 3) engine tests and inspections. A review of that submittal was conducted by PNL and reported to NRC in PNL-5161 dated June 1984.

Section 4 of PNL-5161 deals with considerations for interim licensing of nuclear stations prior to completion of the implementation of the Owners' Group Program Plan. Recommendations in that report relevant to Duke Power Company's license for the Catawba Nuclear Station at this time are:

- The engines should have AE pistons; if they do not, then "lead-engine" tests should be completed prior to licensing.
- The diesel generators should not be required to carry a sustained emergency load in excess of that corresponding to engine brake mean effective pressure (BMEP) of 185 psig, because, at that recommended limit, the maximum cylinder pressure is also approximately 1200 psig. The 6000-hour operating experience at Kodiak establishes a reasonable basis for confidence that AE piston skirts will operate satisfactorily at this load level. Also, pending evaluation and approval of Owners' Group reports addressing crankshaft stress levels at higher loads, the load corresponding to 185 psig BMEP is

considered reasonably conservative for the crankshaft. In addition, because of certain open items in the implementation of the Owners' Group Program Plan, an adequate basis does not yet exist to provide reasonable assurance that TDI diesel engines would operate reliably in nuclear service at power levels higher than those corresponding to a BMEP of 185 psig. Key engine components of particular concern in this regard include the piston skirts and the crankshaft, because their condition cannot be monitored without significant engine disassembly.

- The engines should be inspected to confirm that the components are sound (see Sections 4 and 5).
- Preoperational testing should be performed (see Section 6).
- The engines should receive enhanced surveillance and maintenance thereafter (see Section 7).

2.2 CATAWBA NUCLEAR STATION

In their efforts to establish the reliability and operability of Catawba's TDI diesel engines, Duke Power Company has produced numerous letters and reports, as well as holding meetings and conducting tests, inspections, and examinations. Items pertinent to this Technical Evaluation Report are listed below.

- A letter dated February 17, 1984, to the Atomic Safety and Licensing Board Panel (ASLB), "Duke Power Company et al. (Catawba Nuclear Station, Units 1 and 2), Docket Nos. 50-413 and 50-414", noted problems with some components on the 1A engine at Catawba.
- In a letter dated February 22, 1984, "Catawba Nuclear Station Docket Nos. 50-413 and 50-414", Duke Power Company transmitted their responses to 17 NRC questions regarding the TDI diesel generators installed at Catawba.
- A letter dated March 29, 1984, to the ASLB, "Duke Power Company et al. (Catawba Nuclear Station, Units 1 and 2), Docket Nos. 50-413 and

50-414", noted problems that had occurred with the 1A and 1B diesel engines during the extended operational tests and the ESF test currently being conducted.

- In an April 5, 1984, letter to NRC, Duke provided a written description of the extended operational tests and inspection plans for the 1A diesel generator (engine) in addition to a discussion of Catawba-specific problems.
- On April 26 and 27, 1984, PNL staff and consultants visited Catawba to view the disassembly and inspection of the 1A diesel engine and its components. A PNL letter dated May 7, 1984, summarized comments and suggestions made to NRC pertaining to this visit. A report on the trip was submitted to NRC by PNL in a letter dated May 11, 1984. During the April 26 and 27 visit, the PNL observers recommended 100% (instead of 25%) inspection of AN pistons in 1A. Upon completing the full inspection, Duke personnel reported four AN piston skirts had indications. Subsequently, Duke decided to replace all AN piston skirts with the latest AE design.
- On June 1, 1984, Duke provided a submittal to NRC addressing 76% of the 1A diesel engine inspection results.
- On June 21, 1984, a meeting was held in Washington, D.C., at which Duke Power Company presented results of the 1A diesel engine inspections to NRC and PNL.
- On June 22, 1984, PNL staff and consultants met with representatives of NRC at Failure Analysis Associates in Palo Alto, California, to discuss Owners' Group reports prepared by FaAA.
- A letter dated June 25, 1984, to the ASLB, "Duke Power Company et al. (Catawba Nuclear Station, Units 1 and 2) Docket Nos. 50-413 and 50-414", summarized the findings of the substantially completed 1A diesel engine inspection effort.
- Via a letter to NRC dated June 29, 1984, Duke Power Company transmitted the report, Catawba Nuclear Station Diesel Engine 1A Component Revalidation Inspection Final Report. This report

described the results of the inspections and evaluations performed and addressed over 99% of the inspection plan. Duke also indicated that all remaining inspections would be documented in the Owners' Group Phase II Program report.

- NRC Generic Letter 84-15, dated July 2, 1984, "Proposed Staff Actions to Improve and Maintain Diesel Generator Reliability", was issued to all licensees of operating reactors, applicants for an operating license, and holders of construction permits.
- A letter to NRC dated July 6, 1984, outlined Duke Power Company plans for the inspection of the Catawba 1B diesel engine and the return-to-service testing of the 1A diesel engine.
- On July 10, 1984, two PNL consultants visited the Catawba Nuclear Station to view the status of the 1A diesel engine reassembly.
- In a letter dated July 16, 1984, Duke Power Company submitted its plans to NRC for the periodic maintenance, inspection, and surveillance of the Catawba 1A and 1B diesel engines.
- A July 17, 1984, letter from Duke to C. Ray, Jr., of the TDI Owners' Group detailed the operating history of the 1A and 1B diesels.
- On July 25 and 26, 1984, PNL staff and consultants visited the Catawba Nuclear Station to view the disassembly and inspections being performed on the 1B engine. The PNL team also observed the status of the reassembly of the 1A engine, and reviewed and discussed the findings noted and actions taken on specific engine components with Duke and NRC representatives. During the July 25 and 26 visit, the PNL observers queried various items, including the need to fully inspect the link-pin bushings, and to take pre-turbine exhaust gas temperatures.
- In an August 1, 1984, letter to NRC, Duke responded to concerns and queries raised by NRC and PNL in the July 25 and 26 meeting.

3.0 EVALUATION OF COMPONENT PROBLEM RESOLUTION

During the tests and inspections conducted by Duke Power Company on the Catawba Nuclear Station Unit 1 diesel engines, problems were noted or experienced with certain engine components. The affected components included:

- piston skirts[a]
- push rods[a]
- cylinder head[a]
- fuel line fittings
- fuel oil injection pump valve holders
- turbocharger[a] bearings
- turbocharger adapter
- turbocharger lube oil drain line
- turbocharger prelube oil lines
- turbocharger exhaust gas inlet bolts
- crankcase and camshaft cover capscrews
- triple-clamp bolts
- lube oil and jacket water thermocouples
- rocker box (subcover) assembly
- intermediate rocker arm sockets
- exhaust valve tappets (rocker arm adjusting screw swivel pad)
- intake and exhaust valves
- spring retaining nut and roll pin on air start valves.

Section 3.1 documents PNL's evaluation of the actions taken by Duke Power Company to resolve known problems with these diesel engine components. The information on these components is presented in a worksheet format. Each worksheet identifies the component, briefly reviews its history, and describes the status of, or the actions taken by the Owners' Group and Duke to evaluate or resolve, the problem. The last item on each worksheet presents PNL's evaluative comments and/or conclusions.

(a) TDI engine generic problem components.

Section 3.2 documents the actions taken by Duke regarding the engine components classified in the generic problem category by the TDI Owners' Group. These components include:

- crankshaft
- connecting rod bearing shells
- cylinder blocks
- cylinder liner
- cylinder head studs
- engine base and bearing caps
- rocker arm capscrews
- connecting rods
- engine mounted electrical cable
- high-pressure fuel tubing
- jacket water pumps
- air start valve capscrews.

Although Duke has not experienced any specific failures with these components at Catawba, they are nevertheless documented here for completeness, also in a worksheet format. Each worksheet for these items includes a brief history of the component, a review of actions taken by the Owners' Group to evaluate the problem, a description of the tests, inspections, or evaluations performed on these components at Catawba, and PNL's evaluative comments and/or conclusions.

PNL's conclusions and comments are based on the available Duke Power Company documents, on onsite inspections of the Catawba engine components and examinations of identical or at least similar components of TDI diesels in other nuclear facilities, reviews of the specific known-problem issue reports prepared by (or under the auspices of) the TDI Owners' Group, and the experienced judgment and appropriate evaluations of PNL's diesel engine consultants. However, pending completion of the implementation of the Owners' Group Program Plan, PNL's conclusions as stated in this report are plant-specific, applying only to Duke Power Company's Catawba Nuclear Station Unit 1.

3.1 PLANT-SPECIFIC PROBLEMS

Component: Piston Skirts

Part No.: 02-341

Owners' Group Report: FaAA-84-2-14

Brief History of Component

Based on a number of cracks found in the AF piston skirts at the Grand Gulf Nuclear Station, the Shoreham Nuclear Power Station, and at non-nuclear installations, the skirt design was strengthened in the boss area where the cracks had been found. No operational failures have been reported to date on the redesigned piston skirt, labeled AE, in either nuclear or non-nuclear installations. Kodiak (an electrical generation station) has operated in excess of 6000 hours at approximately 185 psig BMEP (1200 psig maximum firing pressure) with the AE skirts; the TDI R-5 test engine has operated in excess of 600 hours with a maximum firing pressure of 2000 psig and BMEP of 275 psig with a slightly modified AE skirt design.

Another type of piston skirt labeled AN is in wide use according to TDI. Only Catawba, of all of the nuclear plants, had AN piston skirts. TDI has indicated that the AN piston skirts, if properly heat-treated, have performed satisfactorily.

Owners' Group Status

Piston skirts have been identified by the TDI Owners' Group as one of the generic problem components. The Owners' Group consultant, Failure Analysis Associates (FaAA), has analyzed the AE piston skirt design and has concluded that the AE skirts may crack at 10% overload of nameplate rating, but that cracks will not propagate to the point of actual functional failure. Cracks have been found to occur in the vicinity of a structural rib and bolting boss inside the skirt.

The issue of AE piston skirts was addressed by PNL in its June 1984 Review and Evaluation of TDI Diesel Generator Owners' Group Program Plan (PNL-5161), Section 4.0, relative to nuclear plants seeking interim licensing (prior to finalization and full implementation of the OGPP). Therein it was concluded that plants with AE piston skirts having sustained emergency load requirements not exceeding 185 psig BMEP could logically and safely be licensed without prior lead-plant testing to 10 million cycles (750 hours) at or above this load.

Duke Power Company Status

During the extended operational test, the 1A diesel was operated with AN piston skirts that had been heat-treated at the TDI factory. During the subsequent disassembly and inspection, cracks were found in 4 of the 16 piston skirts.

The inspections of AN piston skirts conducted by Duke Power Company were directed at assessing these components' structural integrity. All 16 piston skirts on the 1A engine were subjected to the following inspections:

- visual inspection
- liquid penetrant examination of stud bosses
- liquid penetrant examination of piston pin bosses
- liquid penetrant or magnetic particle examination of areas adjacent to the piston pin bosses (i.e., the areas where several cracks were noted)
- ultrasonic and radiographic examinations if liquid penetrant or magnetic particle examinations revealed indications.

The most significant condition noted during the inspections conducted at Catawba was the presence of cracks adjacent to piston pin bosses in four piston skirts. As reported by Duke, the largest crack was 3 or 4 inches long and penetrated through the wall. The cracks appeared to originate at the skirt ID, on the fillets where a reinforcing rib intersects the piston pin bosses, and to run in an approximately axial direction. The cause of the cracking is undetermined at this time but is believed to be high-frequency cyclic fatigue. One small (1/2-inch long) linear indication was also noted in the bore of a piston pin boss. No indications were found at stud bosses.

The AN piston skirts from the 1A diesel at Catawba have been sent to FaAA for a detailed failure analysis as a part of the TDI Owners' Group Program.

Duke Power Company has reported its intention to replace the AN piston skirts with type AE skirts. This has been done on the 1A diesel engine and is in progress on the 1B engine. PNL understands that Duke either has performed or will perform surface nondestructive examination (primarily magnetic particle tests) and hardness tests on the AE piston skirts prior to their installation in an engine to verify their acceptability.

PNL Conclusions

Upon completion of reassembly of engine 1B, both Catawba diesels will be fully fitted with AE piston skirts. The Catawba emergency load requirements, licted in Section 1.0, do not exceed interim-licensing recommendations of PNL-5161 (referred to above). Based on this knowlege, on all available analytical information (principally the OG generic issue report, FaAA-84-2-14), the operational history of AE skirts, the test results on AE skirts elsewhere, and the judgment of its diesel consultants, PNL concludes that the AE piston skirts are suitable for the intended use in the Catawba 1A and 1B engines, at least until the time of the first reactor refueling outage.[a]

(a) This conclusion, and similar conclusions regarding other components, is based upon the assumption that NRC and the Owners' Group will satisfactorily resolve concerns regarding the component and implement all requirements (see Section 1.2).

Component: Push Rods

Part No.: 02-390-C

Owners' Group Report: FaAA 84-3-17

Brief History of Component

The push rods originally had tubular steel bodies fitted with hardened steel end pieces attached with plug welds. An estimated 2% reportedly developed cracks in or around the plug welds. A push rod design introduced later consisted of a tubular steel body with a carbon steel ball fillet welded to each end. This design proved to be prone to cracking at the weld. A third push rod design, consisting of a tubular steel body friction-welded on each end to a forged plug with a machined hemispherical shape, was then introduced. This third configuration is referred to as the friction-welded design.

Owners' Group Status

Because industry (both nuclear and non-nuclear) had expressed substantial concern about the continued integrity of TDI push rods, the TDI Owners' Group included the component in the known generic problem category for specific study and resolution. Failure Analysis Associates has performed stress analyses as well as cycle wear tests to 10 million cycles on a sample of the friction-welded push rods at conditions simulating full engine nameplate loading. No sign of abnormal wear or deterioration of the welded joints was observed.

Duke Power Company Status

The push rods supplied as the original components of the Catawba 1A and 1B diesels experienced cracking in the plug welds joining the center to the end sections. However, these failures did not prevent the push rods from performing their intended functions, nor did they result in any abnormal or adverse engine performance. During the week of February 5, 1984, all of the push rods in engine 1A were replaced with those of the friction-welded design. In the subsequent extended operational tests, about 400 hours of operation were accumulated on this set of friction-welded push rods prior to the disassembly and inspection of the 1A engine. This set of friction-welded push rods was then removed from the 1A engine and installed in the 1B diesel engine at Catawba. According to Duke Power Company personnel, this set of push rods has now been in operation for over 900 hours, with at least one-half of that time being at engine loads above 185 psig BMEP.

The Duke Power Company inspections of the friction-welded design push rods in the 1A engine included:

- visual inspection of the shaft end-welds to verify that the desired new type of friction welds were used
- liquid penetrant examination of all welds.

Duke Power Company reported their confirmation that all the push rods in the 1A engine had the correct type of end-welds and were free of defects.

Duke is performing visual and surface nondestructive examinations on this same set of push rods after its extended service in the 1B diesel engine. This examination is still underway, but Duke personnel indicated to PNL representatives during the Catawba site visit on July 25 and 26, 1984, that no defects had yet been found.

PNL Conclusions

After reviewing the FaAA report, the Catawba inspection data, and examining some of the friction-welded push rods at Catawba on July 25, 1984, PNL concludes that the push rods incorporating the friction-welded design are satisfactory for their intended purpose, until at least the time of the first reactor refueling outage.

Component: Cylinder Heads

Part No.: 02-360A

Owners' Group Report: FaAA-84-15-12

Brief History of Component

Numerous reports on TDI cast steel cylinder head failures are available from both the nuclear and non-nuclear industry. For identification purposes, TDI cylinder heads are classified as I, II and III, all under the same part number. Group I heads include those cast prior to October 1978; Group II heads are those cast between October 1978 and September 1980; and Group III comprises heads cast after September 1980. Most instances of cracked heads have involved Group I. Only five instances of water leaks in Group II and III heads have been reported, all in marine applications. Most of the reported cracks initiated at the stellite valve seats.

The most recent, known head failure was reported by Mississippi Power & Light relevant to their Division I TDI diesel engine (letter to NRC dated July 30, 1984, AECM 84/0401). It reported a 2-inch through-wall crack in the right exhaust port casting surface between the valve seat area and the exhaust valve guide (head 7L). It allowed jacket water to penetrate from the head cooling passages into the cylinder cavity, and was detected by barring-over the engine with cylinder cocks open. The specific head group classification of this head was not reported. However, the affected head was an original that had undergone 1500 hours of operation. Of this total, approximately 335 operating hours were at 100% load (7000 kW, 225 psig BMEP) and 31 hours were at 110% load. This failure is still undergoing investigation; however, because no similar failure has occurred to MP&L's knowledge, it concludes this was a unique, isolated failure.

Owners' Group Status

The cylinder heads are included in the TDI Owners' Group generic problem category. Failure Analysis Associates' mechanical and thermal stress calculations, which did not include finite element calculations, concluded that Group I, II, and III heads as designed are adequate for the service intended. The report recommends that Group I and II heads be inspected by liquid penetrant and magnetic particle, as well as ultrasonic, testing to determine firedeck thickness. For Group III heads, sample inspection as described above is recommended. For all three groups of heads, FaAA recommended barring the engine over before manual startup, to assure no water has leaked into the cylinders.

Cylinder heads are also included in the TDI Owners' Group design review/ quality revalidation (DR/QR) program. The first such program report, pertaining to the Shoreham Nuclear Power Station, has just been released. In that report, the Owners' Group has concluded that the cylinder heads are acceptable for their intended design function at Shoreham, provided that engine barring-over is conducted.

Duke Power Company Status

Two small jacket water leaks have been experienced in heads at Catawba, one each in engines 1A and 1B. As a result, water leaked into the fuel injector nozzle cavity (i.e., external to the head and cylinder). Failure Analysis Associates performed a metallurgical analysis of the leak that occurred on the 1A engine. FaAA reported that the leak was due to cracks propagating from a corner where a repair plug was welded into the fuel injector nozzle seating area. This welded plug had been installed by TDI during manufacture to repair the injector bore.

As stated by Duke Power Company in their inspection report dated June 29, 1984, the inspections of the 1A engine cylinder heads included:

- liquid penetrant examination of valve seats in cylinder heads
- ultrasonic examination of firedeck thickness at selected locations.

Duke has stated that no other cracks were detected and that all firedeck thicknesses of cylinder heads on the 1A engine were found to be acceptable.

Duke Power Company performed an engineering evaluation to determine if any of the heads now installed on the 1A diesel engine had been repaired during manufacturing. A borescope was used to show whether there was a parting line at the bottom of the fuel injector cavity, indicating the presence of a plug. In addition, visual inspection of the firedeck area of the head was used to check for the presence of weld metal, indicating a plug was installed.

According to Duke, the results of this engineering evaluation indicate that the head installed on the no. 6 cylinder in the left bank was repaired with a welded plug. This head (6L) had been factory-installed on the engine and has seen over 800 hours' operation at varying loads, with at least one-half of that time being at loads in excess of 185 psig BMEP.

Duke has reported that, in its opinion, the cylinder heads currently installed in the 1A diesel engine are satisfactory because they were not leaking when last used, and because they exhibit no cracks in inspectable areas. Further, the leaks caused by cracks due to plug-welding are only to areas external to the head and cylinder, do not affect diesel operation, and are not significant. However, the repaired head (6L) is to be replaced as soon as Duke can obtain a replacement that does not contain similar weld plugs.

The same examinations are to be performed on the 1B engine cylinder heads.

PNL Conclusions

PNL has reviewed all the pertinent documentation noted above: the FaAA report, TDI Owners' Group DR/QR report on the Shoreham plant, and the Duke inspection report. In addition, PNL has reviewed the engine inspection results onsite with Duke Power Company. On these bases, PNL concludes that the cylinder heads on the Catawba 1A diesel engine are acceptable for the first refueling cycle, provided that the engine is barred-over 4 hours after shutdown, then again 24 hours after shutdown, and thereafter prior to each planned start, to check for water leakage into the cylinders.

PNL also concludes that Duke should replace the 6L head on the 1A engine, as well as any of the cylinder heads on the 1B engine that have repair plugs installed.

Based on the assumption that the results of tests and inspections on the 1B cylinder heads will be positive, that Duke has reported only satisfactory operation during the extended tests, and that the 1B engine will be barred-over as was the 1A engine, PNL concludes that the heads on the 1B engine will be acceptable for their intended purpose through at least the first refueling cycle.

Until the generic-issue analysis on heads has been finalized and a technical evaluation report has been released indicating satisfactory conclusion of the issue, PNL cannot grant unreserved approval of the heads, regardless of their manufacturing group classification (I, II, or III).

Component: Fuel Line Fittings

Part No.: 02-450B

Brief History of Component

A low-pressure fuel line between two fittings failed at the Grand Gulf Nuclear Station. Mississippi Power & Light, the owner utility, concluded that this isolated failure was due to fatigue caused by vibration due to insufficient clamping. One low-pressure fuel line was replaced on the Catawba 1A diesel engine because of leakage. Inspection of this line indicated its fittings were not swaged properly. Duke Power Company reported that the leakage resulted after a flat spot in the cone section of the tube eroded away. No similar failure has been noted on the 1B engine.

Owners' Group Status

The TDI Owners' Group has included fuel line fittings in the ongoing DR/QR program. The just-released DR/QR report on the Shoreham Nuclear Power Station concluded that, with stipulated modifications to meet design requirements, the equivalent fuel oil headers-piping and tubing will meet the stress and support design criteria and will perform their intended design function under all normal and earthquake loadings.

Duke Power Company Status

Most of the fuel lines and fittings were disconnected during the recent disassembly and inspection. They will be reinstalled during the reassembly of the 1A diesel engine. Duke Power Company has announced its intention to follow specific fitting installation instructions during the reassembly process to guard against improper swaging. In addition, after the 1A engine is reassembled, Duke personnel will inspect the subject lines and fittings. This will include a walkdown inspection to verify that the piping has been installed according to the applicable design drawings.

PNL Conclusions

The Duke Power Company fitting installation instructions and inspection procedure were discussed during PNL's visit to the Catawba Nuclear Station on July 26, 1984. PNL concurs with Duke's analysis of, and actions taken to correct, the problem. PNL also concurs that reinstallation of the fuel lines and fittings on the Catawba 1A diesel engine, if conducted according to the planned procedure, should be sufficient to assure that they will perform their intended functions. This problem and its resolution appear to be specific to the 1A engine only.

Component: Fuel Oil Injection Pump Valve Holder

Part No.: 02-365-A

Brief History of Component

Minor failures of fuel oil injection pump components have been recorded at the Grand Gulf Nuclear Station.

Owners' Group Status

This component is included in the TDI Owners' Group DR/QR Program. In the recent DR/QR report for the Shoreham Nuclear Power Station, it was concluded that the pump is acceptable for its intended design function at Shoreham. The report also stated that "A review of the operating history of the Bendix fuel injection pumps at Shoreham and other nuclear power plants indicates that any leaks that occurred were attributed to loose connections, fittings and bleed screws, etc., and not to the primary pressure boundary."

Duke Power Company Status

A fuel injection pump valve holder, which is exposed to full discharge pressure, fractured on the Catawba 1A engine. Duke Power Company submitted the part to Babcock & Wilcox Alliance Research Center for examination. Babcock & Wilcox concluded that the fracture initiated at a casting defect in the part, and that it was not the result of a design deficiency.

Transamerica Delaval, Inc., reported to NRC on July 13, 1984, that Bendix Corporation (the fuel injection pump manufacturer) had reviewed the component failure at Catawba and indicated the cause to be a material defect in the valve holder. Further, in Bendix's opinion, this defect was an isolated case. TDI stated that Bendix high-pressure fuel injection pumps have been installed on all DSR and DSRV engines manufactured by TDI in the past 15 years and that the Catawba holder failure is the first and only one of this type of which they are aware.

In addition to Babcock & Wilcox's detailed examination of the one failed valve holder, related inspections performed on the 1A engine to date by Duke Power Company include:

- measuring the hardness of each valve holder
- ultrasonic testing of each fuel pump valve holder.

Duke has reported that, based on the inspections conducted, all fuel pump valve holders on the 1A engine were found to be acceptable.

Duke also performed a failure analysis on the fractured fuel injection pump nozzle valve holder. The results of this analysis indicated that an axially-oriented linear indication in the high-pressure fuel oil passage of the valve holder led to the reported failure. Further analysis revealed that axial linear indications that would lead to cracking of the valve holder could cause cracking to occur within 10 million cycles of fuel pump operation. Because the remaining valve holders on the Catawba 1A diesel engine have withstood 10 million cycles of operation, the valve holder failure experience is considered the result of an isolated material defect.

In addition to this analysis, a borescope evaluation of the high-pressure fuel oil passage was made. Results of this evaluation indicate that several of the valve holder bores were rough-machined, as evidenced by observed protrusions, counterbore type steps, and tool marks. One valve holder, cylinder 6R, appeared to have a linear indication. Three valve holders (5R, 1L, and 8L) had recesses. Duke has stated that these four valve holders will be removed from the engine, cleaned, rechecked by borescope, and reamed if indications are still present after cleaning. Valve holders that have indications after reaming will be replaced.

PNL Conclusions

A failure of this specific pump component will tend to reduce engine capacity by 7% and imbalance the load on the crankshaft, but will not lead to immediate shutdown. Based on the results of examinations and analyses performed by Duke Power Company, as well as an examination by PNL during the Catawba site visit on July 25 and 26, 1984, PNL concurs with Duke's analyses of, and actions taken to correct, the problem. PNL concludes that the fuel injection pumps as now installed on Catawba's 1A engine will perform their intended design functions. This problem and its resolution appear to be a one-time occurrence, limited to the 1A engine only.

Component: Turbocharger Bearings

Part No.: MP-022/23, 02-CFR

Owners' Group Report: FaAA-84-5-7

Brief History of Component

Turbocharger thrust bearing problems reportedly are limited to the nuclear industry. To date, thrust bearing problems have been reported for the Grand Gulf Nuclear Station, Shoreham Nuclear Power Station, San Onofre Nuclear Generating Station, Comanche Peak Steam Electric Station, and Catawba Nuclear Station.

Owners' Group Status

The TDI Owners' Group has included turbochargers in general in the generic problem category.

Failure Analysis Associates analyzed the turbocharger thrust bearing problems for the Elliott 90G turbocharger. In Report FaAA-84-5-7 dated May 1984, FaAA concluded that the problems are due to insufficient lubrication of the thrust bearings during "fast" starts (i.e., automatic starts for which no prelubrication is provided to the thrust bearing). Various types of startup lubrication systems have been implemented at nuclear power plants to avoid these problems. One type is a drip system that provides lubrication from the before-and-after (B&A) recirculation system. Another type (in use at the Grand Gulf Nuclear Station) is an auxiliary B&A lube oil pump. This pump is acti-vated prior to any planned start and provides the turbocharger bearings with sufficient lube oil to complete fast starts as required for nuclear standby tests.

Duke Power Company Status

On February 17, 1984, Duke Power Company reported finding excessive wear on a bearing in one turbocharger of engine 1A. As Duke reported later, on March 29, 1984, the thrust faces of bearings were found to be severely worn in turbochargers in both 1A and 1B engines.

Duke personnel performed visual and dimensional inspections of the 1A engine turbocharger bearings. The thrust faces were found to be severely worn.

However, Duke noted that this wear had not affected turbocharger operation during the extended (>800 hours) operational tests on the 1A engine. Similar inspections of turbocharger bearings on the 1B engine are in progress.

The turbocharger bearings on the 1A engine were replaced. In Duke's opinion, these will operate as well as the original bearings, which caused no operational problems for several hundred hours. In addition, in a June 29, 1984, letter to NRC, Duke has stated its intention to install the new increased flow lube oil system by September 1984. Until that time, Duke plans to inspect the new bearings periodically to assure their continuing operability.

PNL Conclusions

PNL and its consultants have not had an opportunity to review the specific prelube system design planned by Duke for the Catawba engines. However, PNL has reviewed the FaAA report referenced above, the results of the June 22, 1984, meeting among representatives of FaAA, the Owners' Group, NRC, and PNL, and the inspection data presented by Duke Power Company. During the Catawba site visit on July 25 and 26, 1984, PNL examined the 1B engine turbocharger bearings, which, like those from engine 1A, were scarred and substantially worn. PNL also has examined the prelube system at other, similar plants. On these bases, PNL concludes that a similar new prelube system planned for installation on the diesels at Catawba probably will provide sufficient additional lubrication to augment the protection of the turbocharger bearings during planned fast starts. Further, in PNL's view, the number of unplanned fast starts, without prelube, likely will be sufficiently few as to not lead to bearing failure prior to the first refueling outage, at which time the bearings on at least one turbocharger per engine should be reinspected (unless, by that time, the revised turbocharger prelube system has been installed and accepted by the Owners' Group and NRC).

Component: Turbocharger Adapters
Part No.: 00-495A

Duke Power Company Status

At Catawba, one turbocharger adapter on the 1A diesel cracked at a flange weld. This adapter provides the interface between the turbocharger air discharge and the intercooler airbox. Duke Power Company has attributed the crack to poor flange alignment with mismatched bolt holes. Duke reports it now uses updated alignment practices when installing the adapters and torquing turbocharger flange bolts. Duke has reported that the weld joints on the 1A diesel engine turbocharger adapters were examined visually and with magnetic particle detection techniques. These examinations revealed no defects.

During PNL's Catawba site visit in July 1984, Duke personnel reported having obtained TDI's concurrence to overbore the mounting holes and use an alternative gasketing arrangement. It is PNL's understanding that this was done on the right bank of the 1B diesel engine, which was found to be cracked in a manner comparable to that of the 1A right bank. No problems have been noted on the left bank of either engine, which is of a configuration different from that of the right bank.

According to Duke personnel, they and TDI are considering improved configurations for the right bank interface that will assure the elimination of this problem. These may require making a number of changes on the engines.

PNL Conclusions

PNL concludes that Duke has adequately identified the problem and its cause. However, in reviewing the Duke Power Company information available on the turbocharger adapter flange and the noting of the subsequent crack on the 1B diesel engine, PNL has found no evidence to support a conclusion that an adequate corrective method has been implemented. In the opinion of PNL's consultants, the Catawba diesels could be relied on for satisfactory operation for a period of time, possibly up to several days, even with cracks in the welds at this adapter, although some power reduction and imbalance between left and right cylinder banks could result. Thus, these adapters and the entire turbocharger/intercooler interface are considered to be marginally suitable for their intended use in the Catawba 1A and 1B engines even until the first reactor refueling outage. Therefore, PNL recommends that Duke/TDI continue with the development of an alternative design for the right bank connections between the turbocharger and the intercooler and, further, that adapters of a new design be installed.

It is believed by PNL and its consultants that the alternative connection design being considered or developed by Duke/TDI should be one incorporating a flexible joint. Such a design is deemed to be one that could eliminate the problem and have an adequate operating life.

Component: Turbocharger Lube Oil Drain Line
Part No.: 02-467A

Brief History of Component

Duke Power Company reported that a temporary drain line on the 1A diesel engine leaked during the recent extended operational test. The leak was attributed to vibration in the drain line. This drain line was of rubber hose, installed in place of the original compression-coupling fitting furnished by TDI, which, for some unexplained reason, would not fit properly at installation. The installation on the 1B engine reportedly was as per the TDI design.

Owners' Group Status

The TDI Owners' Group Program Plan indicates that the turbocharger lube oil drain line is included in the ongoing DR/QR program. In the DR/QR report on the Shoreham Nuclear Power Station on the equivalent component, it was concluded that, when installed and supported in accordance with TDI design, the small-bore piping and tubing included in the review meets the stress design criteria and will perform its intended design function at Shoreham under all normal and earthquake loadings.

Duke Power Company Status

The leaking 1A engine drain line was replaced with the proper line and fittings during reassembly of the 1A diesel engine. During the July 25 and 26 Catawba site visit, Duke personnel stated that the line now installed on the 1A engine meets the TDI design requirements.

PNL Conclusions

PNL concludes that Duke has appropriately identified the problem and its cause. PNL representatiaves examined the lube oil drain line during the Catawba site visit on July 25 and 26, 1984. They noted that the subject line on the 1A diesel engine now contains only welded or clamped joints. Based on these observations, PNL concludes that the new drain lines as now installed on the Catawba diesels will satisfactorily perform the intended design function. This problem and its resolution appear to be specific to the 1A engine only.

Component: Turbocharger Prelube Oil Lines

Part No.: 02-307B

Brief History of Component:

Two failures of prelube oil lines were reported by Duke Power Company. Both failures occurred on the 1A engine during the extended operational test.

Owners' Group Status

The turbocharger prelube oil lines are included as part of the Owners' Group DR/QR Program. In the DR/QR report on the Shoreham Nuclear Power Station, the conclusion on the equivalent components was as follows:

> The tubing components, as defined by this component design review have been evaluated to the referenced stress design criteria and found acceptable. It is concluded that the system will perform its intended design function at Shoreham under all normal and earthquake loadings.

Duke Power Company Status

Duke personnel performed visual, chemical, and metallographic tests on the failed components. Based on the test results, they reported the probable failure mechanism of the tubes was high-cycle fatigue that originated at stress concentrations produced in the area of the compression fittings.

Duke subsequently replaced the failed lines with heavier wall stainless steel tubings and improved compression fittings. These were installed using an improved procedure, additional clamps, and vibrational dampening devices. No failures have since occurred.

Duke has stated its plans to reassemble and install the piping on the 1A diesel engine in accordance with the latest approval drawings and procedures. In addition, the system will be inspected after reassembly to verify proper installation.

PNL Conclusions

PNL concludes that Duke has adequately identified the problem and its cause, and has responded appropriately. During PNL's onsite visit in July 1984, it was noted that the turbocharger prelube oil lines will be replaced with ones of a different design when the new turbocharger lubrication system is installed on the Catawba engines. In PNL's opinion, lines and fittings installed in a manner similar to those installed after the original failures will adequately fulfill their intended purposes. No comment, evaluations, or conclusions on the redesigned system can be made at this time.

PNL assumes that Duke will follow the improved procedures and use the same additional and improved material on the subject lines of the 1B engine as they did on the 1A engine. If so, PNL concludes that the subject items on the 1B engine would also fulfill their intended purposes.

Component: Turbocharger Exhaust Gas Inlet Bolts

Part No.: 02-380B

Brief History of Component

Duke Power Company has reported the failure of four 1/2-inch diameter turbocharger exhaust gas inlet bolts on the 1A engine.

Owners' Group Status

These components are also included in the TDI Diesel Generator Owners' Group DR/QR Program. The Shoreham Nuclear Power Station DR/QR report concludes that, based on new bolting materials and revised installation procedures, the exhaust manifold components are acceptable for the intended service and design function at Shoreham.

Duke Power Company Status

The failed bolts were examined by Duke Power Company's Physical Sciences Laboratory. They concluded that the bolt failures were caused by

- bonding of the bolt threads to the adapter flange during service at high temperature, necessitating the application of excessive force to remove the bolts
- creep rupture due to a combination of a) use of lubricant plus applied torques leading to high axial stresses (easily over 25,000 psi and possibly as high as 75,000 psi); b) high temperature; and c) use of an alloy not resistant to creep.

The original 36 bolts, which had been exposed to over 800 hours of operation, and the four replacement bolts were inspected visually at 5X magnification. Duke reported that no defects or indications were found on any of these bolts.

Duke has announced their intention to replace all of the subject bolts on the 1A diesel with others of the same material, using installation procedures to assure the application of proper preloads. In addition, new bolts made of a creep-resistant material are being considered as replacements for those currently installed.

PNL Conclusions

During the PNL onsite visit on July 25 and 26, 1984, Duke personnel reiterated their application and use of torque criteria on essentially all fasteners of the Catawba diesel engines. PNL concludes that Duke has adequately identified the problem and its cause and has proceeded with an acceptable resolution. In PNL's opinion, the turbocharger exhaust gas inlet bolts will satisfactorily perform their intended function over their expected service life, provided that procedures which Duke has agreed to use are employed to prevent both under- and overtorquing.

It is PNL's understanding that Duke plans to replace the subject bolts on the 1B engine. If so, and if this is done following the procedures used on the 1A engine, PNL concludes that the subject components will adequately perform their intended function.

Component: Crankcase and Camshaft Cover Capscrews

Part No.: 02-386B

Brief History of Component

Duke Power Company reported occasional failure of crankcase and camshaft cover capscrews at Catawba during the extended operational tests and as found during inspections of the 1A diesel engine. These failures were random and usually occurred as the bolts were being tightened to seal minor oil leaks or as the bolts were being removed. In a few instances, the bolt heads separated while the diesel was operating.

Duke Power Company Status

Based on their examinations of the failed components, Duke has concluded that the capscrews failed due to fatigue caused by over- or undertorquing during installation on the 1A engine. Duke has also reported confidence that the problem has been resolved by replacing the failed components with capscrews of more appropriate quality and by revising installation procedures to control torque.

PNL Conclusions

PNL reviewed the capscrew problem with Duke during the Catawba site visit in July 1984. PNL concludes that Duke has adequately identified the problem and its cause, and that the use of higher strength and higher fatigue endurance limit items (e.g., Grade 5) installed within torque values established by TDI/Duke for that installation and that size item should eliminate any future failures. Thus, the capscrews as now installed on the 1A diesel at Catawba should satisfy the intended design requirements.

Provided that Duke replaces the subject components on the 1B engine with higher strength items under controlled torquing procedures, these capscrews too should satisfy the intended design requirements.

Component: Triple-Clamp Bolts
Part No.: 02-450D

Brief History of Component

The triple clamps support various types of piping lines along the top side of the engine. During the extended operational tests and the subsequent disassembly of the 1A diesel engine at Catawba, Duke Power Company found that several of the triple-clamp bolts had failed in service. These failures occurred in the threaded portion of the bolt inline where the first threads engaged the subcover assembly.

Duke Power Company Status

Duke subjected the failed bolts to a failure analysis. The results indicated that the bolts failed because of fatigue and being under- or overtorqued. Duke indicated that all triple-clamp bolts were replaced with new bolts having higher strength and higher fatigue endurance limits (e.g., Grade 8). In addition, reinstallation procedures now include provisions to assure that under- and overtorquing do not occur.

PNL Conclusions

During the Catawba site visit on July 25 and 26, 1984, PNL personnel and consultants discussed Duke's review of the triple-clamp bolts, their replacements, and torque limitations. PNL concludes that Duke has adequately identified the problem and its cause and that the actions implemented should eliminate the recurrence of similar failures of the subject components. Thus, the bolts as eventually installed in the diesels at Catawba should satisfy the intended design requirements.

Component: Lube Oil and Jacket Water Thermocouples

Part No.: 02-630D

Brief History of Component

Inconsistent or improper indications of operating conditions have been experienced with some thermocouples (T/Cs) at Catawba. According to Duke personnel, when these T/Cs were replaced, the indications of the operating conditions returned to the normal or expected operating range. Duke personnel have stated that these inconsistencies (or failures to indicate properly) were believed to be the result of intermittent shorts.

Owners' Group Status

The Owners' Group DR/QR Program report for the Shoreham Nuclear Power Station concluded that the pyrometer conduit assembly thermocouples are acceptable for their intended design function at Shoreham, provided 1) each T/C indicated temperature is consistent with the engine ambient temperature when the engine is cold and 2) the T/C is removed, cleaned, and inspected for fatigue indications every 36 months.

Duke Power Company Status

Duke Power Company stated that occasional T/C failures can be expected and do occur. Duke further stated that failure of the lube oil and water thermocouples would not affect diesel engine operability under emergency-run conditions. Duke has reported that the failed T/Cs were repaired or replaced and that inspection of the failed T/Cs was not considered useful.

PNL Conclusions

PNL discussed the failed T/C problem and operating history with Duke personnel during the Catawba site visit in July 1984. PNL concurs with Duke's analysis, i.e., T/C failures are an expectable occurrence, particularly during the early stages of equipment or system startup and operation. In PNL's opinion, occasional operating inconsistencies or failures of the subject T/Cs can be expected to occur during the life of the diesel engine. However, if such a failure does occur, it will not likely compromise the continued safe and reliable operation of the diesel engine. Therefore, PNL believes the corrective actions taken by Duke to be logical and supportable, and should be continued as required by subsequent failures in the subject components.

Component: Rocker Box (Subcover) Assemblies

Part No.: 02-362A

Brief History of Component

Two different problems have been experienced with the rocker box (subcover) assembly on the 1A diesel engine at Catawba. The first reported by Duke involves the fracturing off of a piece of a boss located on the inside of the unit (also identified as rocker arm pedestal). The second problem, found in the post-operational test inspections of the 1A diesel, consists of hairline fractures running down the boss in the web between the machined bolt hole and the boss surface.

Owners' Group Status

The subject component is included in the DR/QR program. The DR/QR review for the Shoreham Nuclear Power Station concluded that the subcover is acceptable for its intended design function at Shoreham.

Duke Power Company Status

Duke Power Company reported finding one subcover with a piece of a boss fractured off when the push rods were replaced. However, Duke noted that this situation had not adversely affected the engine's operation.

After the extended operational tests, Duke performed liquid penetrant examinations on all of the bosses in all of the 1A engine subcover assemblies. They found two subcovers with cracked bosses. All others were found to be free of defects.

Although none of these failure had caused a loss of operability of the engine, Duke has replaced all of the affected covers.

Duke reported that the fractured boss was apparently due to installation with a misaligned dowel pin. A failure analysis of the cracked bosses in the other subcovers is being conducted by FaAA.

Duke has reported that, until the cause of failure and the frequency of cracking are better established, they will periodically inspect the subcover assemblies at Catawba to verify that additional cracking has not occurred.

PNL Conclusions

Subcover assemblies and their failures were observed during PNL's Catawba site visits in April and July 1984. PNL concurs with Duke's identification of the problem and its cause, and concludes that Duke's actions, namely replacing the subject components containing failures and providing for future inspection, are adequate to address this problem. However, Duke should provide confirmatory information on the scheduling and extent of future inspections. This should be incorporated into the periodic maintenance, inspections, and surveillance of these items on the Catawba 1A and 1B diesel engines.

Component: Intermediate Rocker Arm Sockets

Part No.: 02-390A

Brief History of Component

Duke Power Company reported that two of the intermediate rocker arm sockets were found to be chipped and/or to have cracks on their peripheral lips. However, these chips and cracks did not adversely affect functioning of the socket or interfere with engine operation because the push rods normally seat into the socket well inside the area where the chips or cracks were found.

Owners' Group Status

The intermediate rocker arm socket is included in the Owners' Group DR/QR Program. The report for Shoreham concluded that similar assemblies were acceptable for their intended design function at Shoreham.

Duke Power Company Status

Duke examined the failed components and reported finding no evidence of the chips or cracks propagating into the functioning part of the socket. Duke believes the problem is due to improper installation of the rocker arms prior to valve adjustment such that excessive clearance existed, allowing the push rod to move and contact the lips of the socket.

All other sockets in the 1A diesel engine at Catawba were visually inspected by Duke Power Company. No other problems were found or noted during these inspections.

Duke considers the chipped and cracked sockets to be only a cosmetic problem. In their opinion, there has been no detrimental effect on diesel engine operability. Duke has instigated procedural changes to assure that excessive clearance does not exist in the rocker arm assembly; this action is expected to prevent recurrence of the problem.

PNL Conclusions

The intermediate rocker arm sockets were visually examined by PNL personnel and consultants during their visits to Catawba in April and July 1984. PNL reviewed the problem with Duke personnel during the July 1984 visit. PNL concurs with Duke's analysis of the cause of the failures experienced to date in the subject components. PNL also concludes that, if Duke follows their newly instigated procedures, the intermediate rocker arm sockets can be expected to meet their intended operational requirements.

Component: Exhaust Valve Tappet (Rocker Arm Adjusting Screw Swivel Pad)
Part No.: 02-390B

Brief History of Component

Duke Power Company has reported that one of the swivel pads on the 1B diesel at Catawba was found to be cracked.

Owners' Group Status

This component is included in the Owners' Group DR/QR program. In the DR/QR report for Shoreham Nuclear Power Station on a similar assembly, it was concluded that the entire intake/intermediate and exhaust rocker shaft assemblies are acceptable for their intended design function at Shoreham.

Duke Power Company Status

Duke conducted a failure analysis of the one failed swivel pad and reported that it was swaged or rolled more excessively than were the other screw swivel pads. They concluded that this apparent one-time manufacturing defect caused an overload on the pad, resulting in its failure.

Using visual and liquid penetrant examination techniques, Duke has inspected all 64 swivel pads on the 1A engine at Catawba. They have reported finding no defects; all of the inspected sockets appear to be consistently and properly swaged.

PNL Conclusions

The subject components were examined by PNL personnel and consultants during the Catawba site visits in April and July 1984. PNL concurs that the results of Duke's analysis appear to be logical and supportable. PNL concurs with Duke that the swivel pads now installed in the 1A engine at Catawba are satisfactory and should be capable of meeting their functional requirements for the life of the diesel engine as dependent on the manufacturer's recommended maintenance and/or replacement programs. It is also assumed that the pads on the 1B engine are also capable of meeting their functional requirements.

Component: Intake and Exhaust Valves

Part No.: 02-360B

Brief History of Component

During the disassembly and inspection of the 1A engine at Catawba after the extended operational tests, Duke found nine exhaust valve stems with areas of flaked or peeling chrome plate. The separation of chrome occurred from about 6 to 8 inches above the seat of the valve and at a location corresponding to where the stem enters the valve guide. Duke has reported that separation of the chrome had no effect on the diesel engine operability and did not cause any observable damage in the valve guides. The valves themselves have undergone over 800 hours of engine operation, with at least half of that at engine loads over 185 psig BMEP.

Owners' Group Status

Intake and exhaust valves are included in the DR/QR Program. The Shoreham DR/QR report on intake and exhaust valves concluded that flaking and loss of chrome plating from the valve stem is an isolated event that has a minor effect on engine performance. It was reported that fuel used at Shoreham does not contain significant quantities of sulfur, and corrosion of the alloy steel stem will be minor if chrome is lost. There may be some increase in oil leakage past the stem seal, but this will not affect engine operation. Thus, an isolated occurrence of chrome loss will not significantly affect engine reliability. The report concludes that the valves are acceptable for their intended design function at Shoreham.

Duke Power Company Status

Duke Power Company observed no structural damage in the valve stems where chrome plate flaking or peeling occurred. During the Catawba site visit in July, Duke reported that the affected valves were replaced during the reassembly of the 1A engine.

PNL Conclusions

The chrome peeling on the valve stem was noted during the April and July 1984 visits to the Catawba plant by PNL personnel and consultants. PNL agrees with Duke that the chrome peeling found on the valve stems is of only minor importance. However, because this peeling could possibly allow corrosion and an accumulation of corrosion products that could eventually affect the operation of the valve and/or the valve guide, valve replacement is considered necessary. This has been completed on the 1A engine; PNL concludes it should be done also on the 1B engine.

Component: Spring Retaining Nut and Roll Pin on Air Start Valves

Part No: 02-359

Brief History of Component

During the extended operational testing of the 1A diesel engine at Catawba, Duke Power Company found the spring retaining nut on one air start valve was jammed due to galled threads. In addition, a spring retaining nut roll pin was missing from another valve. Duke reported that neither the galled threads nor the missing roll pin had any adverse effects on the diesel's operability.

Owners' Group Status

The subject air start valve is an assembly included in the DR/QR program. The DR/QR report for the Shoreham Nuclear Power Station documents the design and quality revalidation reviews conducted on the assembly and its equivalent components. The final conclusion of this report is that the air start valve, as an assembly including these components, is acceptable for its intended design function.

Duke Power Company Status

All of the air start valves on the Catawba 1A engine were disassembled and visually inspected by Duke personnel. The one jammed nut and the one missing roll pin were the only deficiencies found on the 16 subject valves of engine 1A.

Duke has expressed the opinion that the jammed nut and missing roll pin were the result of installation errors. These items have been replaced. Duke has also implemented installation procedures to assure that similar omissions or problems will not recur.

PNL Conclusions

The subject deficiencies were reviewed with Duke by PNL personnel and consultants during the Catawba site visit in July 1984. PNL concurs with

Duke's assessment of the problem, its cause, and its correction, and concludes that similar errors are not likely to occur in any subsequent engine reassembly, provided that appropriate procedures are followed.

3.2 GENERIC PROBLEMS

Component: Crankshaft

Part No: 02-310A

Owners' Group Report: FaAA-84-4-16 (dated May 22, 1984)

Brief History of Component

Three V-16 crankshaft failures have been reported, all in the non-nuclear industry. Two failures were attributed to torsional stress due to operation too close to the critical speed. No cause has been suggested for the third failure. There also have been failures of shafts of other TDI R-4 engine models. However, because of the individual nature of shaft stresses, such are not necessarily germane to V-16 engines in general nor to the Catawba engines specifically.

Owners' Group Status

Failure Analysis Associates has performed torsional and bending stress analyses of the subject crankshaft and has concluded that the shaft will meet the Diesel Engine Manufacturers Association (DEMA) standards at the engines' nameplate rated load and speed. The radius of the fillets in main journal oil holes was identified as an area of potential stress concentration, and careful inspection of this area was prescribed. PNL's review of the FaAA report on these shafts has not yet been concluded. Various considerations remain pending, in the view of PNL's diesel consultants, and must be adequately addressed and favorably resolved before PNL could be confident that the shafts can be shown analytically to be able to function properly over their expected functional life at their design ratings, and also accept such excursions in load, load balance, and speed as sometimes occur with engines.

Duke Power Company Status

Both Catawba engines have undergone extensive operation, with over 750 hours on each; more than half of the loads were above 185 psig BMEP. These crankshafts in the Catawba diesels have 13-inch diameter crankpins and 13-inch diameter main bearing journals, as opposed to the failed R-48 shafts at Shoreham with 13-inch main journals and 11-inch crankpins.

The completed in situ inspection of the 1A diesel crankshaft included:

- web deflection measurements
- torsiograph tests (with the AN piston skirts)
- visual inspection of all crankpin journals and the fillets at either end
- eddy-current testing of all crankpin-to-web fillets except for those of crankpin #2
- visual inspection of main bearing journals and journal-to-web fillets for 50% of the main bearings (#4, #5, #6, and #8)
- fluorescent dye penetrant testing of the lube oil holes in main journals #4, #6, and #8.

No visually discernible indications were found on the crankpin fillets. Minor indications were detected on the crankpin-to-web fillets on crankpin #7 and on the #8 main journal oil hole. The indications found as a result of the eddy-current testing and the fluorescent dye penetrant test were polished out in less than 0.020 inch.

The 1B diesel crankshaft inspection will include web deflection measurements and visual inspections of the crankpin journals and fillets.

Duke has concluded that the 1A crankshaft evidences no meaningful, deleterious problems, present or potential, and that it is serviceable for its designed function.

PNL Evaluation and Conclusions

PNL consultants have reviewed report FaAA-84-5-23 entitled Torsiograph Test of Emergency Diesel Generator 1A at Catawba Nuclear Power Station. They concluded that this test, conducted on the 1A engine while it contained AN piston skirts, is representative of what would be expected of similar tests of the same engine with AE piston skirts installed. Therefore, PNL does not see the need to conduct additional torsiograph tests on the 1A engine at this time. As discussed in this TER, Duke has completed extended operational tests on the 1B diesel engine at Catawba that consisted of sufficient operating time to indicate the crankshaft is capable of the intended service. Further, in the July 6, 1984, letter to NRC, Duke has identified the tests and inspections they plan to perform on the crankshaft of the 1B engine. In PNL's viewpoint, this proposed test and inspection program are adequate to verify the physical condition of the 1B crankshaft. Assuming that the results of Duke's test and inspection program are satisfactory, then PNL would not have any reservations about the crankshaft of the 1B engine being capable of performing its intended functions, at least until the next reactor refueling outage.

Because the relevant Owners' Group analyses of RV-16 crankshafts are not yet finalized to acceptable conclusions, in PNL's view, PNL cannot conclude in an unqualified manner that the Catawba shafts are unreservedly reliable. However, PNL does conclude that sufficient operating time has been accumulated on the 1A engine, and that adequate inspection tests have been performed on the crankshaft in the 1A engine, to verify its adequacy to perform its intended functions at least until the next reactor refueling outage, provided the engine operating BMEP is kept below 185 psig. It is PNL's understanding that Duke's emergency load profile meets this condition. By the next reactor fueling outage, it should be possible to draw definitive conclusions on these shafts.

Component: Connecting Rod Bearing Shells

Part No: 03-340-B1

Owners' Group Report: FaAA-84-31

Brief History of Component

No total failures of the TDI DSRV type diesel engine connecting rod (conrod) bearing shells have been reported in nuclear applications. However, some have been replaced because of deterioration due to inservice conditions or because they were found to be in nonconformance with Owners' Group recommendations regarding voids in the base material.

Owners' Group Status

Failure Analysis Associates has conducted both stress and orbital analyses on the conrod bearing shells. They concluded that the bearings are suitable for the intended service, provided 1) they conform to the manufacturer's specification and 2) they meet a criterion for subsurface voids developed by FaAA for the Owners' Group.

Duke Power Company Status

The engines at Catawba, with original bearing shells in place, have each operated for over 750 hours, more than one-half that time at loads above 185 psig BMEP. That is approximately the maximum emergency load (LOOP and LOCA) for which these engines were selected.

All (100%) of the conrod bearing shells for the 1A diesel engines at Catawba were examined using the following techniques:

- thickness measurement
- visual inspection of bearing and back surfaces
- liquid penetrant examination
- radiograph examination.

These inspections are now underway on the 1B conrod bearing shells.

The thicknesses of the bearing shells from the 1A engine were found to be within specification. Visual and liquid penetrant examinations showed deterioration of the babbit layer in the areas where maximum pressure is exerted on the bearing. Duke has concluded that this deterioration is the result of normal wear; it had not progressed to the point at which engine operation would be affected. Therefore, Duke determined that the bearing shells are acceptable for reuse.

Radiography detected five conrod bearing shell halves that contained voids larger than specified by the Owners' Group criterion. During the July 1984 site visit, Duke personnel indicated that the upper and lower bearing shell halves of no. 5, 6, and 7 conrods were replaced in the 1A engine at Catawba.

PNL Evaluation and Conclusions

The subject bearing shells from the 1A engine were not available for PNL inspection during the Catawba visit in April 1984. However, photographs of the bearing surface of each were reviewed. During PNL's visit to Catawba in July 1984, the bearing shells from the 1B engine were viewed by PNL staff and consultants. The deterioration noted in both sets of bearing shells has been reviewed and discussed. PNL's consultants conclude that this deterioration could be the result of insufficient oil pressure, and PNL recommends that Duke investigate this possibility. PNL concurs with Duke that the subject components retain sufficient service life for reinstallation and use. However, subsequent inspections should be made on the bearing shells within the next 500 hours operation to verify their continued integrity. This is approximately the operating time expected over the next 10 years and agrees roughly with Duke's inspection plan. Duke's planned regular monitoring of the lube oil for contaminants, such as bearing babbit metal, will help assure reliability of these components.

Component: Cylinder Blocks

Part No: 02-315A

Owners' Group Report: FaAA-84-5-4

Brief History of Component

Numerous incidents of cylinder block cracking have been reported in the non-nuclear field. In the nuclear field, all three engines at Shoreham have cracks in their cylinder blocks. At Comanche Peak, cracks were observed after 90 hours of operation. None has resulted in catastrophic engine failure or emergency shutdown. A number of engines have continued to operate many hours with known cracks.

Affected areas are primarily the cylinder liner landing area, between the cylinder opening and adjacent head stud holes, and between adjacent cylinder head stud holes.

Owners' Group Status

Failure Analysis Associates performed strain gauge testing combined with two-dimensional analytical modeling of the block top and liner. In their report only recently published, FaAA concluded:

- Eventually, depending upon sufficiently high load and operating hours, cracks will initiate between stud hole and liner counterbore. Cracks are predicted to be benign (e.g., non-propagative) if the block materials are free of deleterious materials and properly cast, and if engine loads remain below 225 psig BMEP. [That some (such as those at Catawba) have operated many hours at loads at and exceeding these levels without even initial crack indications is, in FaAA's opinion, indicative of the conservative nature of their evaluation.]
- Cracks between stud hole and liner counterbore will increase the likelihood of cracks developing between stud holes of adjacent cylinders. The deepest crack measured in this region (5-1/2 inches in depth at Shoreham) did not degrade engine operation or loosen studs.

- Provided there are no cracks between stud holes between adjacent cylinders, the block is predicted to have sufficient margin to withstand a LOOP/LOCA event.

The FaAA report recommends visual and eddy-current inspections of cylinder blocks at intervals related to load and operating hours.

Duke Power Company Status

Both Catawba engines have operated over 750 hours each, over half of that time at loads exceeding 185 psig BMEP.

The block inspection for the 1A diesel, which revealed no cracks, included:

- liquid penetrant examination of all cylinders around the studs, and between the cylinder studs and liner
- dimensional and liquid penetrant examination of the cylinder liner landing area of seven cylinders
- eddy-current testing of stud holes of these seven cylinders.

The proposed inspection plan for the 1B engine will include only 25% of the block (four cylinder areas), covering only dimensional and liquid penetrant examination.

PNL Evaluation and Conclusions

After reviewing the FaAA report and noting that Duke's inspections of the 1A engine blocks revealed no indication of cracks, PNL concurs that the blocks are acceptable for their intended purpose, at least until the next reactor refueling outage. PNL's conclusions regarding the scope and frequency of inspections are expressed in Section 7.0.

If the results of Duke's inspections on the cylinder blocks of the 1B engine are satisfactory, PNL would have no reservation about the continued use of these components and their ability to fulfill their intended purpose.

Component: Cylinder Liners

Part No: 02-315C

Owners' Group Report: FaAA 84-5-4

Brief History of Component

Only one incident of cylinder liner "failure" in nuclear service is available. This failure occurred in 1982 at Grand Gulf when a piston crown separated from the skirt during testing of the Division II engine and marred the liner.

Owners' Group Status

The Owners' Group analysis has identified some cylinder liner dimensions as not being compatible with those of interfacing components. This incompatibility could be a contributing factor in liner stresses.

Duke Power Company Status

The original liners on both the 1A and 1B engines at Catawba have served for over 750 hours of operation, with over one-half that period at loads exceeding 185 psig BMEP.

Cylinder liner inspection on the 1A diesel included those listed below. The 1B diesel inspection percentages are shown in parentheses.

- visual inspection of 100% of the cylinder liners (100%)
- bore measurements of 100% of the cylinder liners (100%)
- material comparitor and hardness tests on 20% of the liners (0%)
- dimensional check of cylinder protrusion above the block on 100% of the liners (100%)
- dimensional check of the cylinder liner landing area for 40% of the cylinders (25%).

All cylinders showed minor scuffing. Duke has concluded that the scuffs are a result of normal wear and are acceptable. Twenty-three percent of the bore measurements and 33% of the cylinder protrusion measurements did not meet TDI specifications. Duke has concluded that the out-of-specification measurements are acceptable for used cylinders. Although the material comparitor tests showed differences from the Owners' Group standard, Duke considers the liners to be satisfactory based on their performance record. The hardness test results were found by Duke to be acceptable.

PNL Observations and Conclusions

PNL concurs with Duke that the inspections made and the results are acceptable. The Duke conclusions regarding scuffing, bore measurement, and materials composition are judged to be reasonable and supportable. In view of these considerations, the already acceptable service for over 750 hours in the 1A engine, and the general history of reliability of TDI liners, PNL concludes that the liners in the 1A engine are suitable for their intended purpose. If the results of the inspections on the 1B engine cylinder liners are acceptable, PNL concludes that these liners also will suit their intended purpose.

Component: Cylinder Head Studs

Part No: 03-315-01-0A (Old Design)

Owners' Group Report: Stone & Webster, March 1984

Brief History of Component

To date, no failure of cylinder head studs has been reported in the nuclear industry. However, some isolated failures have been reported in the non-nuclear field. The cause has not been reported.

Owners' Group Status

Stone & Webster Engineering Corporation has analyzed both the old design studs and new necked-down studs developed by TDI to minimize potential cylinder block cracking, and has concluded that both stud designs are adequate for the service intended, provided proper stud preload is applied.

Duke Power Company Status

The original studs in both Catawba engines have experienced over 750 hours of operation, over half of which has been at loads exceeding 185 psig BMEP.

Duke has not replaced any of the cylinder head studs with the new necked-down design. In the 1A diesel inspection, head studs of four cylinders were measured for as-found torque and then visually inspected. Also, material comparitor and hardness tests were performed on a single stud from each of four cylinders.

The as-found torque was above 1100 ft-lb (1500 ft-lb specified) for all measured studs. Duke believes this to be acceptable. No significant indications or material problems were detected. The 1B diesel inspection will include a visual inspection of 25% of the cylinder head studs as in the 1A diesel inspection.

PNL Observations and Conclusions

From the analysis and inspections performed on the subject studs, PNL concludes that the old design as being used at Catawba remains adequate for its intended purpose, assuming all stud preloads are as specified.

Component: Engine Base and Bearing Caps

Part No: 02-305C

Owners' Group Report: FaAA-84-6-53

Brief History of Component

The only failure reported by the Owners' Group for DSRV-16 engines occurred in a non-nuclear application: a nut pocket failed on a DSRV-16 engine at the ANAMAX mine near Tucson, Arizona. According to FaAA, TDI determined that this failure was due to impurities in the casting material that reduced the engine base strength.

Owners' Group Status

Failure Analysis Associates, as discussed in the Owners' Group report, has analyzed the base, bearing saddles, bearing caps, nut pockets, and bolting/nuts. FaAA has concluded that the base assembly components have the strength necessary to operate at full rated load for indefinite periods, provided that all components meet manufacturer's specifications, that they have not been damaged, and that proper preloads are maintained.

Duke Power Company Status

On engine 1A, 50% of the main bearing saddle area (around four bearings) was checked by liquid penetrant and visually examined around and between the stud holes. In addition, stud tension for removal of the nuts was measured. No abnormalities were detected. This component will not be inspected as part of the 1B diesel inspection, per Duke's current inspection plans.

PNL Evaluations and Conclusions

The one reported failure of these components appears to be traceable to a manufacturing defect in a particular casting. There has been no indication of a similar failure occurring in the 1A engine that has been operated for over 800 hours, with at least one-half of this time at BMEPs of over 185 psig.

PNL concludes that Duke has conducted adequate inspections and, further, that there is no apparent reason why these components cannot continue to perform their intended functions in both of the TDI diesel engines at Catawba.

Component: Rocker Arm Capscrew

Part No: 02-390-01-OG

Owners' Group Report: Stone & Webster, March 1984

Brief History of Component

Rocker arm capscrew failures at Shoreham have been reported. There have been no reports of similar failures elsewhere.

Owners' Group Status

Stone & Webster Engineering Corporation, a consultant to the Owners' Group, has performed stress analyses of both the original capscrew design (the type that failed at Shoreham) and a newer design. Stone & Webster has concluded that both designs are adequate for the service intended. Stone & Webster has attributed the failure at Shoreham to undertorquing.

Duke Power Company Status

The rocker arm capscrews at Catawba are of the original design. These capscrews have experienced in excess of 10 million loading cycles in both Catawba diesel engines without reported failures.

Inspections of all rocker arm capscrews on the 1A diesel included:

- measuring breakaway torques
- visual examination
- magnetic particle testing
- material comparitor and hardness tests.

The range of breakaway torques for the intake/intermediate and exhaust capscrews was 278 to 376 ft-lb and 324 to 498 ft-lb, respectively. Comparing these values to the specified torque of 365 ft-lb, Duke concluded that these ranges were acceptable. Further, no indications or material problems were identified. Due to the satisfactory inspection results on the 1A diesel, Duke proposes to examine the 1B diesel rocker arm capscrews visually and by magnetic particle detection only.

PNL's Conclusions

Based on the satisfactory performance of the subject capscrews at Catawba for over 10 million cycles, PNL concludes that the currently available components are adequate for the intended service in both the 1A and 1B diesel engines. Also, in view of the satisfactory service performance, PNL concurs with the reduced scope of inspections as Duke has proposed on the 1B engine.

Component: Connecting Rods

Part No: 02-340A

Owners' Group Report: FaAA-84-3-14

Brief History of Component

Various connecting rod failures have been reported from the non-nuclear field. One failure mode was in the link-rod blade-to-pin bolting, due to loss of bolt preload. Another mode of failure was fatigue cracking of connecting rod bolts and/or the link rod box in the area of the mating threads. No connecting rod failures have occurred in nuclear service.

Owners' Group Status

The first failure mechanism cited was fatigue failure of the link rod bolts resulting from loss of bolt preload. The problem and its solution were addressed by TDI in Service Information Memo (SIM) No. 349, dated September 18, 1980. According to this SIM, engines manufactured between 1972 and February 1980 may have been shipped with an insufficient locating-dowel counterbore depth in the link rod or link pin, resulting in unintended clearance between the link rod and link pin as assembled. Under firing load, this locating dowel will yield, allowing the unintended clearance to disappear and resulting in loose link rod bolts. The Owners' Group (through the above-mentioned FaAA report) has determined that there must be zero clearance under the specified bolt torque of 1050 ft-lb.

The second failure mechanism is fatigue cracking of the connecting rod bolts and/or the link rod box at the mating threads. TDI attributed these rod cracks to "thread fretting." This "thread fretting" was concluded by TDI to result from distortion of the rod bolt under operating loads in the area of the mating threads; the distortion could occur if the bolts had been installed with the originally specified bolt preloads. The Owners' Group addressed this concern for the two versions of the connecting rod, namely the original design equipped with 1-7/8-inch bolts and a later design in which the rod boxes are equipped with a 1-1/2-inch bolts. Stress analysis, including finite element studies, has been completed by FaAA. Failure Analysis Associates has concluded that both designs are adequate for the service intended, provided conrod bolt preload is checked within time limits specified as related to engine load requirement in terms of percentage of nameplate rating. However, the rod with the 1-1/2-inch bolts has an 8% to 9% higher margin of safety than the rod with 1-7/8-inch bolts because the related rod box structure is more massive with the smaller bolt configuration.

Duke Power Company Status

The Catawba engines were furnished with connecting rods employing the 1-7/8-inch bolt. The 1A engine has undergone over 800 hours of operation (over 10 million load cycles), with over half of that at engine loads exceeding 185 psig BMEP. The 1B engine has been operated for over 750 hours, with over 80% of this time at engine loads exceeding 185 psig BMEP.

The connecting rod bolt inspections on engine 1A were as follows:

- visual inspection of 100% of areas subject to wear (rack teeth, washers, seating surfaces)
- measurement of 100% of link pin and link bushing dimensions (25% for piston pin bushing)
- material comparitor and hardness tests on 25% (4) connecting rod assemblies (master rod, rod box, and link rod)
- liquid penetrant test of rod box areas subject to cracking
- eddy-current inspection of 100% of the rod box threaded holes
- measurement of breakaway torque on 100% of connecting rod assemblies
- inspections of connecting rod oil passages
- magnetic particle testing of 100% of connecting rod bolts
- visual inspection of the connecting rod contact surfaces
- measurement of the contact of the connecting rod rack-teeth (serrations) with the mating part by "bluing", for 100% of the rods
- measurement of connecting rod bolt elongation by ultrasonic testing.

Results of the material comparitor and hardness tests, the magnetic particle and eddy-current examinations, and the oil passage inspections showed no abnormalities. Some scratches and pitting were detected through the visual inspection of possible wear areas, which Duke concluded have no adverse effects. The TDI-allowed clearance tolerance for new piston pin bushings is 10 to 15 mils; for used piston pin bushings, it is 20 mils. The four bushings measured 11 to 13 mils, which is within the specification for new bushings. The dimensions of the link pin and the link pin bushing were satisfactory in all cases.

The liquid penetrant test showed a 1-1/2-inch long scratch on link rod bushing 1L, which was replaced. Breakaway torque values for the master rods and the link rods ranged from 1260 to 2150 ft-lb (specified torque of 1700 ft-lb) and 880 to 1410 ft-lb (specified torque of 1050 ft-lb), respectively. Galling under bolt heads was observed in the visual inspection of the contact surfaces. Duke has concluded that the galling was due to bolt torquing and is acceptable. The degree of contact from bluing showed a range of 80 to 100%. The manufacturer requires at least 75% contact. Inspection results are not yet available for the elongation tests.

PNL Evaluations and Conclusions

TDI and the Owners' Group have each conducted extensive investigations and analyses of the connecting rod failures. PNL has not been able to reach final closure on the sufficiency of their results, but generally concurs with their conclusions as to the failure mechanisms, subsequent corrective actions, and overall operability and reliability of the components if given sufficient surveillance and maintenance.

Duke has appropriately addressed the generic issue of potential connecting rod problems through extended operations, disassembly, and inspection. PNL concludes from the available evidence that the connection rods on the Catawba engines can be expected to perform their intended function reliably. This is stated, however, with the proviso that Duke fully check (and correct as needed) the locating-dowel problem and the rack-teeth contact ratio, and establish a comprehensive surveillance and maintenance program (see Section 7.0).

Component: Engine Mounted Electrical Cable

Part No: 02-688B

Owners' Group Report: Stone & Webster, June 1984

Brief History of Component

No failure of this part has been reported. However, in TDI Service Information Memo (SIM) No. 361, Rev. 1, TDI reported that two engine-mounted cables, those associated with the Woodward governor/actuator and the Air-Pax magnetic pick-up, represent potential fire hazards.

Owners' Group Status

Based on the survey results for Catawba, Stone & Webster has recommended to Duke that they implement TDI SIM 361 and that they replace some of their installed 14 AWG wire with wire that is qualified to the IEEE-383-1974 standard. Stone & Webster has also recommended that Duke verify the time period during which their type N7 sliding link terminal blocks were manufactured.

Duke Power Company Status

In their report issued to NRC on June 29, 1984, Duke stated their intentions to replace wiring and implement TDI SIM 361 by September 1984. This report also referenced Duke's program for inspecting sliding link terminal blocks rather than verifying the manufacturing date of the TDI-provided items.

PNL Evaluation and Conclusions

When the electrical cable is replaced with IEEE-38-1974 qualified cable capable of withstanding the ambient temperature that might occur adjacent to the diesel engine proper, PNL concludes that there should be no more concern about the integrity of the cable and its ability to function at the normally expected temperatures.

During the Catawba site visit in July, PNL obtained information from Duke on sliding link terminal blocks. According to these data (Reference 19 to the report issued on June 29, 1984, to NRC), they have found a small percentage of defective links at Catawba. However, Duke reported no incidents of a defective link causing degradation or failure of an electrical circuit.

PNL and its consultants have not completed their review of either the Stone & Webster reports on the subject components at the TDI Owners' Group plants (including Catawba) or Duke's inspection approach on the sliding link terminal blocks. However, PNL concludes that the terminal blocks as installed at Catawba will be capable of fulfilling their intended functions, at least until the first refueling outage at the reactor.

Component: High-Pressure Fuel Tubing

Part No.: 02-365C

Owners' Group Report: Stone & Webster, April 1984

Brief History of Component

High-pressure (HP) fuel tubing leaks have developed during preoperational engine testing on Shoreham and Grand Gulf engines. There are no other reported failures in nuclear application.

Owners' Group Status

Stone & Webster has analyzed the failed HP fuel tubing and has concluded that the failures originated in inner surface flaws that were initiated during fabrication. If, through eddy-current inspection, the inner surface condition of new tubing is found to be within manufacturer specification, Stone & Webster has concluded the HP tubing is suitable for the service intended.

Duke Power Company Status

The tubing for both diesels at Catawba has operated satisfactorily for greater than 10 million cycles. Duke proposes to perform eddy-current tests along with visual inspections of the HP tubing of both the 1A and 1B diesel engines. The inspection results have not yet been made available.

PNL's Evaluation

The isolated failures that have occurred on the high-pressure fuel tubing appear to have been a result of internal flaws. The subject components have neither been a source of problems nor failed on either of the diesel engines at Catawba during their extended operational tests.

PNL concurs that, if the eddy-current tests show all new or replaced tubing does not contain unacceptable inner surface flaws, then these components should be capable of fulfilling their intended design function.

Component: Jacket Water Pumps

Part No.: 02-425

Owners' Group Report: Stone & Webster, June 1984

Brief History of Component

A TDI engine at Shoreham has experienced a jacket water pump shaft failure. There is no history of failures on jacket water pumps designed for the V-16 engines.

Owners' Group Status

Stone & Webster has investigated the jacket water pumps as installed on the TDI in-line and V engines. They reviewed these jacket water pumps from the standpoints of mechanical design, material suitability, and hydraulic performance. Stone & Webster found the pumps such as those installed on the Catawba 1A and 1B engines to be acceptable, with a recommendation that a limiting torque be established for one of the pump shaft nuts.

Duke Power Company Status

The 1A diesel jacket water pump inspections included:

- visual inspection of the driving gear, coupling, and clearance ring
- material comparitor and hardness tests of the shaft
- liquid penetrant examination of the coupling, shaft, and impeller
- radiography examination of the impeller.

Porosity was noted in the impeller casting. Based on radiography results, Duke concluded that the porosity was acceptable. The jacket water pump will not be inspected as part of the 1B diesel inspection.

PNL's Evaluation

The analysis conducted on the subject pump has been quite extensive. PNL concurs with the investigations' conclusions and concludes that the pumps as installed should be adequate to meet their design purposes. However, Duke must check the subject component on the 1B engine to assure that the nut holding the external spline in the shaft taper is neither under- nor overtorqued. Duke should also confirm that the 1A engine jacket water pumps were reinstalled within the recommended torque ranges.

Component: Air Start Valve Capscrews

Part No.: Gg-032-114

Owners' Group Report: Stone & Webster, March 1984

Brief History of Component

No actual failures of these capscrews have been reported. However, on May 13, 1984, TDI reported a potential defect due to the possibility of the 3/4-10 x 3-inch capscrews bottoming out in the holes in the cylinder heads, resulting in insufficient clamping of the air start valves.

Owners' Group Status

Stone & Webster and TDI both have recommended that the 3-inch capscrews be either shortened by 1/4 inch or replaced with 2-3/4-inch capscrews.

Duke Power Company Status

Capscrews on both the 1A and 1B diesels were modified prior to the extended operational tests. All of the 1A air start valve capscrews were measured for torque with values varying from 45 to 134 ft-lb. Duke concluded that this range represents an acceptable variation from the specified torque of 100 ft-lb. Twenty-five percent of the 1A capscrews were measured for length; all those measured were within tolerance. For the 1B diesel inspection, Duke will measure and retorque 25% of the capscrews.

PNL's Evaluation

PNL agrees with Duke's assessment of the problems. The actions taken by Duke to eliminate the potential interference would appear to be adequate to prevent any subsequent failures. PNL concludes that, with the continued use of Duke's installation procedures to control torque of bolts, studs, and screws to specified ranges, these components will not present future problems on the Catawba engines.

3.3 RESPONSES TO NRC QUERIES ON COMPONENT PROBLEMS

In their August 1, 1984, letter to NRC, Duke Power Company has indicated its reponses to, or the actions to be taken on, specific items or issues raised during the Catawba site visit in July. PNL has reviewed this letter and concludes that the response to each item or issue is acceptable.

4.0 EVALUATION OF CATAWBA 1A DIESEL ENGINE INSPECTION

This section documents PNL's technical evaluation of the disassembly, inspection, and reassembly of the 1A diesel engine at Catawba. These efforts were performed by Duke Power Company following successful completion of the planned extended operational tests.

4.1 STATUS AT CATAWBA

When the extended operational tests were finished in March 1984, the 1A diesel engine had accumulated more than 800 hours total operating time. For 50% of this time, the 1A engine was operated with loads at or greater than 5800 kW (186 psig BMEP). A load of 5714 kW (184 psig BMEP) is the maximum required in any emergency postulated for Catawba. Duke subsequently initiated extensive disassembly and inspection of the engine to confirm the condition of various parts and to identify any parts requiring repair, replacement, and/or redesign to ensure highly reliable standby electric generator service. Duke's inspection program involved 100% inspection of parts for which there was a history of problems or other reasons for special concern. Substantial sampling inspections were performed on other important parts for which there was no history of problems.

The inspections of the 1A diesel engine were performed during April through June 1984. As reported by Duke, the diesel disassembly, inspections, and reassembly were performed in accordance with Duke Power Company's Quality Assurance Program. The work was performed primarily by Duke personnel; however, selected inspections were performed by Failure Analysis Associates (FaAA), Stone & Webster Engineering Corporation, and others in conjunction with the TDI Owners' Group Program. Duke has stated that the inspections of the 1A diesel are now complete, except for a few that must be performed during or following engine reassembly. "Walkdown" inspections of the various piping, tubing, and electrical conduit runs on the engine are planned following completion of the 1A engine reassembly. Results of these inspections will be factored into the Owners' Group Phase II DR/QR program for Catawba.

Duke Power Company's report, entitled Catawba Nuclear Station Diesel Engine 1A Component Revalidation Inspection, dated June 29, 1984, describes the methodology and results of the inspections and examinations performed.

4.2 TEST AND INSPECTION RESULTS

The post-extended operational test inspections on the 1A engine are now nearly complete. Engineering and quality assurance evaluations of the inspection results have been performed by Duke. They consider this work to have identified all significant conditions.

As reported by Duke, the most significant results of the Catawba 1A diesel engine post-test inspections are as follows:

- Many of the major problems experienced with other TDI diesel engines did not occur in the Catawba 1A diesel engine.
- One major problem was noted on the 1A diesel. Four of the type AN piston skirts used in the 1A diesel were found to have one or more cracks in the region where an internal circumferential reinforcing rib intersects the piston pin boss.
- The turbocharger thrust bearings were found to be severely worn, although they had continued to function satisfactorily during the test. This condition was anticipated because similar problems have been experienced at other stations. As a result of this history, a redesigned lube oil system is being developed to minimize possible recurrence of the problem. It will be installed by September 1, 1984. In the meantime, the bearings have been replaced as necessary to ensure operability.
- Several other problems of potential significance to engine 1A operability were detected and are being investigated further as part of the TDI Owners' Group Program:
  - Two subcover castings were found to have cracks in an intake rocker arm pedestal.

- Two Catawba cylinder heads (one on diesel 1A and one on 1B) experienced small jacket water leaks into the exterior fuel injector cavity. Metallographic examinations of the head removed from the 1A diesel indicates that the leak was due to a fatigue crack of the spray nozzle hole repair at a weld performed at the TDI factory.

- A small eddy-current test (ECT) indication was detected in crankpin-to-web fillet #7 (generator end) on the crankshaft. Metallurgical examination suggests that the indication was due to 0.027-inch and 0.021-inch long linear defects located about 0.105 inches apart. The 0.021-inch defect was polished out at a depth of less than 0.005 inch. The 0.027-inch indication was polished out in about 0.020 inch of depth. Another indication was detected by fluorescent dye penetrant in the #8 main journal oil hole. This indication was approximately 0.25-inch long and made up of a series of extremely small pores. This indication was polished out in less than 0.005 inch. Evaluation of these indications shows that they were due to initial fabrication.

- A variety of routine minor conditions was noted; these are discussed in Section 3.0 of this TER. None of these conditions impacts the operability or structural integrity of the diesel. Typical conditions included:
  - chipped and cracked edges of rocker arm sockets and cracked tappet
  - flaked and peeled valve stem chrome plate
  - jammed air start valve adjusting nut
  - heads of small bolts broken off, due to under- or overtorquing
  - fuel oil injection pump valve holder cracked at a casting defect
  - repeated cracking of the right-bank turbocharger/intercooler adapter
  - turbocharger prelube oil line fractures at connection fittings.

4.3 EVALUATION

As stated in PNL-5161, Review and Evaluation of TDI Diesel Generator Owners' Group Program Plan, engine testing and inspections are the key elements of the TDI Owners' Group Program for tying corrective actions together and for verifying adequate results.

PNL believes that the extended operational tests conducted by Duke on the 1A engine at Catawba, lasting over 800 hours (over half of which were at loads of over 185 psig BMEP), were of sufficient length and magnitude and adequate to verify the operability and reliability of components. Further, in PNL's opinion, the tests were adequate to demonstrate whether or not the components will meet load and service requirements without evidence of distress under conditions that could induce high-cycle fatigue.

4.4 CONCLUSIONS

Based on its evaluation of the activities associated with or reported on the inspection and reassembly of the 1A diesel engine, PNL concludes that

- Except for the AN piston skirts, the significant engine components were found to be in operable and reliable condition after the extended operational tests, or were appropriately serviced or replaced.
- No major problems were found at the end of the extended operational tests that would have prevented the 1A engine from continuing to operate at that point in time.
- The miscellaneous problems found have been addressed, and corrective actions have been taken or proposed that should be adequate to prevent a recurrence.

PNL concludes overall that, upon Duke's satisfactory completion of the return-to-service testing, the 1A diesel engine at Catawba should be adequately operable and reliable to fulfill its intended purpose, at least until the first reactor refueling outage.[a]

(a) The phrase "until the first reactor refueling outage" is defined in Section 1.2 on p. 3 of this report.

5.0 EVALUATION OF CATAWBA 1B DIESEL ENGINE OPERATION TEST AND INSPECTION

The Duke Power Company report, Catawba Nuclear Station Extended Operation Tests and Inspections of Diesel Generator, transmitted to NRC on April 5, 1984, outlined the inspections that had been performed on the 1B diesel engine prior to operation tests. The report also expressed Duke's intent to extend the 1B engine high load operating time to at least 750 hours and to perform additional inspections on the engine and its components following the extended operation tests. Duke noted that the extent of the inspections to be conducted on the 1B engine would be based on the results of the Catawba 1A and other TDI emergency diesel engine inspections.

Duke Power Company has now completed its planned extended operation tests on the 1B diesel engine at Catawba. During the NRC-PNL/Duke Power Company meetings on July 25 and 26, 1984, Duke personnel indicated that the 1B engine had been operated more than 750 hours, and that 80% of those hours were at $\geq$ 5800 kW. A July 17, 1984, Duke Power Company letter from G. W. Hallman to C. L. Ray, Jr., summarized the operating history of Catawba Unit 1 diesels (1A and 1B). In an earlier letter, dated July 6, 1984, from H. B. Tucker to NRC, Duke presented a proposed inspection plan for the 1B engine at Catawba.

5.1 CATAWBA 1B DIESEL ENGINE OPERATION

Duke established the extended operation tests to demonstrate the fatigue resistance of the diesel engine components and to demonstrate the ability of the Catawba engines to operate in a reliable fashion. Duke has concluded that the 810 hours of operation on the 1A engine (50% at $\geq$ 5800 kW) has served to demonstrate the fatigue life capability of the engine parts; that the 1A engine is capable of sustained operation at high loads; and that the 1A engine has the ability to operate continuously for periods of time that may be required in an emergency situation.

According to Duke Power Company personnel, the 1B engine at Catawba recently sucessfuly completed its extended operation test, which consisted of over 750 hours of operation. Duke has concluded that the 1B engine has demonstrated its ability to operate in reliable fashion.

5.1.1 PNL Evaluation

As covered in PNL-5161, Review and Evaluation of TDI Diesel Generator Owners' Group Program Plan, engine testing and inspections are the key elements of the TDI Owners' Group Program for tying corrective actions together and for verifying adequate results. Engine tests are required to demonstrate whether or not a component or unit will meet load and service requirements without evidence of unacceptable stress. This is particularly important in plants seeking licensing prior to the full implementation of the Owners' Group Program Plan.

5.1.2 PNL Conclusions

As reported in Section 4.3, PNL believes that the extended operation tests conducted by Duke on the 1A engine at Catawba were of sufficient length and magnitude and adequate to verify the acceptable function of components, as well as to demonstrate the ability of components to meet load and service requirments under conditions that could induce high-cycle fatigue.

Likewise, in PNL's opinion, tests of a sufficient duration and intensity have been performed on the 1B diesel engine at Catawba to demonstrate its state of component adequacy, subject to satisfactory inspection results. Over 750 hours of operation were involved, with nearly 80% at or over 185 psig BMEP.

5.2 CATAWBA 1B DIESEL ENGINE INSPECTIONS

Duke Power Company has developed and published in the July 6th letter noted above their proposed inspection plan matrix for the Catawba 1B diesel engine. The sample size of components they plan to inspect on the 1B engine, except for a few components, is the same as that performed on the 1A engine.

5.2.1 PNL Evaluation

The plans for the 1B diesel engine inspection were reviewed by NRC/PNL and Duke Power Company personnel at the Catawba meeting on July 25, 1984. PNL considered Duke's plans in light of published results of inspections on the 1A engine, as well as the results to date of the Owners' Group analyses on known issues and DR/QR.

5.2.2 PNL Conclusions

In PNL's opinion, the inspection plan is adequate to determine if the key and critical components of the 1B diesel engine have met load and service conditions without undue evidence of stress.

PNL recommends that Duke Power Company perform the following inspection in addition to those listed in their referenced inspection plan:

- 100% disassembly of link and master rods and in situ inspection (visual and surface nondestructive evaluation) of the link rod bushings. In their August 1, 1984, letter to NRC, Duke has concurred with this activity.

The inspections of the 1B diesel engine have only recently begun and the results are, of course, not complete at this time. Hence, the unavailability of the 1B engine inspection report precludes PNL from evaluating the inspection findings and dispositions. After Duke Power Company has completed the 1B engine inspections, they should document the methodology, the findings, and the actions taken. Pending successful completion of the 1B engine inspection, reassembly, and return-to-service testing, it is assumed that the Catawba 1B diesel engine will have compiled a record that will demonstrate its operability and reliability.

6.0 REVIEW OF POST-INSPECTION TEST PLAN

This section documents PNL's review of the post-inspection tests to be performed by Duke Power Company on the Catawba diesel engines. Elements of Duke's proposed return-to-service tests are presented first. Next, factors and data considered in PNL's evaluation of Duke's test plan are described. Last, the overall conclusion reached by PNL regarding Duke's post-inspection test plan is presented.

6.1 DUKE POWER COMPANY POST-INSPECTION TEST PLAN

Duke Power Company outlined its plans for the return-to-service testing of the 1A diesel engine in a July 6, 1984, letter to NRC (H. B. Tucker to H. R. Denton, "Catawba Nuclear Station Docket Nos. 50-413 and 50-414"). The planned tests included:

- run-in operations in accordance with the TDI Instruction Manual
- ten modified-start[a] load tests of at least 3500 kW (i.e., 50% of nameplate rating)
- a 24-hour run consisting of 22 hours at 7000 kW and 2 hours at 7700 kW (i.e., 100% and 110% of nameplate rating, respectively)
- two fast starts[a] to a peak load of 4100 kW (59% of nameplate rating): one start with manual turbocharger prelube, and one without
- trip device verification
- load rejection test.

During PNL's visit to the Catawba site on July 25 and 26, 1984, Duke personnel indicated that these tests could not be performed on the 1A engine before August 1, 1984. Similar tests cannot be performed on the 1B engine until the current inspection program is completed and the engine is reassembled.

(a) A modified start is a start including turbochargers prelube; a fast start simulates ESF signal with the engine in ready-standby status.

6.2 EVALUATION

PNL evaluated the elements of Duke Power Company's post-inspection test plan within the context of two principal items:

- PNL recommendations made earlier to NRC regarding diesel engine preoperational testing
- NRC-proposed staff actions to improve and maintain diesel generator reliability.

These items are described in detail in the next two paragraphs.

In June 1984, PNL recommended to NRC that preoperational testing be performed on all diesel engines following their assembly, to confirm that the engine is operable (PNL-5161). For engines such as at the Catawba Nuclear Station Unit 1 (viz, a candidate for an operating license prior to completion of the implementation of the Owners' Group Program Plan) PNL recommended that this testing include the manufacturer's preoperational test recommendations as well as the following elements, if they are not already contained in the manufacturer's recommendations:

- ten modified starts to at least 40% of "qualified" load (as defined in PNL-5161)
- two fast starts to "qualified" load
- one 24-hour run at "qualified" load.

PNL had also recommended to NRC (PNL-5161) that, because of the plant-specific nature of engine installations, the owners should prepare detailed plans for engine tests and inspections.

During the July 1984 Catawba site visit, PNL learned of NRC Generic Letter 84-15 dated July 2, 1984, that addressed proposed staff actions to improve and maintain diesel generator reliability. Enclosure 1 of this generic letter states:

> It is the staff's technical judgment that an overall improvement in diesel engine reliability and availability can be gained by performing diesel generator starts for surveillance testing using engine prelube and other manufacturer recommended procedures to reduce engine stress and wear. The staff has also determined that the demonstration

> of a fast start test capability for emergency diesel generators from ambient conditions cannot be totally eliminated because the design basis for the plant, i.e., large LOCA coincident with loss of offsite power, requires such a capability.
>
> In view of the above, the staff has concluded that the frequency of fast start tests from ambient conditions of diesel generators should be reduced.

PNL reviewers noted that Duke's return-to-service test plan states that all 10 modified start load tests will be performed with a prelube of the engine and that one of the fast start tests will be conducted under prelube conditions. The other of these tests will be performed with the engine in ready-standby status without prelube.

PNL also notes that Duke's post-inspection return-to-service test plan calls for a 24-hour run to nameplate rating (22 hours) and overload rating (2 hours), as detailed in Section 6.1 above. In light of the need for conservative operation relative to crankshaft and cylinder block conditions (as previously discussed in Section 3 of this TER and in Section 4 of PNL-5161), PNL concludes it would be inappropriate for Duke to further operate the Catawba engines above 185 psig BMEP, as long as emergency loads do not necessitate such operation. (Refer also to Section 1 and 2.1 herein.)

PNL also recommends that, as part of the return-to-service tests, Duke observe, record, and report pre-turbine exhaust gas inlet temperatures at levels of 25%, 50%, 75%, and 82% of nameplate rating (i.e., at BMEPs of 56, 113, 169, and 185 psig).

6.3 CONCLUSIONS

Based on its review, PNL concludes that Duke's post-inspection test plan is compatible with NRC requirements described in Section 6.2. It is the opinion of PNL's consultants that TDI engines such as those at Catawba should not be operated above a BMEP of 185 psig except for brief periods, at least until all concerns pertaining to the current crankshaft are fully resolved. Therefore, PNL recommends that Duke conduct the post-inspection 24-hour runs on the 1A and 1B engines at a qualified maximum load of 5800 kW. Finally, PNL concludes that the successful completion of Duke's return-to-service tests will be adequate to confirm that the 1A engine and its associated systems are operable.

PNL also concludes that similar return-to-service tests on the 1B engine will be adequate in scope and objective. However, any failure to meet the objectives of the tests will require reconsideration of this conclusion.

7.0 REVIEW OF THE PROPOSED MAINTENANCE, INSPECTION, AND SURVEILLANCE PROGRAM

While reviewing the Owners' Group Program Plan (OGPP), PNL recognized that a comprehensive maintenance and surveillance (M/S) program would be a key aspect of the overall effort to assure future TDI diesel engine operability and reliability, and so stated eventually in its formal review of the OGPP as published in June 1984 (PNL-5161). Recognizing that the Owners' Group Program Plan had not yet specifically addressed M/S activities, PNL recommended that the Owners' Group develop a definitive M/S program (in consultation with TDI), and that detailed plans based on those Owners' Group recommendations be developed for each engine installation by the individual owners.

Elements of such a M/S plan were initially identified by PNL in letters of April 16 and 17, 1984, to C. Berlinger at NRC (dealing specifically with Mississippi Power & Light's Grand Gulf Nuclear Station). The features of the enhanced M/S program suggested by PNL were subsequently incorporated by the NRC staff in a letter to MP&L dated April 25, 1984.

A letter from H. B. Tucker of Duke Power Company to H. R. Denton, Office of Nuclear Reactor Regulation, NRC, dated July 16, 1984, addressed "Periodic Maintenance, Inspection and Surveillance of the Catawba 1A and 1B Diesel Engines (Catawba Nuclear Station, Docket Nos. 50-413 and 50-414)." Therein, Mr. Tucker references the NRC staff letter of April 25, cited above, as one basis of the Duke Power Company M/S program plan. (Other bases cited by Tucker include an engineering evaluation of the results of the Catawba 1A diesel engine post-extended operating test inspection and the TDI Owners' Group recommendations.)

Duke's July 16th letter discussed NRC's comments, and indicated how Duke plans to resolve those comments. Table 1 of the letter provided a schedule for periodic inspection, maintenance and surveillance.

This section presents PNL's review of Duke Power Company's planned M/S program. Significant features of the program are discussed, followed by summary observations and comments.

7.1 PNL EVALUATION

In Section 4 of PNL-5161, Review and Evaluation of TDI Diesel Generator Owners' Group Program Plan, PNL recommended that utilities seeking licensing prior to completion of the Owners' Group Plan for M/S and its full implementation by the individual utilities, should provide for enhanced surveillance and maintenance. In general, Duke's July 16th proposal has provided for this, although their program differs somewhat from the NRC staff's April 25th recommendations. Table 1 provides a comparison of the two approaches (NRC and Duke), and presents a parallel listing of PNL's recommendations. Comments on individual component plans follow.

7.1.1 Cylinder Heads

Barring the engine over is done to detect water in the cylinder, which would indicate a cracked cylinder head (or liner), with water not drained to crankcase. Any substantial water accumulation in a cylinder could lead to severe damage to head and/or piston on engine startup and could seriously impact engine operability. The Duke proposal is to bar-over weekly, rather than daily, to reduce engine unavailability. PNL does not consider this proposal to be adequate for assuring timely detection of water in the cylinders.

PNL Recommendation

PNL recommends a revised schedule for barring-over, as follows:

- an initial barring-over at least 4 hours (but not over 8 hours) after engine shutdown
- a second barring-over approximately 24 hours after shutdown
- thereafter, bar-over immediately prior to any planned engine operation.

The basis for the change from the earlier PNL recommendation (which called for barring-over the engine every 24 hours) is the recognition that, if a leak of substantial, detectable proportions has not occurred within the first 24 hours of cooldown, it is unlikely that one will develop before the next engine operation. However, because it is still possible, although not likely, for a

TABLE 1. PNL's Recommendations Concerning Duke's Proposed Maintenance/Surveillance Plans for Key Components of the Catawba TDI Engines

Component	NRC Guidance (April 25)	Duke Proposal (July 16)	PNL Recommendation
Cylinder Heads	Bar-over 4 hours after engine runs and each day thereafter.	Bar-over within 4 hours after engine runs and weekly thereafter, and prior to routine starts.	Bar-over 4 to 8 hours after engine runs, and again after 24 hours and prior to routine starts.
Engine Block and Base	Visually inspect after 24 hours operation or monthly	Visually inspect monthly "or more often".	Visually inspect daily during operation, with intensely lighted inspection monthly, while operating.
Connecting Rods	Visually inspect and retorque after 24 starts, 50 hours of operation, or 6 months, whichever is first.	Check bolt preloads at first refueling outage (estimated equivalent to 25 to 50 starts and 50 to 200 hours of operation).	Visual surface inspection and bolt preload check at 200 hours or 9 months, whichever is first.
Lube Oil Check	Check for water following preoperational tests, then weekly or after 24 hours of operation, whichever is first. Check monthly for contaminants and water in sump; check filters.	Check following preoperational tests, then monthly or after 24 hours of operation, whichever is first. Check monthly for water in sump; semiannually for contaminants. Check filter pressure drop during diesel operation.	Check for water following preoperational tests, then monthly or after 24 hours of operation, whichever is first. Check for chemical and particulate contamination on same schedule. Check filter pressure drop hourly during operation.

TABLE 1. (contd)

Component	NRC Guidance (April 25)	Duke Proposal (July 16)	PNL Recommendation
Studs/ Fixtures	Spot-check 25% monthly for torque.	Spot-check 25% at each refueling outage.	Check 100% of air-start valve capscrews and 25% of all other items at each refueling outage.
Push Rods, Cams, Tappets, Etc.	Visually check after pre-operational testing and after each 24 hours of operation.	Visually check at each refueling outage.	Visually check at each refueling outage.
Other M/S Items	Standby: Lube oil filter differential pressure - daily	Standby: Weekly	Standby: Weekly
	Crankshaft deflections - hot and cold every 6 months; hot within 15 minutes of shutdown.	Once each refueling cycle; hot within 4 hours of shutdown.	Once each refueling cycle; hot to start in 15 minutes, complete within 30 minutes.
	Operations: Exhaust temperature - continuous (record hourly) including pre-turbine inlet temperature.	Operations: Continuously monitored and recorded (no comment re: pre-turbine exhaust inlet)	Operations: Continuously monitored and recorded, including pre-turbine exhaust inlet.
	Lube oil, jacket water, inter-cooler temperatures, air pressure accelerometers - monitor continuously, record hourly.	Generally per NRC guidance (excepting accelerometers, which give no readings)	As per Duke proposal.

small leak to weep and accumulate (i.e., the water be retained by the piston rings), it remains prudent to check for the presence of water before any planned start.

Duke contends that the absence of a history of cracked heads at Catawba precludes the necessity of such precautions. Nevertheless, Duke has offered to bar-over the engine weekly as a precaution. Because Catawba has neither identified the "group" affiliation of its heads, nor replaced all with heads clearly of Group III (when TDI manufacturing QA/QC reportedly was better), it is important that these reasonable precautions be taken so as to assure engine reliability. The desirability of doing so is further substantiated by the recent occurrence of just such a leak, detected by barring-over, at Grand Gulf Nuclear Station (see Section 3 re: cylinder heads).

7.1.2 Engine Block and Base

There are three primary structural components to a Vee engine: the base; the crankcase; and the cylinder block. The history of problems in the population of TDI engines, and relevant analyses by TDI and the Owners' Group, lead PNL to conclude that there is insignificant likelihood of failures to occur in the base and crankcase in external locations where they are visibly discernible. However, there has been a substantial history of cracks on the top of the cylinder block, some of which are visibly discernible and/or detectable by NDE methods without head removal. The Owners' Group generic issue report (FaAA-84-15-12) calls for careful surveillance of this surface on certain engines at unspecified intervals. By their criteria, however, this would not be necessary on the Catawba engines on a regular basis (until a substantial number of additional operating hours at high load levels have accumulated).

Duke's proposal is to conduct "visual inspections of the block and base" (and, presumably, the crankcase) "routinely during engine operation, i.e, every month or more often. These inspections will be directed at... verifying that dangerous cracks are not propagating from stud holes in the block... and will be limited to those inspections which can be performed without disassembly of any parts." (Emphases added).

In light of the history of block cracks and the FaAA analysis, PNL and its diesel consultants remain concerned that even at Catawba there remains legitimate reason to maintain enhanced surveillance of the blocks at least through the first opportunity for heads-off reinspection and until a more definitive resolution of the problem is established by the Owners' Group and Duke. Nevertheless, because of the favorable Catawba history, and in light of FaAA's evaluation thereof, PNL concurs with Duke's plan for regular, thorough visual monitoring, which must be done under conditions of strong lighting.

PNL Recommendation

PNL recommends routine daily inspection during operating periods, with a more thorough inspection under strong lighting at least monthly. These should be conducted while the engine is operating.

7.1.3 Connecting Rods

In light of the history in the TDI engine population (however limited) of connecting rod link-rod box cracking, bolting problems (viz, some galling, some preload relaxation, some failures), and fretting along contact areas of the serrated teeth, some regular visual inspection and bolt retorquing (or equivalent checking) is deemed warranted. The relevant Owners' Group known-issue report (FaAA 84-3-14) recommends that the interval on bolt retorquing not exceed 200 hours of operation at full load (i.e., manufacturer's rated load), 248 hours at 85% load, or 286 hours at 75% load. In making that recommendation there was no differentiation between connecting rods having 1-1/2-inch bolts and those with 1-7/8-inch bolts. Although the history of 1-1/2-inch bolting is reportedly better, it apparently is not totally devoid of problems (either experientially or analytically). Thus, even by the Owners' Group's own analysis, it is deemed prudent to establish an enhanced surveillance plan.

Duke contends that it has experienced no relevant problems or indications thereof, such as fretting of the connecting rod serration teeth. However, some surface "roughing" has been observed, the interpretation and importance of which is viewed differently by Duke and PNL observers. Furthermore, the equivalent rods (with 1-1/2-inch bolting) at Comanche Peak evidenced apparent fretting somewhat more pronounced, to PNL's observers, than that observed at Catawba.

There is some uncertainty, also, on the required amount of 'tooth' contact area to be expected in a proper fit, and just how the lapping and 'bluing' is to be properly achieved. ('Bluing' is a process of using a thin surface coating of a chemical which, when pressed or rubbed against a mating surface, will be removed where contact is achieved.)

In light of these points, PNL recommends a degree of surveillance somewhat more conservative than that proposed by Duke (viz, at the first refueling outage, generally expected to be at 18 months of operation and, by Duke's own estimate, involving up to 50 starts and 200 hours of operation).

PNL Recommendation

PNL recommends visual surface inspection and bolt preload check at 200 hours of operation or 9 months, whichever occurs first.

This should conservatively address the Final Safety Analysis Report load levels (for LOOP or LOCA events) for Catawba's units, as well as all pre-operational testing following engine reassembly, and the possible impacts of low-cycle fatigue associated with a multitude of starts. At the same time, this revised pattern will reduce the cumulative downtime required, thereby enhancing engine availability.

7.1.4 Lube Oil Checks

These checks serve two main functions:

- They reveal any water in the oil, indicative of cracks in water-bounded components or leakage past lower liner seals. Such water can lead to lubrication failures, with potential major damage.
- They reveal abnormal wear of bearings and related engine parts.

It is important to collect and analyze samples with sufficient frequency that adverse conditions are detected early enough to avoid either engine damage or engine outage (and possibly consequential reactor shutdown). Upon further consideration of likely operating patterns at Catawba, PNL and its consultants agree that weekly sampling is not warranted. However, PNL does not believe that Duke's proposed 6-month intervals between contaminant analyses is frequent enough to avoid possible problems.

PNL Recommendation

PNL recommends the following pattern:

- Check for water contamination after preoperational testing and then monthly, or after 24 hours of operation, whichever comes first; collect the sample from the bottom of the sump tank, preferably about 4 hours after engine shutdown, at the time of the engine bar-over.
- Check for chemical and particulate contamination and imbalance near the close of preoperational testing and then monthly or after 24 hours of operation, whichever comes first; collect the sample while the engine is running, immediately prior to shutdown.
- Check differential pressure across all filters and strainers hourly during engine operation.

7.1.5 Studs and Fixtures

Loss of preload on cylinder head studs, rocker arm capscrews, and air-start valve capscrews can adversely affect engine operability if it goes unnoticed. The generally positive experience at Catawba in this regard warrants a less rigorous schedule of checking, which, as proposed by Duke, will reduce engine downtime while head covers are off.

PNL Recommendation

PNL concurs with Duke's proposal for a 25%-sample check of head stud and rocker arm capscrew preload at each reactor refueling outage. However, because the air-start valve capscrews are more susceptible to relaxation (due to the associated soft metal gaskets), PNL recommends these be checked 100% at the same frequency. (One consequence of the loss of capscrew preload may be loss of cylinder compression; another will be "torching" of the passage permitted by a "loose" valve with consequential irreparable damage to the head, and with potential risk to operating personnel from high velocity, unnoticeable hot gases.)

7.1.6 Push Rods, Cams, Etc.

Engine operability is affected by defects in push rods, cams, tappets, and other similar components and their supporting structures. Some of these components at Catawba have suffered damage. Hence, regular visual inspection is needed, although few operating hours are anticipated. The difference between the NRC guidance (after 24 hours of operation) and the Duke proposal (at the first refueling outage, estimated by Duke to involve 50 to 200 hours of operation) is not considered significant in light of the low wear rate or limited likelihood of structural failure for these components, because all parts will have been inspected recently, and because, in the opinion of the PNL consultants, very little change in the condition of these parts is expected during the 50- to 200-hour operating time involved in the Duke proposal.

PNL Recommendation

PNL considers the Duke proposal acceptable.

7.1.7 Lube Oil Pressure Drop

The NRC guidance called for the pressure drop across the filters to be checked daily, during engine standby, and hourly during operation. Duke contends that during standby there is little opportunity for contaminants to develop so as to plug the filters, and that only low, keep-warm flow is involved so that a significant pressure drop is not likely. Although this view is relatively valid, it does not reflect two factors:

- Entrained water will tend to plug some filter media (or weaken others), and so would gradually change pressure drops.
- The continuous keep-warm flow through the filters will (purposefully) continually "polish" the oil, with gradual buildup of contaminants in the media; the material scavenged out thereby itself helps filter even finer particles as time continues.

Thus, it remains valid to monitor oil filter pressure drops during standby. However, the difference between a daily check (per NRC guidance) and a weekly check (as proposed by Duke) is not deemed significant; the latter is considered acceptable.

PNL Recommendation

PNL recommends a weekly check of oil filter pressure drop during standby. The hourly check during sustained engine operation remains important, for comparable reasons.

7.1.8 Crankshaft Deflection Checks

Three purposes are accomplished in crankshaft deflection checks:

- detection of changes in shaft configuration, such as a developing crack in a web or journal
- detection of gradual shifts in shaft support internal to the engine (most likely being significant bearing deterioration)
- detection of changes in external engine support, as in the concrete foundation, or a shift of shims between the foundation rails and the engine base plate. (The foundation will indeed change shape with prolonged engine operation, tending to hump toward the middle due to thermal growth, which must be reflected in appropriately shimming the engine. It may also undergo long-term permanent change as chemical processes continue within the concrete.)

The NRC guidance was for checks each 6 months, the hot-deflection check being completed within 15 minutes of engine shutdown. Duke has counterproposed a check at each refueling outage, to be completed within 4 hours of engine shutdown. Such an interval would increase total engine availability, of course.

PNL Recommendations

Reflecting all considerations, PNL recommends the following pattern:

- Take hot and cold deflection readings at every refueling outage (as proposed by Duke). PNL's consultants deem it unlikely that the expected hours and character of operation in the longer period will raise the risks significantly.

- The hot deflection checks should be taken immediately after the 24-hour preoperational testing, so as to reflect representative operational foundation temperatures.

- The hot checks should be initiated within 15 to 20 minutes after shutdown, and completed as rapidly as possible, preferably within 1/2 hour, and starting with the last throw of the engine (generator end). Such a schedule, although strenuous, is deemed achievable.

7.1.9 Monitoring Exhaust Temperatures

NRC's guidance was for continuous monitoring and hourly recording of engine exhaust temperatures, including pre-turbine temperatures. Duke has proposed continuous recording, but with no mention of pre-turbine (inlet) temperatures. [However, in an August 1, 1984, letter to NRC following onsite discussions on July 26, 1984, Duke has agreed to make provision for pre-turbine temperature checks in addition to cylinder exhaust temperature and turbine outlet (stack) temperature, as is already being done.]

PNL's consultants deem it very desirable to monitor the turbine inlet temperature for these reasons:

- Monitoring would avoid the possibility of such temperatures exceeding the limits set by the turbocharger manufacturer.

- It is possible for the "average" temperature thereat to exceed the "average" temperature measured at the individual cylinder outlet (the latter reflects a time-averaged combination of true exhaust temperature and a much lesser quantity of cooler "scavenging air" that occurs during valve overlap in the exhaust/intake strokes). This higher actual turbine inlet temperature results from three possible conditions: 1) the pulse of hot exhaust and the subsequent, lesser pulse of cool air may not mix, even though two cylinders are involved with each manifold; 2) exothermic chemical reactions tend to continue after the cylinder exhausts, even with proper firing timing; and 3) any inappropriate timing of fuel injection can lead to continuing flame propagation during exhaust.

- Plots of pre-turbine temperatures for such engines as at Catawba show that, at full load and overload (i.e., the TDI rating of 7000 and 7700 kW, respectively), the temperatures of even properly-timed engines can approach 1200°F (the reported upper limit allowed by the turbocharger manufacturer).
- While vanes have not been found missing on the Catawba turbochargers, they have been noted elsewhere on similar nuclear engines. Because the mechanism of the vanes' disappearances has not been identified with certainty, it is important to avoid influences toward thermally-induced failures.

PNL Recommendation

PNL recommends continuous monitoring and hourly recording of turbine inlet exhaust gas temperatures.

7.1.10 Surveillance of Operating Parameters

Surveillance of a number of key engine operating parameters is essential to assuring reliable engine performance. The initial NRC guidance and the Duke proposed surveillance generally are quite similar.

PNL Recommendation

The Duke proposals are deemed acceptable, with the clarification that engine lube oil and jacket water temperatures continuously recorded should be discharge temperatures, and that the inlet temperatures should also be monitored, with hourly recording.

7.1.11 Other Inspection and Surveillance

In its letter of July 16, 1984, Duke includes Table 1, which lists its proposed "Periodic Inspection, Maintenance and Surveillance Schedule". In general, it reflects sound and acceptable patterns. However, to incorporate the recommendations herein above, some will need to be modified in the final Duke plan. This includes several components that are categorized as needing surveillance or maintenance only every 10 years. PNL does not deem this to be an acceptable frequency for these, considering the nature of the component, the overall TDI-owner history of problems and indications, and the analyses (to date) of known issues.

PNL Recommendation

Until DR/QR resolution is achieved on all these items and/or until further field experience justifies a longer interval such as Duke proposes, PNL comments and recommends sampling inspections as follows:

Part No.	Part Name	Remarks/PNL Recommendations
02-305D	Main bearing caps	Disassemble two caps and visually inspect at first refueling
02-310B	Crankshaft bearing shells	Visual and RT of two highly loaded bearing sets at first refueling
02-340B	Connecting rod bearing shells	Dimensional, visual, and RT of bearing shells at first refueling
02-341A	Pistons	Disassemble four pistons and inspect visually and with magnetic particle detection at first refueling
02-360A	Cylinder heads	Remove four heads and inspect visually and with liquid penetrant at first refueling
02-390A,B 02-362A	Rocker arms Rocker box assemblies	Visually inspect rockers and supports monthly and check capscrew preloads on four heads at first refueling.
02-315A	Cylinder block	Inspect top surface visually monthly in accessible areas. Remove four heads and inspect areas at liner landings and head studs visually and with liquid penetrant at first refueling.
02-315C	Cylinder liner	Inspect liner surfaces, four cylinders, for surface scuffing or scratching and other signs of lubrication problems at first refueling.

Assuming the turbocharger prelube system as finally developed is deemed adequate by NRC, the 5-year inspection plan proposed by Duke is acceptable. Otherwise, at least one turbocharger per engine should be inspected at the first refueling outage.

7.2 PNL CONCLUSIONS

PNL concludes that the Duke proposed M/S activities need some modification to provide adequate assurance of engine reliability/operability. Those recommendations, with supporting rationale, are fully delineated above. With those modifications, the Duke proposed M/S program is considered acceptable through the first refueling cycle. As the OGPP and related M/S activities become fully developed and accepted by NRC, it may be appropriate for Duke to modify their plan still further.

8.0 OVERALL CONCLUSIONS

8.1 GENERAL CONCLUSION

In general, PNL and its consultants conclude that the two TDI DSRV-16-4 diesel engines in Catawba Nuclear Station Unit 1 will have the needed operability and reliability to fulfill their intended emergency power function, at least to the time of the first reactor refueling outage.

This conclusion is predicated upon the known results of the completed extended operational tests and subsequent inspections on the 1A engine, and upon the premise that test and inspection results on the 1B engine will prove that it is comparable to the 1A engine. It also reflects PNL's current knowledge and evaluation of the ongoing Owners' Group investigation on specific, generic component issues. Further, it is necessarily contingent upon satisfactory completion of all actions recommended in this TER and upon final reassembly of both engines with satisfactory return-to-service test results, as well as on the assumption that the Catawba-specific DR/QR investigations will further confirm operability and reliability of key components.

8.2 LONG-TERM APPLICABILITY

In Section 1.2 of this TER, PNL expressed its opinion and rationale that it cannot responsibly reach unconstrained conclusions on the operability and reliability of the Catawba 1A and 1B standby engines. Hence, throughout this report, PNL has expressed its conclusions in such terms as "until the first reactor refueling outage". These conclusions have been predicated upon all evidence available to PNL, including preliminary elements of the OGPP and the Duke DR/QR analyses as applicable to these specific engines. As these analyses are completed and appropriately implemented, and as operational results on these engines (under enhanced surveillance and maintenance) and on others in the general population of equivalent TDI engines are accumulated, it may then be possible to draw unconstrained, long-term conclusions. Until that time, however, the suggested time constraint is deemed essential.

It is not PNL's intent, however, in expressing this constraint to infer any inherent unreliability or inoperability of these engines, either specifically at Catawba or in general nuclear standby service.

8.3 KEY CONSIDERATIONS

The conclusion stated in Section 8.1 reflects PNL's careful evaluation of all known considerations. Specific considerations have been addressed in Sections 3 through 7 of this TER and reference should be made thereto for PNL's component-specific conclusions and recommendations.

Certain key considerations warrant emphasis, however.

- Should remaining inspections, return-to-service testing, or DR/QR analyses at Catawba or functional occurrences in other plants, reveal adverse conditions or results not currently expected, modification of this general conclusion may be warranted.
- The conclusion presumes that relevant emergency loads will not require the Catawba engines to operate under other than momentary loads exceeding 185 psig BMEP.
- Duke must implement and rigorously control a plan of regularly barring-over the engines to check for cylinder head water leaks.
- An improved, successful turbocharger prelubrication system must be devised and installed.
- An improved right-bank turbocharger-to-intercooler connection must be devised and installed.
- Duke must appropriately revise its surveillance and maintenance program to achieve the objectives set out in Section 7 of this TER.

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CN 815.06
80-08

May 7, 1980

K. S. Canady

Attention: R. O. Sharpe

Subject: Catawba Nuclear Station
IE Information Notice 80-08
States Sliding Link Terminal Block
File: CN1412.11-1; EGS N-14.01

In response to your 3/17/80 letter to B. M. Rice, we have reviewed the subject notice relative to Catawba. It has been determined that there have been a small percentage of defective links found at Catawba, but there have been no incidents of a defective link causing degradation or failure of an electrical circuit.

All Duke Nuclear Stations will be requested to inspect States sliding link blocks upon installation and each time a link is operated. The stations will also be requested to notify Design Engineering of any performance problems and to replace defective links as they are identified.

If clarification is required, please contact me.

C. J. Wylie
Chief Engineer, Electrical Division

G. T. Lamb
Technical Specialist

GTL/nt

cc: D. G. Owen
L. E. Suther
R. T. Amos

March 17, 1980

C. J. Wylie
Design Engineering

Attention: B. M. Rice

Subject: Catawba Nuclear Station
IE Information Notice 80-08

Attached is a March 7, 1980 letter from Mr. J. P. O'Reilly, NRC/OIE, which transmits IE Information Notice 80-08. This information notice concerns sliding link electrical terminal blocks.

No written response to the NRC is required. Please advise of any action taken in regards to this notice.

K. S. Canady, Manager
Project Coordination and Licensing

R O Sharpe

By: R. O. Sharpe

ROS:vr
Attachment

cc: W. H. Rasin
S. K. Blackley
S. B. Hager
C. J. Wylie
J. W. Cox
C. A. Graybeal
R. A. Morgan
Section File CN 801.01, 815.06, 802.15
Master File CN 801.01, 815.06, 802.15

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA ST., N.W., SUITE 3100
ATLANTA, GEORGIA 30303

In Reply Refer To:
RII:JPO
50-369, 50-370
50-269, 50-270
50-287, 50-413
50-414

MAR 07 1980

Duke Power Company
Attn: W. O. Parker, Jr.
Vice President, Steam Production
P. O. Box 2178
Charlotte, North Carolina 28242

Gentlemen:

This Information Notice is provided as notification of a potentially significant matter. It is expected that recipients will review the information for possible applicability to their facilities. No specific action or response is requested at this time. If further NRC evaluations indicate the need, an IE Circular or Bulletin will be issued to request specific licensee actions. If you have questions regarding this matter, please contact the Director of the appropriate NRC Regional Office.

Sincerely,

for James P. O'Reilly
Director

Enclosures:
1. IE Information Notice No. 80-08 w/its Enclosure
2. List of Recently Issued IE Information Notices

SSINS: 6870
Accession No.:
7912190689

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D.C. 20555

March 7, 1980

IE Information Notice No. 80-08

THE STATES COMPANY SLIDING LINK ELECTRICAL TERMINAL BLOCK

Description of Circumstances:

On July 19, 1979, the Consumers Power Company notified the Nuclear Regulatory Commission of a defect found in the sliding link electrical terminal block manufactured by the States Company, a subsidiary of Multi Amp Corp. The defective terminal blocks were found at the Midland plant.

The connection between the two slotted bars on the terminal block is made by a U-shaped sliding link and spacer located between the two bars. The top of the U-shaped link and the spacer are drilled and the bottom of the link is threaded to accept a 8-32 screw. When the screw is tightened it binds the link, spacer and bar together to make electrical connection. Loosening the screw and sliding the link from between the bars breaks the connection. The purpose of the link is to provide easy insertion of test instruments, etc. into the circuit.

The defect, which has been identified in 5% of the terminal blocks checked, occurs in the form of a crack between the threaded screwhole and the side of the U-shaped link. When the screw is tightened the crack widens and a poor or intermittent electrical connection can result. A defective link is impossible to cinch tightly in place and is difficult to detect visually.

Enclosure 1 shows the States Company terminal block. The defect, a crack in the bottom portion of the metal U-shaped link, is displayed in the exploded view of the terminal block assembly. These terminal blocks are widely used in the nuclear industry and may be used as permanent installations in safety related systems. The defective mechanical connection can cause an electrical circuit malfunction.

This Information Notice is provided to inform licensees of a potentially significant matter. It is expected that recipients will review the information for applicability to their facilities. No written response to this IE Information Notice is required. However, the reporting requirements as set forth in the regulations must be met. If you require additional information regarding this matter, contact the Director of the appropriate NRC Regional Office.

Enclosure:
Graphic Display of Terminal
Block

cc w/encl:
J. W. Hampton, Station Manager
Post Office Box 392
Clover, South Carolina 29710

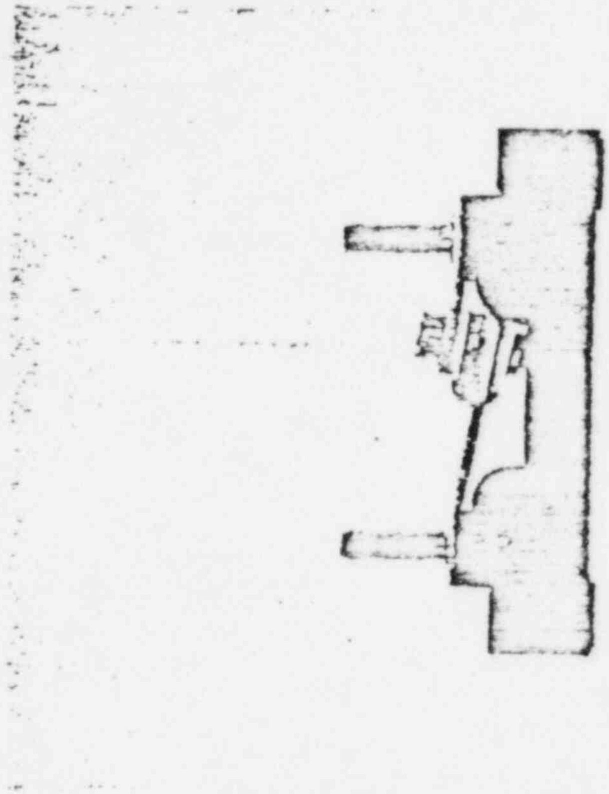
D. G. Beam, Project Manager
Post Office Box 223
Clover, South Carolina 29710

M. D. McIntosh, Plant Manager
Post Office Box 488
Cornelius, North Carolina 28031

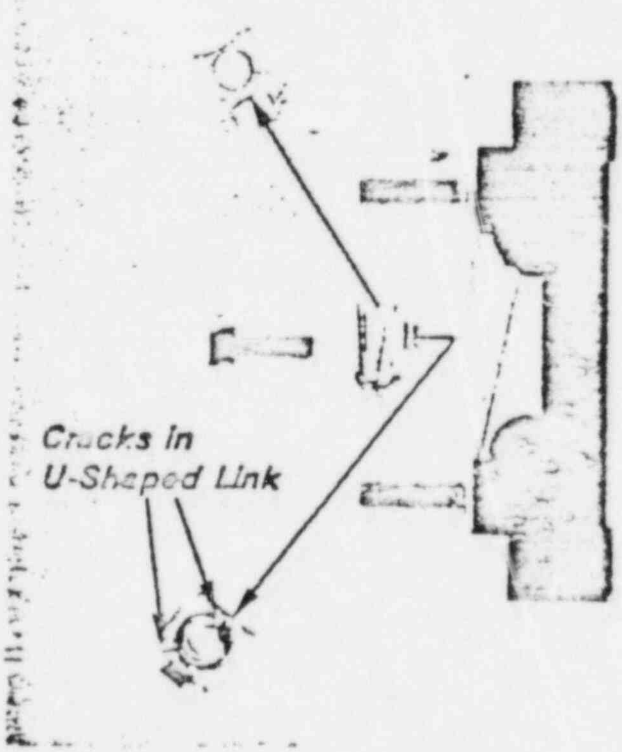
J. C. Rogers, Project Manager
Post Office Box 33189
Charlotte, North Carolina 28242

J. E. Smith, Station Manager
Post Office Box 1175
Seneca, South Carolina 29678

ENCLOSURE 1 TO IE INFORMATION NOTICE 80-08



Side View of States Company Terminal Block in Assembled Position



Exploded View of States Company Terminal Block

Enclosure

RECENTLY ISSUED
IE INFORMATION NOTICES

Information Notice No.	Subject	Date Issued	Issued To
80-08	The States Company Sliding Link Electrical Terminal Block	3/07/80	All holders of an OL or a CP
80-07	Pump Shaft Fatigue Cracking	2/29/80	All Light Water Reactor Facilities holder power reactor OLs and CPs
80-06	Notification of Significant Events	2/27/80	All holders of Reactor OLs and to near term OL applicants
80-05	Chloride Contamination of Safety Related Piping	2/8/80	All licensees of nuclear power reactor facilities and applicants and holders of nuclear power reactor CPs
80-04	BWR Fuel Exposure in Excess of Limits	2/4/80	All BWR's holding a power reactor OL or CP
80-03	Main Turbine Electro-Hydraulic Control System	1/31/80	All holders of power reactor OLs and CPs
80-02	8X8R Water Rod Lower End Plug Wear	1/25/80	All BWR Facilities holder power reactor OLs or CPs
80-01	Fuel Handling Events	1/4/80	All holders of power reactor OLs and CPs
79-37	Cracking in Low Pressure Turbine Discs	12/28/79	All power reactor OLs and CPs
79-36	Computer Code Defect in Stress Analysis of Piping Elbow	12/31/79	All power reactor OLs and CPs
79-35	Control of Maintenance and Essential Equipment	12/31/79	All power reactor facilities with an OL or CP
79-34	Inadequate Design of Safety-Related Heat Exchangers	12/27/79	All holders of power reactor OLs and CPs

DRAFT

FaAA-84-5-23

PA07702

TORSIOGRAPH TEST OF EMERGENCY DIESEL GENERATOR 1A AT CATAWBA NUCLEAR POWER STATION

Prepared by

Failure Analysis Associates

Prepared for

Duke Power Company

422 South Church Street

Charlotte, NC 28242

May 29, 1984

TABLE OF CONTENTS

1.0 INTRODUCTION

The purpose of the torsiograph test of the emergency diesel generator was to measure the angular displacements of the forward end of the crankshaft. These displacements were then used in conjunction with a dynamic torsional analysis of the crankshaft to assess the maximum stresses in the crankshaft.

2.0 INSTRUMENTATION

The instrumentation generally consisted of an HBM Torsiograph, Signal Conditioner, Data Tape Recorder, Frequency Analyzer, Oscilloscope, Multimeter, and assorted interconnecting cables. The specific instrumentation used is shown in Table 2.1.

3.0 PROCEDURE

The torsiograph, which was attached to the front end of the crankshaft through an adapter plate supplied by the Catawba plant, was used to measure angular displacements of the crankshaft relative to its mean rotational speed. The angular displacement signal from the signal conditioner was recorded on magnetic tape for further analysis to determine angular displacement components for each order. Tests were conducted at several speeds under no-load conditions, and at several loads at operating speed. The spectrum analyzer was used to verify data integrity by determining harmonic components for each test condition.

The test was carried out in the following four stages:

1. Calibration and instrumentation run-in.
2. Variable speed tests at 0% load.
3. Variable load tests at rated speed.
4. Post test calibration.

3.1 Calibration and Instrumentation Run-in

The torsiograph was mounted on the front end of the crankshaft using a rigid adapter plate. The torsiograph was connected to the signal conditioner and the signal conditioner to the instrumentation recorder with the designated cables. The signal conditioner was also connected to the spectrum analyzer and oscilloscope to monitor the torsiograph signals.

The following steps were completed to calibrate the instrumentation before and after testing:

1. The recording equipment and cabling was calibrated by introducing a known signal into the signal conditioner connection and recording the signal.

2. The calibration signal was verified by playing back the calibration recording.

3. A field calibration of the torsiograph was completed following the manufacturer's instructions [1]. The field calibration signal was recorded.

4. The field calibration signal was played back for verification.

After the calibration procedure was completed, the diesel engine was operated at no load for approximately ten minutes while data was recorded. The engine was then shut down while the recorded data was examined to verify the instrumentation and recording system operation.

The test documentation information in Table 3.1 was logged.

3.2 Variable Speed, 0% Load Tests

The engine was operated for five minutes at rated speed and no load. The speed was then adjusted using the mechanical governor to operate at speeds between 410 and 470 rpm. The engine was operated at each speed for five to ten minutes while the torsiograph output was recorded. The output speeds and tape footage were recorded (Table 3.2).

3.3 Variable Load, Operating Speed Tests

The engine was brought to operating speed. The load was adjusted successively to operate at the following load conditions for five to ten minutes: 50%, 75%, 100%, and 110%. The load, current, speed, and tape footage were recorded (Table 3.3).

3.4 Post Test Data Verification and Calibration

Selected data records were played back to verify proper measurement and recording. The calibration procedure outlined above was repeated and the signals recorded.

4.0 RESULTS

4.1 Calibration Data

The pre and post test static calibration data are shown in Tables 4.1 and 4.2. The torsiograph sensitivity was calculated as follows:

$$\text{Torsiograph Sensitivity, } \frac{mV/V}{\text{degree}} = \frac{\left(\begin{matrix}\text{Teac}\\ \text{Output, V}\end{matrix}\right)\left(\begin{matrix}\text{Amp. Range}\\ \text{Setting } \frac{mV/V}{10V}\end{matrix}\right)\left(\begin{matrix}\text{Teac Range}\\ \text{Setting V/V}\end{matrix}\right)}{\text{Input, degrees}}$$

Thus, from Table 4.1 for Channel 1,

$$\text{Torsiograph Sensitivity} = \frac{(1.180)\left(\frac{50}{10}\right)(5)}{6} = 4.917 \ \frac{mV/V}{\text{degree}} \pm .2\%$$

and for Channel 2,

$$\text{Torsiograph Sensitivity} = \frac{(1.179)\left(\frac{50}{10}\right)(5)}{6} = 4.913 \ \frac{mV/V}{\text{degree}} \pm .2\%$$

The sensitivities for the post test calibration were found to be 4.921 and

4.904 $\frac{mV/V}{degree}$ for channels 1 and 2, respectively.

The multiplication factors used in data reduction were calculated as follows:

$$\text{Vibration Amplitude (degrees-pk)} = \frac{\left(\text{Tape Deck* Output, Vpk}\right)\left(\text{Amp. Range Setting, } \frac{mV/V}{10Vpk}\right)\left(\text{Tape Deck Range Sensitivity, V/V}\right)}{\left(\text{Torsiograph Sensitivity, } \frac{mV/V}{degree}\right)}$$

where Amp. Range Setting = $\frac{10\ mV/V}{10\ Vpk}$

Tape Deck Range Setting = 2 V/V

Thus, for time domain response

$$\text{Input, degrees-pk} = (\text{Output, Vpk})\ \left(0.407\ \frac{\text{degrees-pk}}{\text{Vpk}}\right)$$

and for frequency domain response

$$\text{Input, degrees-pk} = (\text{Output, } V_{RMS})\ \left(0.575\ \frac{\text{degrees-pk}}{V_{RMS}}\right)$$

4.2 Variable Speed, No-Load Data

The variable speed test was performed to determine the frequency of the first mode of the crankshaft torsional system. The results of this test are shown in Table 4.3. The speeds shown in this table are those calculated from the frequency of the 4th order and differ slightly from those shown in Table 3.2. Figure 4.1 shows that the 4th order critical speed is reached at about 429 rpm. Thus, the first natural frequency is 28.6 Hz. This is in good agreement with the Holzer calculation of 28.8 Hz made by Delaval [2]. The damping was established to be approximately 1.3%.

* For output in V_{RMS} (as in spectral plots) multiply by $\sqrt{2}$.

The amplitude of nominal shear stress may be estimated from the amplitude of free-end vibration by assuming that the shaft is vibrating in its first mode. Under these conditions, the nominal shear stress in the number 8 crankpin journal and the number 9 main journal is 8452 psi per degree of free-end vibration [2]. Thus, the maximum amplitude of nominal shear stress during the variable speed test was 4649 psi.

4.3 Variable Load Data

The variable load test at rated speed was performed to determine the amplitude of vibration and estimate the nominal shear stress as a function of load. The results of this test are shown in Table 4.4. Figure 4.2 shows the amplitude of vibration increases with load to a maximum of 0.60 degrees. The figure also shows the response of the other major orders. While the 1 1/2, 2 1/2, and 3 1/2 order responses increase with increasing load, the 4th order response has an increase followed by a decrease, so that the response of this order is approximately the same at full load as it is at no load.

The amplitude of nominal shear stress may be estimated from the amplitude of free-end vibration by assuming that the shaft is vibrating in its first mode. Under these conditions, the nominal shear stress in the number 8 crankpin journal and the number 9 main journal is 8452 psi per degree of free-end vibration [2]. Thus, the amplitude of nominal shear stress at full load and overload are as follows:

	Full Load 7000 kW	Overload 7800 kW	DEMA [3] allowable
Single order (3 1/2)	2079 psi	2172 psi	5000 psi
Combined response	4987 psi	5071 psi	7000 psi

5.0 CONCLUSIONS

The following conclusions are made:

- the first natural frequency of the torsional system is approximately 28.6 Hz, and is in good agreement with Delaval Holzer calculations [2].
- the stresses are below DEMA's [3] allowables for both single order and combined response at full load and 110% load.

References

1. HBM Operating Manual for Rotary Vibration Transducer, 160.03-1.0-1.0e.

2. Yang, Roland, "Torsional and Lateral Critical Speed, Engine Numbers 75017/20 Delaval-Enterprise Engine Model DSRV-16-4, 7000 kW/9770 BHP at 450 RPM," Delaval Engine & Compressor Division, Oakland, California, October 22, 1975.

3. Standard Practices for Low and Medium Speed Stationary Diesel and Gas Engines, Diesel Engine Manufacturers Association, 6th ed., 1972.

DRAFT

Table 2.1: EQUIPMENT LIST

Equipment Manufacturer	Equipment Description	Model No.	Serial No.	FaAA ID No.
HBM	Rotary Vibration Transducer	BD 5	597	n/a
HBM	5KHz Carrier Frequency Amp.	KWS 73.D8	79372	n/a
Teac	Cassette Data Recorder	MR-30	116404	01459
B&K Precision	Sweep/Function Generator	3020	89-11576	01441
B&K Precision	Dual Trace 40MHz Oscilloscope	1540P	11400731	01440
Hewlett Packard	Dual Channel FFT Analyzer	3582A	L039823	-
HBM	cable (connect transducer to amplifier)	n/a	n/a	n/a
n/a	cable (connect amplifier to tape deck)	n/a	n/a	n/a
n/a	cable (connect tape deck monitor to Spectrum analyzer or oscilloscope)	n/a	n/a	n/a
Fluke	Digital Multimeter	8060A	8395136	n/a

DRAFT

Table 3.1: TORSIOGRAPH TEST DOCUMENTATION

Date: 4/3/84

Job Name: Duke Power

Job Number: PAO 7702

Location: Catawba Power Station
Duke Power Co.

Engine Description:
EDG 1A
Transamerica Delaval Inc.
DSRV-16-4
Serial No. 2752.75018

Generator Description:
Synchronous EP Generator, Portec, Inc.
7000 kW
Serial No. 17503519-200

Notes: Tape ID No. 001

Test Personnel:

Steve Riess	FaAA
Paul Johnston	FaAA
Rae McElwee	Duke Power
Dennis Ivey	QA-Duke Power

Table 3.2: TORSIOGRAPH VARIABLE SPEED TEST

Test Personnel: Steve Riess, FaAA
Paul Johnston, FaAA
Dennis Ivey, QA-Duke Power
Rae McElwee, Duke Power

Date: 4/3/84

Test Speed (RPM)*	Tape I.D.	Tape Footage
450 (test-system check)	Duke Power #001	132-159
450-451	#001	159-184
440	#001	184-209
435	#001	209-236
430	#001	236-259
425	#001	259-282
420	#001	282-304
407	#001	304-326
460	#001	326-348
470	#001	348-371

* All speeds determined by stroboscope synchronized with mark on EDG flywheel.

Table 3.3: TORSIOGRAPH VARIABLE LOAD TEST

Test Personnel: Steve Riess, FaAA
Paul Johnston, FaAA
Rae McElwee, Duke Power
Dennis Ivey, QA-Duke Power

Date: 4/3/84

Test Speed: 450 rpm

Load (Kw)	Current (Amp)	Tape I.D.	Tape Footage
3400 (50%)	490	Duke Power #001	371-395
5200 (75%)	760	#001	395-419
7000 (100%)	1010	#001	419-441
7800 (110%)	1110	#001	441-464

Table 4.1: PRE TEST STATIC CALIBRATION

Static Input (degrees)	Voltage Output (Vdc)(V/V) Ch. 1*	Ch. 2*	Teac Range Setting (mV/V) Ch. 1	Ch. 2	HBM Signal Cond. Setting U_B 10 Vp	(V)
+3	.585	.587	5	5	50	5
-3	-.596	-.592	5	5	50	5
+3	.584	.587	5	5	50	5
0	.004	.009	5	5	50	5

Table 4.2: POST TEST STATIC CALIBRATION

Static Input (degrees)	Voltage Output (Vdc) Ch. 1*	Ch. 2*	Teac Range Setting (V/V) Ch. 1	Ch. 2	HBM Signal Cond. Setting (mV/V) 10 Vp	U_B (V)
+3	.587	.589	5	5	50	5
-3	-.594	-.588	5	5	50	5
+3	.586	.589	5	5	50	5
0	-.007	-.003	5	5	50	5

* ± .002 Vdc

Table 4.3: VARIABLE SPEED RESPONSE OF EDG 1A

Order	Amplitude of free-end vibration (millidegrees) for given speed (rpm)								
	406	413	422	429	432	440	452	460	471
0.5	28	22	14	27	25	14	16	16	24
1.0	7	9	7	6	7	6	7	6	8
1.5	41	41	40	40	40	41	41	42	43
2.0	5	6	6	8	9	10	12	12	14
2.5	57	58	58	60	50	61	64	66	68
3.0	1	1	1	1	1	1	2	3	4
3.5	40	44	47	51	54	61	77	95	141
4.0	76	140	236	410	375	171	90	66	51
4.5	48	32	26	24	22	19	15	13	11
5.0	2	1	2	2	3	2	2	1	1
5.5	9	8	7	7	6	5	5	5	5
6.0	5	6	8	11	10	4	3	3	3
Total	210	260	400	550	470	310	250	270	280

Table 4.4: VARIABLE LOAD RESPONSE OF EDG 1A

	Amplitude of free-end vibration (millidegrees) for given load (kw)				
Order	0	3400	5200	7000	7800
0.5	16	49	67	49	55
1.0	7	7	6	6	4
1.5	41	102	140	178	195
2.0	12	8	5	4	3
2.5	64	134	183	231	246
3.0	2	3	3	3	4
3.5	77	146	201	246	257
4.0	90	141	143	89	95
4.5	15	29	43	55	56
5.0	2	2	2	2	3
5.5	5	9	13	15	16
6.0	3	7	10	11	12
Total	250	410	520	590	600

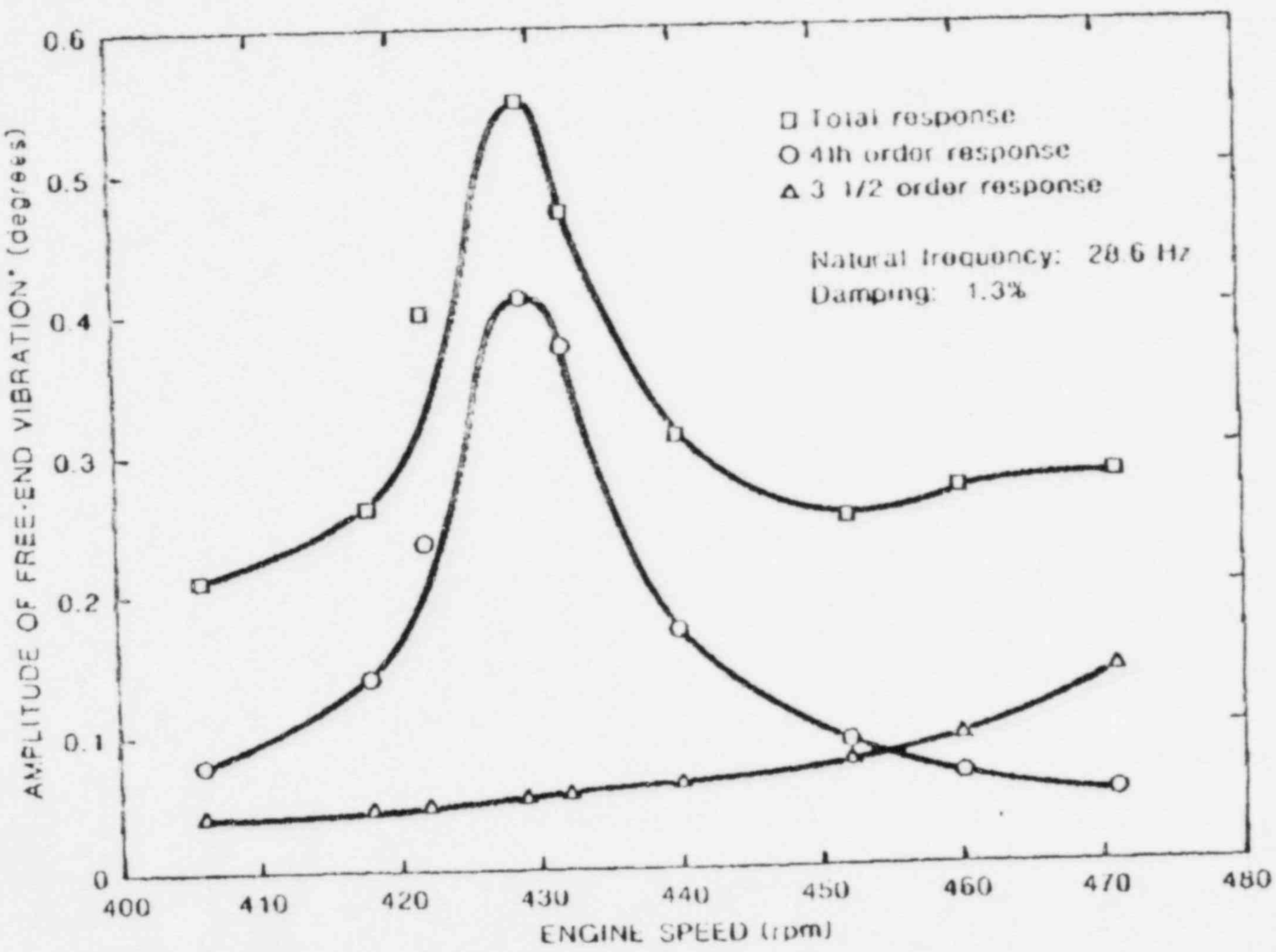


Figure 4-1. Variable speed response of EDG 1A.
*Amplitude of nominal shear stress is 8452 psi/degree of free-end vibration, assuming the shaft is vibrating in its first mode.

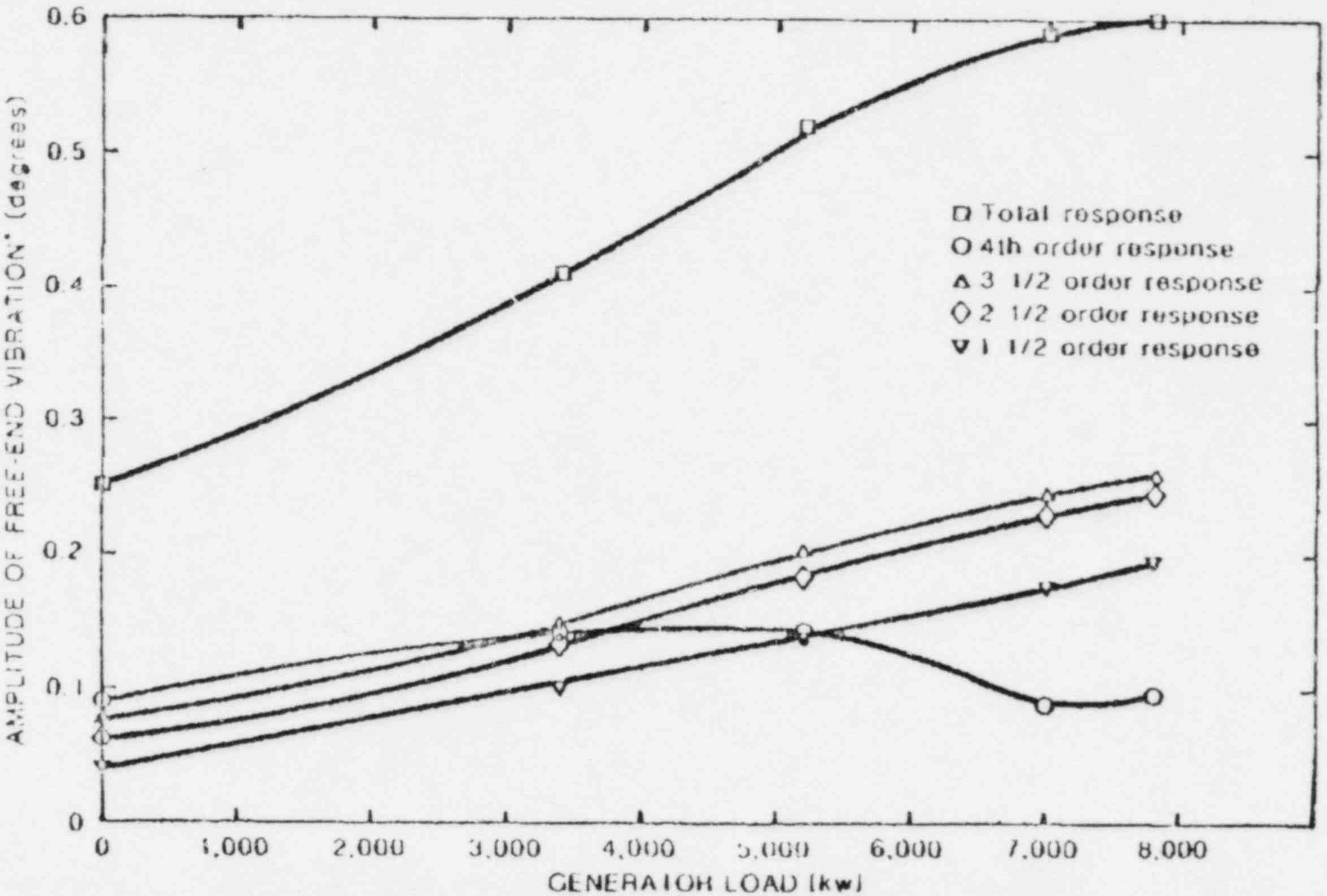


Figure 4-2. Variable load response of EDG 1A.
*Amplitude of nominal shear stress is 8452 psi/degree of free-end vibration, assuming the shaft is vibrating in its first mode.

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

July 2, 1984

TO ALL LICENSEES OF OPERATING REACTORS, APPLICANTS FOR AN OPERATING LICENSE, AND HOLDERS OF CONSTRUCTION PERMITS

Gentlemen:

SUBJECT: PROPOSED STAFF ACTIONS TO IMPROVE AND MAINTAIN DIESEL GENERATOR RELIABILITY (Generic Letter 84-15)

As part of the proposed technical evaluation of Unresolved Safety Issue (USI) A-44, Station Blackout, the staff is considering new requirements that would reduce the risk of core damage from station blackout events. The reliability of diesel generators has been identified as being one of the main factors affecting the risk from station blackout. Thus, attaining and maintaining high reliability of diesel generators is a necessary input to the resolution of USI A-44.

Plants licensed since 1978 have been required to meet the reliability goals of Regulatory Guide 1.108 for their diesel generators. However, the staff has determined that many operating plants do not have reliability goals in place for their diesel generators. Considering the critical role diesel generators play in mitigating various transients and postulated events following a loss of offsite power, the staff has determined that there is an important need to assure that the reliability of diesel generators at operating plants is maintained at an acceptable level. The staff has determined that the risk from station blackout is such that early actions to improve diesel generator reliability would have a significant safety benefit. Toward this objective, we have developed the following approach to assess and enhance, where necessary the reliability of diesel generators at all operating plants.

The items covered by this letter fall into the following three areas:

1. <u>Reduction in Number of Cold Fast Start Surveillance Tests for Diesel Generators</u>

   This item is directed towards reducing the number of cold fast start surveillance tests for diesel generators which the staff has determined results in premature diesel engine degradation. The details relating to this subject are provided in Enclosure 1. Licensees are requested to describe their current programs to avoid cold fast start surveillance testing or their intended actions to reduce cold fast start surveillance testing for diesel generators.

2. <u>Diesel Generator Reliability Data</u>

   This item requests licensees to furnish the current reliability of each diesel generator at their plant(s), based on surveillance test data. Licensees are requested to provide the information requested in Enclosure 2.

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3. Diesel Generator Reliability

Licensees are requested to describe their program, if any, for attaining and maintaining a reliability goal for their diesel generators. An example of a performance Technical Specification to support a desired diesel generator reliability goal has been provided by the staff in Enclosure 3. Licensees are requested to comment on, and compare their existing program or any proposed program with the example performance specification.

Accordingly, pursuant to 10 CFR 50.54(f), operating reactor licensees are requested to furnish, under oath or affirmation, no later than 90 days from the date of this letter, the information requested in Items 1 through 3 above. Applicants for operating licenses and holders of construction permits are not required to respond.

Licensees may request an extension of time for submittals of the required information. Such a request must set forth a proposed schedule and justification for the delay. Such a request shall be directed to the Director, Division of Licensing, NRR. Any such request must be submitted no later than 45 days from the date of this letter.

This request for information has been approved by the Office of Management and Budget under Clearance Number 3150-0011, which expires April 30, 1985.

Sincerely,

Darrell G. Eisenhut, Director
Division of Licensing

Enclosures:
1. Reduction in Number of Cold Fast Starts for Diesel Generators
2. Diesel Generator Reliability Data
3. Diesel Generator Reliability

ENCLOSURE 1

REDUCTION IN NUMBER OF COLD FAST START SURVEILLANCE TESTS FOR DIESEL GENERATORS

Fast Start Testing

The staff has for sometime had under review and assessment methods of diesel generator testing. The staff has determined that many licensees use a method of testing which does not take into consideration those manufacturer recommended preparatory actions such as prelubrication of all moving parts and warmup procedures which are necessary to reduce engine wear, extend life and improve availability. The existing Standard Technical Specifications require fast starts from ambient conditions for all surveillance testing which in many engine designs and operating practices subject the diesel engine to undue wear and stress on engine parts. Concerns were expressed by ACRS regarding the imposition of severe mechanical stress and wear on the diesel engine due to frequent cold fast starts. Nuclear Industry related groups (INPO and American Nuclear Insurer) have also expressed concern based on operating experience that cold fast start testing results in incremental degradation of diesel engines and that, if proper procedures covering warmup prelubrication, loading/unloading etc., were taken, an improvement in reliability and availability would be gained. Similar views have been identified by the nuclear power industry and the regulatory authority in Sweden. The authority in Sweden has taken corrective actions to reduce the frequency of fast starts.

It is the staff's technical judgement that an overall improvement in diesel engine reliability and availability can be gained by performing diesel generator starts for surveillance testing using engine prelube and other manufacturer recommended procedures to reduce engine stress and wear. The staff has also determined that the demonstration of a fast start test capability for emergency diesel generators from ambient conditions cannot be totally eliminated because the design basis for the plant, i.e., large LOCA coincident with loss of offsite power, requires such a capability.

In view of the above, the staff has concluded that the frequency of fast start tests from ambient conditions of diesel generators should be reduced. An example of an acceptable Technical Specification to accomplish this goal is provided in the attachment to this enclosure. Licensees are requested to describe their current programs to avoid cold fast starts or their intended action to reduce the number of cold fast start surveillance tests from ambient conditions for diesel generators. Licensees are encouraged to submit changes to their Technical Specification to accomplish a reduction in the number of such fast starts.

Other Testing

Also, the staff is concerned regarding a number of additional diesel generator tests that are currently being required by Technical Specifications for some of the earlier licensed operating plants. For example, when subsystems of the emergency core cooling system on some plants are declared inoperable, the diesel generators are required to be tested. The staff has concluded that excessive testing results in degradation of diesel engines. In order to make those few plants consistent with the majority of the plants, it is the staff's position that the requirements for testing diesel generators while emergency core cooling equipment is inoperable, be deleted from the Technical Specifications for such plants. The affected licensees are encouraged to propose Technical Specifications to make such changes.

TYPICAL TECHNICAL SPECIFICATION

SURVEILLANCE REQUIREMENTS

4.8.1.1.1 Each of the above required independent circuits between the offsite transmission network and the onsite Class 1E distribution system shall be:

a. Determined OPERABLE at least once per 7 days by verifying correct breaker alignment, indicated power availability, and

b. Demonstrated OPERABLE at least once per 18 months during shutdown by transferring (manually and automatically) unit power supply from the normal circuit to the alternate circuit.

4.8.1.1.2 Each diesel generator shall be demonstrated OPERABLE:

a. In accordance with the frequency specified in Table 4.8-1 on a STAGGERED TEST BASIS by:

1. Verifying the fuel level in the day and engine-mounted fuel tank,

2. Verifying the fuel level in the fuel storage tank,

3. Verifying the fuel transfer pump starts and transfers fuel from the storage system to the day and engine-mounted tank,

4. Verifying the diesel starts from ambient condition and accelerates to at least (900) rpm in less than or equal to 10 seconds.* The generator voltage and frequency shall be (4160) ± (420) volts and (60) ± (1.2) Hz within (10)* seconds after the start signal. The diesel generator shall be started for this test by using one of the following signals:

   a) Manual

   b) Simulated loss of offsite power by itself.

*The diesel generator start (10 sec) from ambient conditions shall be performed at least once per 184 days in these surveillance tests. All other engine starts for the purpose of this surveillance testing may be preceded by an engine prelube period and/or other warmup procedures recommended by the manufacturer so that mechanical stress and wear on the diesel engine is minimized.

NOTE: Bars in the margin show changes made to the Standard Technical Specifications.

SURVEILLANCE REQUIREMENTS (Continued)

c) Simulated loss of offsite power in conjunction with an ESF actuation test signal.

d) An ESF actuation test signal by itself.

5. Verifying the generator is synchronized, loaded to greater than or equal to (continuous rating) in less than or equal to ( ) seconds,* and operates with a load greater than or equal to (continuous rating) for at least 60 minutes,

6. Verifying the diesel generator is aligned to provide standby power to the associated emergency busses.

b. At least once per 31 days and after each operation of the diesel where the period of operation was greater than or equal to 1 hour by checking for and removing accumulated water from the day and engine-mounted fuel tanks.

c. At least once per 92 days and from new fuel oil prior to additional to the storage tanks by verifying that a sample obtained in accordance with ASTM-D270-1975 has a water and sediment content of less than or equal to .05 volume percent and a kinematic viscosity @ 40°C of greater than or equal to 1.9 but less than or equal to 4.1 when tested in accordance with ASTM-D975-77, and an impurity level of less than 2 mg. of insolubles per 100 ml. when tested in accordance with ASTM-D-2274-78.

d. At least once per 18 months, during shutdown by:

1. Subjecting the diesel to an inspection in accordance with procedures prepared in conjunction with its manufacturer's recommendations for this class of standby service.

2. Verifying the generator capability to reject a load of greater than or equal to (largest single emergency load) kw while maintaining voltage at (4160) ± (420) volts and frequency at (60) ± (1.2) Hz (less than or equal to 75% of the difference between nominal speed and the overspeed trip setpoint, or 15% above nominal whichever is less).

3. Verifying the generator capability to reject a load of (continuous rating) kw without tripping. The generator voltage shall not exceed (4784) volts during and following the load rejection.

*See footnote on previous page

ENCLOSURE 2

DIESEL GENERATOR RELIABILITY DATA

The reliability of diesel generators has been identified as one of the main factors affecting the risk of core damage from station blackout. Thus, attainment and continued maintenance of high reliability for diesel generators is necessary to the resolution of USI A-44. To assist the staff in assessing the current reliability of diesel generators at operating plants, licensees are requested to report the reliability of each diesel generator at their plant for its last 20 and 100 demands. This should include the number of failures in the last 20 and 100 valid demands indicating the time history for these failures. Licensees are requested to indicate whether they maintain a record which itemizes the demands and failures experienced by each diesel generator unit, in the manner outlined in Regulatory Guide 1.108 position C.3.a, for each diesel generator unit. Licensees should also indicate whether a yearly data report is maintained for each diesel generator's reliability. The criteria for determining the reliability of diesel generators is as follows:

a. Valid demands and failures are to be determined in accordance with the recommendations of Regulatory Guide 1.108 position c.2.e.

b. The reliability of each diesel generator will be calculated based on the number of failures in the last 100 valid demands.

ENCLOSURE 3

DIESEL GENERATOR RELIABILITY

In the staff's ongoing program to resolve USI A-44, Station Blackout, diesel generator reliability is one of the factors used to determine the length of time a plant should be able to cope with a station blackout. If all other factors are constant, the higher reliability of the diesel generator will result in the lower probability of a total loss of AC power. Maintaining diesel generators at or above specific reliability levels is assumed in the development of the resolution of USI A-44. The reliable operation of diesel generators should be assured by a reliability program designed to monitor, improve (if necessary), and maintain reliability at a specified level.

In view of the above, licensees are requested to describe their diesel generator reliability improvement program, if any, for attaining and maintaining a reliability goal. The program description should address the surveillance and testing the licensee performs to demonstrate the selected diesel generator reliability. All licensees have received the staff's previous letter transmitting the findings of NUREG/CR-0660, "Enhancement of Onsite Emergency Diesel Generator Reliability, February 1979" identifying areas where diesel generator operational problems were occurring in general. Licensees should consider the recommendations of NUREG/CR-0660 in their reliability program. The staff has developed an example for a diesel generator performance Technical Specification to support the maintenance of diesel generator reliability at a specified level. The proposed performance specification encompasses certain aspects of the existing requirements for surveillance testing of diesel generators stipulated in Regulatory Guide 1.108 and the qualitative recommendations of NUREG/CR-0660. This performance specification is presented, as an example, in the attachment to this enclosure. Licensees are requested to comment on and/or compare their program with the performance specification and provide comments for staff consideration in finalizing surveillance testing requirements for diesel generators.

ATTACHMENT TO ENCLOSURE 3

EXAMPLE OF DIESEL GENERATOR PERFORMANCE TECHNICAL SPECIFICATION

Background

Review of LER data gathered as part of the staff's study of USI A-44, Station Blackout, indicates the median value of diesel generator reliability at operating plants to be 0.98/demand with about 75% of diesel generators currently in service having a reliability of 0.95/demand or greater. The following is an elaboration of the example performance Technical Specification proposed to maintain reliability levels in this range:

Reliability Program

1. Reliability Goals

   The staff's proposed resolution of USI A-44 currently under development would provide guidance for plants to maintain diesel generator reliability at or above specified levels (0.95 being the minimum desired level). In order to assure that this level is achieved and maintained, a surveillance test program is necessary. Based on surveillance testing, should a diesel generator's reliability fall below a specified level, certain actions should be taken as presented in the next section.

2. Reliability Level Remedial Actions

   The reliability of each diesel generator is based on the number of failures in the last 100 valid demands, with appropriate remedial actions as follows. Note that "P" is defined as the probability of failure per demand per diesel.

PLANT GROUP	RELIABILITY	ACTION
A	$(1-P) \geq .95$	Continue surveillance testing at 31 day interval. Increase surveillance testing per Table 4.8.1 of Appendix A if the failures in the last 20 tests were ≥ 2.
B	$.95 > (1-P) \geq 0.90$	Increase surveillance testing per Table 4.8.1 of Appendix A and take action per Table 4.8.2 of Appendix A.
C	$(1-P) < .90$	Disqualify DG. Requalify DG in accordance with Table 4.8.2 Appendix A.

The diesel generator would remain inoperable from the time of the last failure through the period required for corrective action and until the first subsequent valid successful test is completed.

3. Surveillance Test Frequency

In order to meet the timeliness goal, a normal test frequency is established and a criterion for increasing the test frequency is necessary to determine whether a major degradation in reliability is indicated.

a. Normal plant surveillance - each diesel generator unit should be tested at a frequency which is in accordance with the manufacturer's recommendations, but in no case should the time between tests be greater than 31 days.

b. Accelerated plant surveillance - whenever a diesel generator unit has experienced two or more failures in the last twenty demands, the maximum time between tests should be reduced to seven days. This test frequency should be maintained until seven consecutive failure-free demands have been performed and the number of failures in the last 20 demands has been reduced to one or less. Two failures in 20 demands is a failure rate of 0.1, or the threshold of acceptable diesel generator performance, and hence may be an early indication of degradation of the reliability of a diesel generator. However, when considered in the light of a long history of tests, two failures in the last 20 demands may only be a statistically probable distribution of two random events. Increasing the test frequency will allow for a more timely accumulation of additional test data upon which to base judgment of the reliability of the unit.

4. Remedial Action Criteria

If the number of failures in the last twenty valid tests is three or more or in the last 100 valid tests is six or more, the licensee should within 14 days prepare and maintain a report describing the reliability improvement program at the facility which includes, but is not limited to; 1) the implementation of NUREG/CR-0660 recommendations, and 2) perform a reliabilty assessment of the offsite and onsite power system. (See Table 4.8.2 of Appendix A for details regarding action required).

5. Requalification Criteria

If the number of failures in the last twenty valid tests is five or more, or in the last 100 valid tests is 11 or more, the affected unit would be disqualified from nuclear service and subjected to a requalification program. A requalification program would be a series of 14 successful consecutive tests without a failure. The licensee would perform seven consecutive successful demands without a failure within 30 days of the diesel generator being restored to operable status and 14 consecutive demands without a failure within 75 days of the diesel generator being restored to operable status. Refer to Attachment 2 to Table 4.8-2 of Appendix A for criteria. Two attempts would be allowed to achieve the acceptable test series. During requalification testing, a diesel generator unit would not be tested more frequently than once in any 24-hour interval.

6. Failure to Requalify a Diesel Generator

If the diesel generator is not requalified as defined above, the unit would be declared inoperable and the action statement in the plant Technical Specification for one diesel generator inoperable should be followed immediately.

7. Diesel Generator Inoperability Limits

The staff has determined that the allowable out-of-service period for a diesel generator should be in excess of the current 72 hour Technical Specification limit, while at the same time placing a yearly limit upon the total cumulative time that a plant may operate with one of the diesel generators inoperable. By placing an individual limit on maximum inoperable time for a diesel generator and a cumulative limit of inoperability of the onsite power system, a framework is established within which flexibility is provided to allow a licensee to best optimize planned and unplanned service of diesel generators at a plant. This would limit plant risk from station blackout at the same time allowing flexibility for any given outage. Licensees may propose a total cumulative outage time for diesel generators in the Technical Specification along with the basis for the outage time chosen.

8. Valid Demands and Failures

Valid demands and failures used in the above paragraphs should be determined in accordance with the recommendations of Regulatory Guide 1.108, position C.2.e.

9. Reliability Records

A record should be maintained in accordance with the recommendations of Regulatory Guide 1.108 position C.3.a for each diesel generator unit at a site which itemizes the demands and failures experienced by the diesel generator unit. (See also Attachment 1 to Table 4.8.2 of Appendix A).

TYPICAL TECHNICAL SPECIFICATIONS

3/4.8 ELECTRICAL POWER SYSTEMS

3/4.8.1 A.C. SOURCES

OPERATING

LIMITING CONDITION FOR OPERATION

3.8.1.1 As a minimum, the following A.C. electrical power sources shall be OPERABLE:

a. Two physically independent circuits between the offsite transmission network and the onsite Class 1E distribution system, and

b. Two separate and independent diesel generators, each with:

1. Separate day and engine-mounted fuel tanks containing a minimum volume of____ gallons of fuel,

2. A separate fuel storage system containing a minimum volume of _____ gallons of fuel, and

3. A separate fuel transfer pump.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTION:

a. With an offsite circuit of the above required A.C. electrical power sources inoperable, demonstrate the OPERABILITY of the remaining A.C. offsite source by performing Surveillance Requirement 4.8.1.1.1.a within 1 hour and at least once per 8 hours thereafter; and Surveillance Requirement 4.8.1.1.2.a.4 within 24 hours; restore at least two offsite circuits and two diesel generators to OPERABLE status within 72 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

NOTE: The modified Standard Technical Specification is intended as an example of changes due to the reduction in number of fast starts and diesel generator reliability improvement program surveillance requirements. Bars in the margin show changes for those portions of technical specifications associated with these two items. It is necessary for licensees to incorporate these changes into existing plant technical specification upon implementation of these two items.

ACTION: (Continued)

b. With a diesel generator of the above required A.C. electrical power sources inoperable,* demonstrate the OPERABILITY of the A.C. offsite sources by performing Surveillance Requirement 4.8.1.1.1.a within 1 hour and at least once per 8 hours thereafter; and Surveillance Requirement 4.8.1.1.2.a.4 within 24 hours; restore diesel generators to OPERABLE status within (A**) days*** or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours. At the number of failures for the inoperable diesel indicated in Table 4.8-2 perform the Additional Reliability Actions prescribed in Table 4.8-2 and its attachments.

c. With one offsite circuit and one diesel generator of the above required A.C. electrical power sources inoperable, demonstrate the OPERABILITY of the remaining A.C. offsite source by performing Surveillance Requirement 4.8.1.1.1.a within 1 hour and at least once per 8 hours thereafter and Surveillance Requirement 4.8.1.1.2.a.4 within 8 hours; restore at least one of the inoperable sources to OPERABLE status within 12 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours. With the diesel generator restored to OPERABLE status, follow Action Statement a. With the offsite circuit restored to OPERABLE status, follow Action Statement b.

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*A diesel generator shall be considered to be inoperable from the time of failure until it satisfies the requirements of Surveillance Requirement 4.8.1.1.2.4 ELECTRIC POWER SYSTEMS

**The maximum time that an individual diesel generator may be inoperable (A) shall be established by the licensee based on the manufacturer's recommendations and previous maintenance and repair experience. Every reasonable effort shall be made to restore individual diesel generators to operable status within that time period (A). Every reasonable effort shall be interpreted to mean that diagnosis and repairs are to begin immediately and are to continue uninterrupted until the diesel generator is declared operable or an orderly retreat to cold shutdown is initiated.

***The maximum total cumulative time that the diesel generators of the onsite emergency AC power system may be in the INOPERABLE status in a given year shall be proposed by the licensee.

ACTION: (Continued)

d. With two of the above required offsite A.C. circuits inoperable, demonstrate the OPERABILITY of two diesel generators by performing Surveillance Requirement 4.8.1.1.2.a.4 within 8 hours unless the diesel generators are already operating; restore at least one of the inoperable offsite sources to OPERABLE status within 24 hours or be in at least HOT STANDBY within the next 6 hours. With only one offsite source restored, follow Action Statement a.

e. With two of the above required diesel generators inoperable, demonstrate the OPERABILITY of two offsite A.C. circuits by performing Surveillance Requirement 4.8.1.1.1.a within 1 hour and at least once per 8 hours thereafter; restore at least one of the inoperable diesel generators to OPERABLE status within 2 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours. With one diesel generator unit restored, follow Action Statement b and d.

SURVEILLANCE REQUIREMENTS

4.8.1.1.1 Each of the above required independent circuits between the offsite transmission network and the onsite Class 1E distribution system shall be:

a. Determined OPERABLE at least once per 7 days by verifying correct breaker alignments, indicated power availability, and

b. Demonstrated OPERABLE at least once per 18 months during shutdown by transferring (manually and automatically) unit power supply from the normal circuit to the alternate circuit.

4.8.1.1.2 Each diesel generator shall be demonstrated OPERABLE:

a. In accordance with the frequency specified in Table 4.8-1 on a STAGGERED TEST BASIS by:

1. Verifying the fuel level in the day and engine-mounted fuel tank,

2. Verifying the fuel level in the fuel storage tank,

3. Verifying the fuel transfer pump starts and transfers fuel from the storage system to the day and engine-mounted tank,

4. Verifying the diesel starts from ambient condition and accelerates to at least (900) rpm in less than or equal to 10 seconds.* The generator voltage and frequency shall be (4160) ± (420) volts and (60) ± (1.2) Hz within (10) seconds after the start signal. The diesel generator shall be started for this test by using one of the following signals:

a) Manual
b) Simulated loss of offsite power by itself.

*The diesel generator start (10 sec) from ambient conditions shall be performed at least once per 184 days in these surveillance tests. All other engine starts for the purpose of this surveillance testing may be preceded by an engine prelube period and/or other warmup procedures recommended by the manufacturer so that mechanical stress and wear on the diesel engine is minimized.

SURVEILLANCE REQUIREMENTS (Contined)

c) Simulated loss of offsite power in conjunction with an ESF actuation test signal.

d) An ESF actuation test signal by itself.

5. Verifying the generator is synchronized, loaded to greater than or equal to (continuous rating) in less than or equal to ( ) seconds,* and operates with a load greater than or equal to (continuous rating) for at least 60 minutes,

6. Verifying the diesel generator is aligned to provide standby power to the associated emergency busses.

b. At least once per 31 days and after each operation of the diesel where the period of operation was greater than or equal to 1 hour by checking for and removing accumulated water from the day and engine-mounted fuel tanks.

c. At least once per 92 days and from new fuel oil prior to addition to the storage tanks by verifying that a sample obtained in accordance with ASTM-D270-1975 has a water and sediment content of less than or equal to .05 volume percent and a kinematic viscosity @ 40°C of greater than or equal to 1.9 but less than or equal to 4.1 when tested in accordance with ASTM-D975-77, and an impurity level of less than 2 mg. of insolubles per 100 ml. when tested in accordance with ASTM-D2274-70.

d. At least once per 18 months, during shutdown, by:

1. Subjecting the diesel to an inspection in accordance with procedures prepared in conjunction with its manufacturer's recommendations for this class of standby service.

2. Verifying the generator capability to reject a load of greater than or equal to (largest single emergency load) kw while maintaining voltage at (4160) ± (420) volts and frequency at (60) ± (1.2) Hz (less than or equal to 75% of the difference between nominal speed and the overspeed trip setpoint, or 15% above nominal whichever is less).

3. Verifying the generator capability to reject a load of (continuous rating) kw without tripping. The generator voltage shall not exceed (4784) volts during and following the load rejection.

*See footnote on page 4

SURVEILLANCE REQUIREMENTS (Continued)

4. Simulating a loss of offsite power by itself, and

   a) Verifying de-energization of the emergency busses and load shedding from the emergency busses.

   b) Verifying the diesel starts on the auto-start signal, energizes the emergency busses with permanently connected loads within (10) seconds, energizes the auto-connected shutdown loads through the load sequencer and operates for greater than or equal to 5 minutes while its generator is loaded with the shutdown loads. After energization, the steady state voltage and frequency of the emergency busses shall be maintained at (4160) ± (420) volts and (60) ± (1.2) Hz during this test.

5. Verifying that on an ESF actuation test signal, without loss of offsite power, the diesel generator starts on the auto-start signal and operates on standby for greater than or equal to 5 minutes. The generator voltage and frequency shall be (4160) ± (420) volts and (60) ± (1.2) Hz within (10) seconds after the auto-start signal; the steady state generator voltage and frequency shall be maintained within these limits during this test.

6. Simulating a loss of offsite power in conjunction with an ESF actuation test signal, and

   a) Verifying de-energization of the emergency busses and load shedding from the emergency busses.

   b) Verifying the diesel starts on the auto-start signal, energizes the emergency busses with permanently connected loads within (10) seconds, energizes the

SURVEILLANCE REQUIREMENTS (Continued)

auto-connected emergency (accident) loads through the load sequencer and operates for greater than or equal to 5 minutes while its generator is loaded with the emergency loads. After energization, the steady state voltage and frequency of the emergency busses shall be maintained at (4160) ± (420) volts and (60) ± (1.2) Hz during this test.

c) Verifying that all automatic diesel generator trips, except engine overspeed and generator differential, are automatically bypassed upon loss of voltage on the emergency bus concurrent with a safety injection actuation signal.

7. Verifying the diesel generator operates for at least 24 hours. During the first 2 hours of this test, the diesel generator shall be loaded to greater than or equal to (2-hour rating) kw and during the remaining 22 hours of this test, the diesel generator shall be loaded to greater than or equal to (continuous rating) kw. The generator voltage and frequency shall be (4160) ± (420) and (60) ± (1.2) Hz within (10) seconds after the start signal; the steady state generator voltage and frequency shall be maintained within these limits during this test. Within 5 minutes after completing this 24-hour test, perform Surveillance Requirement 4.8.1.1.2.d.7.b.

8. Verifying that the auto-connected loads to each diesel generator do not exceed the 2000-hour rating of ___ kw.

9. Verifying the diesel generator's capability to:

   a) Synchronize with the offsite power source while the generator is loaded with its emergency loads upon a simulated restoration of offsite power,

   b) Transfer its loads to the offsite power source, and

   c) Be restored to its standby status.

10. Verifying that with the diesel generator operating in a test mode, connected to its bus, a simulated safety injection signal overrides the test mode by (1) returning the diesel generator to standby operation and (2) automatically energizing the emergency loads with offsite power.

ELECTRIC POWER SYSTEMS

Table 4.8.1

DIESEL GENERATOR TEST SCHEDULE

Number of Failure in Last 20 Valid Tests*	Test Frequency
≤ 1	At least once per 31 days
≥ 2	At least once per 7 days**

*Criteria for determining number of failures and number of valid tests shall be in accordance with Regulatory Position C.2.e of Regulatory Guide 1.108, Revison 1, August 1977, where the number of tests and failures is determined on a per diesel generator basis. For the purposes of this test schedule, only valid tests conducted after the OL issuance date shall be included in the computation of the "last 20 valid tests."

**This test frequency shall be maintained until seven consecutive failure free demands have been performed and the number of failures in the last 20 valid demands has been reduced to one or less.

TABLE 4.8-2

ADDITIONAL RELIABILITY ACTIONS

No. of failures in last 20 valid test	No of failures in last 100 valid tests	Action
3	6	Within 14 days prepare and maintain a report for NRC audit describing the diesel generator reliability improvement program implemented at the site. Minimum requirements for the report are indicated in Attachment 1 to this table.
5	11	Declare the diesel generator inoperable. Perform a requalification test program for the affected diesel generator. Requalification test program requirements are indicated in Attachment 2 to this table.

ATTACHMENT 1 TO TABLE 4.8-2

REPORTING REQUIREMENT

As a minimum the Reliability Improvement Program report for NRC audit shall include:

a) a summary of all tests (valid and invalid) that occurred within the time period over which the last 20/100 valid tests were performed

b) analysis of failures and determination of root causes of failures

c) evaluation of each of the recommendations of NUREG/CR-0660, "Enhancement of Onsite Emergency Diesel Generator Reliability in Operating Reactors," with respect to their application to the Plant

d) identification of all actions taken or to be taken to 1) correct the root causes of failures defined in b) above and 2) achieve a general improvement of diesel generator reliability

e) the schedule for implementation of each action from d) above

f) an assessment of the existing reliability of electric power to engineered-safety-feature equipment

Once a licensee has prepared and maintain an initial report detailing the diesel generator reliability improvement program at his site, as defined above, the licensee need prepare only a supplemental report within 14 days after each failure during a valid demand for so long as the affected diesel generator unit continues to violate the criteria (3/20 or 6/100) for the reliability improvement program remedial action. The supplemental report need only update the failure/demand history for the affected diesel generator unit since the last report for that diesel generator. The supplemental report shall also present an analysis of the failure(s) with a root cause determination, if possible, and shall delineate any further procedural, hardware or operational changes to be incorporated into the site diesel generator improvement program and the schedule for implementation of those changes.

In addition to the above, submit a yearly data report on the diesel generator reliability.

ATTACHMENT 2 TO TABLE 4.8-2
DIESEL GENERATOR REQUALIFICATION PROGRAM

(1) Perform seven consecutive successful demands without a failure within 30 days of diesel generator being restored to operable status and fourteen consecutive successful demands without a failure within 75 days of diesel generator of being restored to operable status.

(2) If a failure occurs during the first seven tests in the requalification test program, perform seven successful demands without an additional failure within 30 days of diesel generator of being restored to operable status and fourteen consecutive successful demands without a failure within 75 days of being restored to operable status.

(3) If a failure occurs during the second seven tests (tests 8 through 14) of (1) above, perform fourteen consecutive successful demands without an additional failure within 75 days of the failure which occurred during the requalification testing.

(4) Following the second failure during the requalification test program, be in at least HOT STANDBY within the next 6 hours and COLD SHUTDOWN within the following 30 hours.

(5) During requalification testing the diesel generator should not be tested more frequently than at 24-hour intervals.

After a diesel generator has been successfully requalified, subsequent repeated requalification tests will not be required for that diesel generator under the following conditions:

(a) The number of failures in the last 20 valid demands is less than 5.

(b) The number of failures in the last 100 valid demands is less than 11.

(c) In the event that following successful requalification of a diesel generator, the number of failures is still in excess of the remedial action criteria (a and/or b above) the following exception will be allowed until the diesel generator is no longer in violation of the remedial action criteria (a and/or b above).

Requalification testing will not be required provided that after each valid demand the number of failures in the last 20 and/or 100 valid demands has not increased. Once the diesel generator is no longer in violation of the remedial action criteria above the provisions of those criteria alone will prevail.

DUKE POWER COMPANY
NUCLEAR PRODUCTION DEPARTMENT
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JUL 17 1984

Mr. C.L. Ray, Jr.
Technical Program Director
TDI Diesel Generator Owner's Group
1225 Harding Place
Charlotte, N.C. 28204

Re: Catawba Nuclear Statio
Diesel Generator Operating History

In response to the Owners Group request of March 20, 1984, attached herewith is the documented operating history of the Unit 1 Diesels at Catawba. Attachment 1 contains a summary of the operating history of the Unit 1 Diesels, and a discussion of the failures to start and steps taken to prevent recurrence. Attachment 2 is the complete listing of all documented start attempts on the 1A and 1B diesels.

you have any questions, please contact me at extension 2345.

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ATTACHMENT 1

1.0 Purpose

This document summarizes the attempts to start the Catawba Nuclear Station Unit 1 diesel generators from its documented operating history. This document also provides a discussion of each failure to start and steps taken or being taken to prevent recurrence.

2.0 Summary

The Catawba Unit 1 diesels have been through a combines total of 361 documented attempts to start, of which there have been 7 valid failures to start (2%). (See Section 3.0 for definitions.) A summary of the starts for the 1A and 1B diesel engines are shown graphically in figures 1 and 2. The valid failures to start are addressed in section 4.0. It should be noted that there are no invalid failures to start for both the 1A and 1B diesels.

3.0 Definitions

To assure consistency with U.S. Regulatory Guide 1.108 (Reference 1) and station operating procedures, the terms in this document are defined as follows:

3.1 Valid Successful Start - Applies when <u>both</u> of the following conditions are met:

A) The diesel engine starts and accelerates to ≥ 427 RPM (≥ 95% speed) within 11 seconds.

B) The D/G is successfully loaded to ≥ 3500KW (50% continuous rating) and operates at this load for > one hour.

3.2 Valid Failure To Start - Applies to all start attempts (automatic or manual) that result in a failure to start except for those conditions given in 3.3.A. below and C.2.e(2) of Reg. Guide 1.108.

3.3 Invalid Successful Miscellaneous Starts - Apply when <u>any</u> of the following conditions are met:

A) Any unsuccessful start or loading attempt that can definitely by attributed to:

1. Operating error
2. Spurious operation of a trip that is bypassed in the emergency operating mode.
3. Malfunction of equipment that is not operative in the emergency operating mode or is not part of the defined diesel generator unit design.

B) A successful start that is terminated intentionally without loading.

C) Tests that are terminated intentionally before completion (as defined in 3.1.)

D) Tests performed during trouble-shooting.

3.4 Invalid Failure To Start - A start attempt that results in a failure to start or load during the process of trouble-shooting a separate unrelated problem, except as noted in 3.3.A, 3.3.B, and 3.3.C above and C.2.e(2), C.2.e(4) of Reg. Guide 1.108.

4.0 <u>Valid Failures To Start</u>

Diesel Generator 1A

- Start No: 66
  Reason For Start: Continuation of Extended Run Test .
  Trip Indication: Low Low Lube Oil Pressure
  Causative Factors: Prior to this start (at the end of Start/Run Number 64) the engine had been manually shut down to replace turbochargers, pushrods, a cracked cylinder head, and a damaged rocker box assembly (See Note 8, Attachment 2). At this time the lube oil filters were swapped. This operation had been performed incorrectly. However, since the start following this shutdown was terminated after 5 minutes to readjust the valve lash associated with the push rod replacement (See Note 9, Attachment 2), the problem did not appear until Start No. 66.

  Corrective Action: Stricter adherence to procedures and closer scrutiny will be placed on the operations involving swapping the lube oil filters to prevent recurrence of this problem.

- Start No: 94
  Reason For Start: Blackout Test
  Trip Indication: None Received
  Causative Factors: The Timer/Not 9 Module of the shutdown logic board, a device which allows the switchover from the Group II alarm lockout circuit to the Group II alarm active circuit, had drifted out of calibration. This pneumatic timer had not been calibrated since the beginning of the extended run test, e.g. 68 hours. Recalibration of this item corrected this problem.

Corrective Action: Per Reference 2, the **pneumatic engine** shutdown system is loop tested and calibrated during each refueling outage. With engine operation anticipated at less than 50 hours per year, this calibration frequency should provide adequate surveillance to prevent recurrence of this problem.

Diesel Generator 1B

- Start No: 58
  Reason For Start: One Hour Test Run @ 3500KW
  Trip Indication: Breaker Open on Diesel Generator
  Causative Factors: Reverse power relaying, due to deteriorating voltage regulator and SCR. These defective devices were not isolated and replaced until three months (and 171 starts) later.

  Corrective Action: The generator control system is tested and aligned each refueling (Reference 2). With engine operation anticipated at less than 50 hours per year, this frequency should provide adequate surveillance to prevent recurrence of this problem.

- Start No: 70
  Reason For Start: Trouble-Shooting*
  Trip Indication: Failure To Reach 427 RPM in 11 Seconds
  Causative Factors: As part of the search for the voltage regulator problem described in Start No. 58, adjustments were made to the speed regulating governor. The failure of the engine to come up to speed was due to misadjustment of the governor. Re-adjustment corrected the problem.

  Corrective Action: In addition to the corrective action taken on the voltage regulator in Start No. 58, the settings on the speed regulating are verified each refueling (Reference 2). With engine operation anticipated at less than 50 hours per year and engine speed monitored during engine operation, this should provide adequate surveillance for preventing recurrence of this problem.

* See footnote, next page.

- Start No.: 82
  Reason For Start: Engineered Safety Features (ESF) Test
  Trip Indication: Failure to Reach 427 RPM in 11 Seconds
  Causative Factors: The primary cause of failure to start was a low oil level in the speed regulating governor's actuator. Secondary causes were leaking seals in the actuator and failure to inspect the sight glass on the governor prior to the test. (The engine had just been shut down from a 48 hour run to perform the ESF Test, and was assumed to be in a state of readiness). The actuator was filled with oil and the problem cleared. The leaking seals were undetected at this time.

  Corrective Action: During the 1B disassembly and inspection the actuator seals will be replaced as required to correct the leakage (reference 3). Additionally, the oil level in the governor will be checked during operation and monthly during ESF readiness checks to prevent recurrence of this problem.

- Start No: 202
  Reason For Start: Trouble-Shooting*
  Trip Indication: Overspeed
  Causative Factors: Primary cause was again low oil in the speed regulating governor's hydraulic actuator. Leaking seals were not replaced, but the actuator was refilled with oil and the problem cleared. While this was a trouble-shooting start, associated with the voltage regulator problem described in Start No. 58, no ESF check was made.

  Corrective Action: Because of the duplicate nature, the corrective action described in Start No. 70 will be taken to prevent recurrence of this problem.

* While this falls under the criteria of "Invalid Failure To Start", Duke Power Co. believes that should this condition have existed in an operational mode rather than trouble-shooting, it would have produced a "Valid Failure To Start". Therefore, it is being treated as such.

Start No: 212

Reason For Start: Trouble-Shooting*

Trip Indication: Failure to Reach 427 RPM in 11 Seconds

Causative Factors: In an effort to rectify the oscillations associated with the voltage regulator problem, adjustments were made to the speed regulating governor and the fuel rack linkage. Improper adjustment of the rack linkage caused it to bind in the no fuel position. Readjustment corrected the problem.

Corrective Action: The fuel rack linkage is checked during operation for freedom of movement (Reference 2) and lubricated semi-annually. This lubrication and surveillance schedule should prevent recurrence of this problem.

* See footnote, previous page.

REFERENCES

1. U.S. Regulatory Guide 1.108, "Periodic Testing of Diesel Generator Units Used As Onsite Electric Power Systems At Nuclear Power Plants", Revision 1, Dated August 1977.

2. Duke Power Company letter to Harold R. Denton, U.S. Nuclear Regulatory Commission, from Hal B. Tucker, dated July 16, 1984, "Periodic Maintenance, Inspection, and Maintenance of Catawba 1A and 1B Diesel Engines."

3. Duke Power Company letter to NRC, dated July 6, 1984, "Catawba 1B Inspection and Return To Service Testing".

Diesel Generator 1A

Total Start Attempts 120

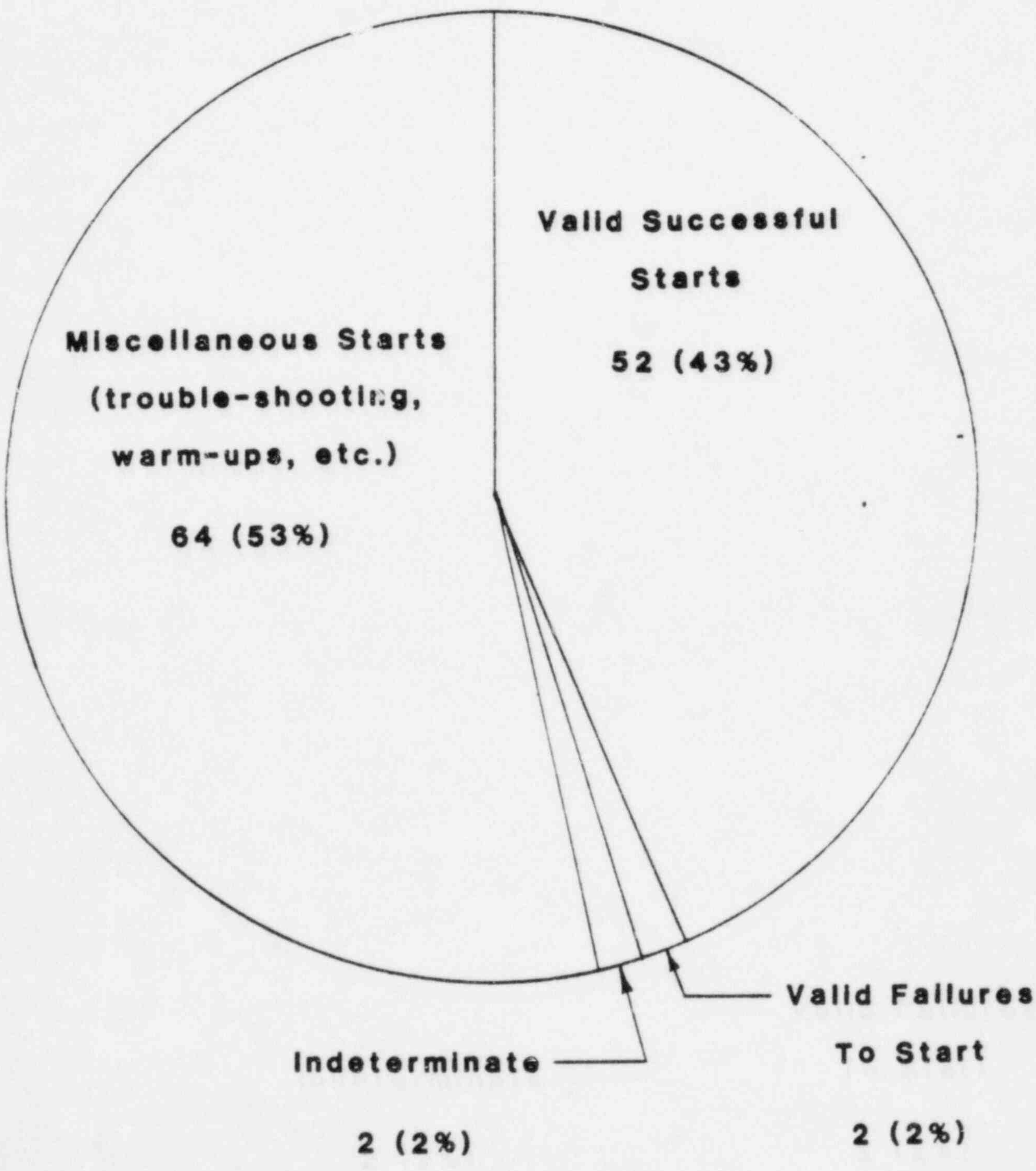

Fig. 1.

Diesel Generator 1B

Total Start Attempts 241

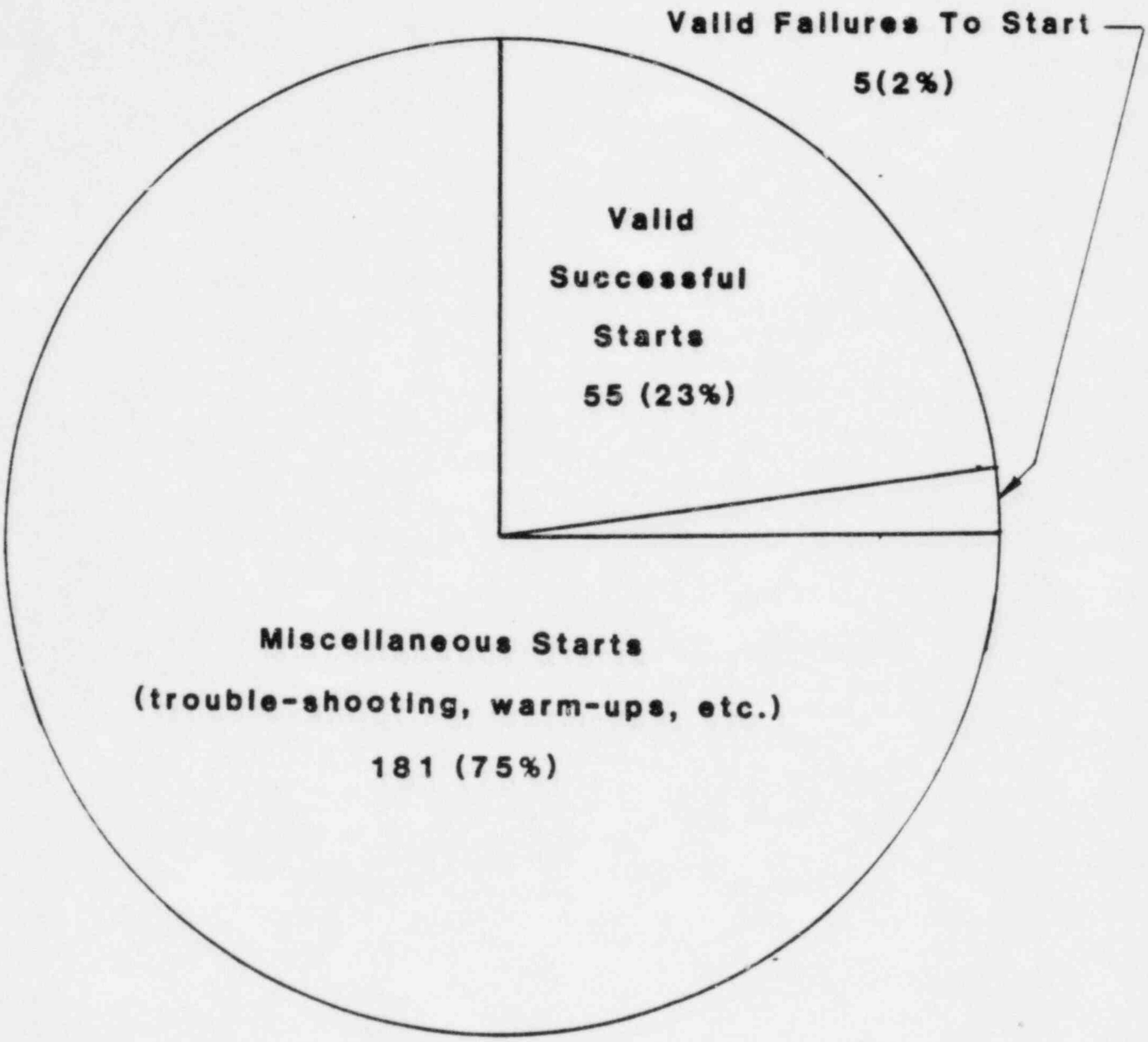

Fig. 2.

ATTACHMENT 2

Documented Diesel Operating History

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. ___ (Diesel Generator 1A)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
1	9/24/83	Dana E. Smith	1 hr. @ 7000 KW	X		1 hour	65 min @ 7000 KW	X		No		
2	9/24/83	Dana E. Smith	Engine Start No Load	X		5 min.	5 min.	X		No	Testing Trips	
3	9/24/83	Dana E. Smith	Engine Start No Load	X		5 min.	5 min.	X		No	Testing Trips	
4	9/24/83	Dana E. Smith	Engine Start No Load	X		5 min.	5 min.	X		No	Testing Trips	
5	9/24/83	Dana E. Smith	Engine Start No Load	X		5 min.	5 min.	X		No	Testing Trips	
6	9/24/83	Dana E. Smith	Engine Start No Load	X		5 min.	5 min.	X		No	Testing Trips	
7	9/24/83	Dana E. Smith	Engine Start No Load	X		5 min.	5 min.	X		No	Testing Trips	
8	9/24/83	Dana E. Smith	Engine Start No Load	X		5 min.	5 min.	X		No	Testing Trips	
9	9/24/83	Dana E. Smith	Engine Start No Load	X		5 min.	5 min.	X		No	Testing Trips	
10	9/24/83	Dana E. Smith	Engine Start No Load	X		5 min.	5 min.	X		No	Testing Trips	
11	9/24/83	Dana E. Smith	Engine Start No Load	X		5 min.	5 min.	X		No	Testing Trips	
12	9/24/83	Dana E. Smith	Engine Start No Load	X		5 min.	5 min.	X		No	Testing Trips	
13	9/24/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	80 min @ 4000 KW	X		No		
14	9/24/83	Dana E. Smith	1 hour @ 4500 KW	X		1 hour	70 min @ 4500 KW	X		No		

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. ,18 (Diesel Generator 1A)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
15	9/25/83	Dana E. Smith	Engine Start No Load	X		5 min.	5 min.	X		No	Testing Trips	
16	9/25/83	Dana E. Smith	Engine Start No Load	X		5 min.	5 min.	X		No	Testing Trips	
17	9/25/83	Dana E. Smith	Engine Start No Load	X		5 min.	5 min.	X		No	Testing Trips	
18	9/25/83	Dana E. Smith	Engine Start No Load	X		5 min	5 min.	X		No	Testing Trips	
19	9/25/83	Dana E. Smith	Engine Start No Load	X		5 min.	5 min.	X		No	Testing Trips	
20	9/25/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	90 min @ 4000 KW	X		No		
21	9/25/83	Dana E. Smith	Engine Start No Load	X		5 min.	5 min.	X		No	Testing Controls	
22	9/25/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	65 min @ 4000 KW	X		No		
23	9/26/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	70 min @ 4000 KW	X		No		
24	9/26/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	75 min @ 4000 KW	X		No		
25	9/26/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	65 min @ 4000 KW	X		No		
26	9/26/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
27	9/27/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	65 min @ 4000 KW	X		No		
28	9/28/83	Dana E. Smith	1 hour @ 7000 KW	X		1 hour	65 min @ 7000 KW	X		No		
29	9/28/83	Dana E. Smith	1 hour @ 7000 KW	X		1 hour	65 min @ 7000 KW	X		No		
30	9/28/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	70 min @ 4000 KW	X		No		

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. 18 (Diesel Generator 1A)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
31	9/29/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
32	9/29/83	Dana E. Smith	1 hour @ 7000 KW	X		1 hour	65 min @ 7000 KW	X		No		
33	9/29/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	65 min @ 4000 KW	X		No		
34	9/29/83	Dana E. Smith	1 hour @ 7000 KW	X		1 hour	90 min @ 7000 KW	X		No		
35	9/30/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
36	9/30/83	Dana E. Smith	1 hour @ 7700 KW	X		1 hour	65 min @ 7700 KW	X		No		
37	9/30/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	65 min @ 4000 KW	X		No		
38	9/30/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
39	10/1/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
40	10/1/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
41	10/1/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
42	10/1/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
43	10/1/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
44	10/1/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
45	10/1/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
46	10/2/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
47	10/2/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. 3 (Diesel Generator 1A)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
48	10/2/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
49	10/2/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
50	10/3/83	Dana E. Smith	1 hour @ 5000 KW	X		1 hour	1 hour @ 5000 KW	X		No		
51	10/3/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	70 min. @ 4000 KW	X		No		
52	10/3/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
53	11/6/83	Dana E. Smith	Simultaneous Start, No Load	X		5 min.	5 min.	X		No		
54	11/6/83	Dana E. Smith	Simultaneous Start, No Load	X		5 min.	5 min.	X		No		
55	1/23/84	Dana E. Smith	Prep. for Extended Run		X	1 hour	2 min.		X	No	See Remarks #1 Details	
56	1/23/84	Dana E. Smith	Prep. for Extended Run		X	1 hour	2 min.		X	No	See Remarks #2 Details	
57	1/28/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 min.	X		No		
58	1/25/84	Dana E. Smith	Prep. for Extended Run		X	1 hour	2 min.		X	No	See Remarks #3 Details	
59	1/25/84	Dana E. Smith	Prep. for Extended Run		X	1 hour	2 min.		X	No	See Remarks #3 Details	
60	1/25/84	Dana E. Smith	Prep. for Extended Run	X		1 hour	2 min.		X	No	See Remarks #4 Details	
61	1/25/84	Dana E. Smith	Extended Run	X			43 hrs @ 7000 KW		X	No	See Remarks #5 Details	
62	1/27/84	Dana E. Smith	Extended Run	X			49 hrs @ 7000 KW		X	No	See Remarks #6 Details	

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. 8 (Diesel Generator 1A)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
63	1/29/84	Dana E. Smith	Extended Run		X		2 min.		X	No	See Remarks #7 Details	
64	1/29/84	Dana E. Smith	Extended Run	X			138 hrs. @ 7000 KW		X	No	See Remarks #8 Details	
65	2/15/84	Dana E. Smith	Extended Run	X			5 min.	X		No	See Remarks #9 Details	
66	2/15/84	Dana E. Smith	Extended Run		X		2 min.		X	No	See Remarks #10 Details	
67	2/15/84	Dana E. Smith	Extended Run	X			77 hrs. @ 7000 KW	X		No	See Remarks #11 Details	
68	2/20/84	Dana E. Smith	Extended Run	X			20.5 hrs. @ 7000 KW	X		No	See Remarks #12 Details	
69	2/22/84	Dana E. Smith	Extended Run	X			1 hr. @ 7000 KW		X	No	See Remarks #13 Details	
70	2/23/84	Dana E. Smith	Extended Run	X			53 hrs. @ 7000	X		No	See Remarks #14 Details	
71	2/26/84	Dana E. Smith	Extended Run	X			58.5 hrs. @ 7000 KW		X	No	See Remarks #15 Details	
72	3/1/84	Dana E. Smith	Extended Run	X			168.5 @ 7000 KW	X		No		
73	3/9/84	Dana E. Smith	Extended Run	X			15.5 hrs. @ 7000 KW	X		No	End of Extended Run	
74	3/14/84	Dana E. Smith	Prep. for ESF Test		X	1 hour	1 min.		X	No	See Remarks #16 Details	
75	3/14/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 min.	X		No		
76	3/16/84	Dana E. Smith	ESF Testing	X		1 hour	2 min.		X	No	See Remarks #17 Details	
77	3/16/84	Dana E. Smith	ESF Testing	X		1 hour	2 min.		X	No	See Remarks #17 Details	
78	3/16/84	Dana E. Smith	ESF Testing	X		1 hour*	6 hrs. @ 6500 KW	X		No		

LOCATION CATAWBA   PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. J18 (Diesel Generator 1A)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
79	3/17/84	Dana E. Smith	24 hr. run (2 hrs. @ 7700 KW & 22 hrs. @ 7000 KW)	X		1 hour	2 hrs. @ 7700 KW & 29.5 hrs. @ 7000 KW	X		No		
80	3/19/84	Dana E. Smith	ESF Testing	X		1 hour	2 hrs. @ 7000 KW	X		No		
81	3/19/84	Dana E. Smith	ESF Testing	X		1 hour	1 hr. @ 7000 KW	X		No		
82	3/20/84	Dana E. Smith	Calibration		X	1 hour	2 min.		X	No	See Remarks #18 Details	
83	3/20/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #18 Details	
84	3/20/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #18 Details	
85	3/20/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #18 Details	
86	3/20/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #18 Details	
87	3/20/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #18 Details	
88	3/20/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #18 Details	
89	3/21/84	Dana E. Smith	ESF Testing	X		1 hour	1 hr. @ 7700 KW	X		No		
90	3/21/84	Dana E. Smith	ESF Testing	X		1 hour	1 hr. @ 7000 KW	X		No		
91	3/22/84	Dana E. Smith	ESF Testing	X		1 hour	66 min @ 4100 KW	X		No		
92	3/26/84	Dana E. Smith	Calibration	X		1 hour	1 hr. No Load	X		No		
93	3/27/84	Dana E. Smith	ESF Testing	X		1 hour	1 hr. No Load	X		No		
94	3/29/84	Dana E. Smith	B/O Testing		X	1 hour	2 min.		X	No	See Remarks #19 Details	

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. 018 (Diesel Generator 1A)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
95	3/29/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
96	3/29/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
97	3/29/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
98	3/29/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
99	3/29/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
100	3/29/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
101	3/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
102	3/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
103	3/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
104	3/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
105	3/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
106	3/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
107	3/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
108	3/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
109	3/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
110	3/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
111	3/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. 018 (Diesel Generator 1A)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
112	3/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
113	3/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
114	3/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
115	3/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	2 min.		X	No	See Remarks #19 Details	
116	3/30/84	Dana E. Smith	B/O Testing	X		15 min.	15 min. @ 7000 KW	X		No		
117	3/31/84	Dana E. Smith	B/O Testing	X		15 min.	15 min. @ 3000 KW	X		No		
118	4/2/84	Dana E. Smith	1 hr. @ 7000 KW	X		1 hour	1 hour @ 7000 KW	X		No		
119	4/3/84	Dana E. Smith	Engine Start No Load	X		15 min.	15 min.	X		No		
120	4/3/84	Dana E. Smith	40 min. @ 7700 KW	X		40 min.	40 min. @ 7700 KW	X		No		

REMARKS DETAILS

For 75018 (Diesel Generator 1A)

1. Diesel Generator 1A was started to check operation prior to commencing Extended Run. Engine tripped on Low Turbo Oil Pressure after approximately 2 minutes. Contributing factors were cold lube oil and the first indications of turbocharger bearing failure. Turbochargers were replaced later.

2. Diesel Generator 1A was started to check operation prior to commencing Extended Run. Engine started but after approximately 2 minutes, 4 trip lights alarmed without the engine shutting down. The Operator then stopped the engine manually. Problem was with the Control Air System which had developed a small leak. This was corrected by I&E.

3. Diesel Generator 1A was started to check operations prior to commencing Extended Run. Engine tripped on Low Turbo Oil Pressure after approximately 2 minutes. Contributing factors were cold lube oil and the first indications of turbocharged bearing failure. Turbochargers were replaced later.

4. Diesel Generator 1A was started to check operation prior to commencing Extended Run. Engine tripped after approximately 2 minutes because the Barring Device was not properly reset. Barring Device was reset.

5. While loaded to 7000 KW, the Right Front Turbocharger Lube Oil Drip Line failed at ferrule. The engine was manually shutdown to prevent oil spray. The tubing was replaced by I&E under WR #80640PS.

6. While loaded to 7000 KW, the delivery valve holder on the IL Fuel Oil Injection Pump cracked. The engine was manually shutdown to prevent a fire hazard. The entire Fuel Oil Injection Pump was replaced under WR #80950PS.

7. Diesel Generator 1A was started to continue with the Extended Run. Engine tripped after approximately 2 minutes because of Low Turbo Oil Pressure. Contributing factors were cold lube oil and the first indications of turbocharger bearing failure. Turbochargers were replaced later.

8. While loaded to 7000 KW, a temporary modification to the Left Front Turbocharger Lube Oil Drain failed resulting in an oil spill. The engine was manually shutdown to prevent a fire hazard. While the engine was shutdown:

   A. The turbochargers were replaced
   B. A cracked cylinder head was replaced
   C. Push rods were replaced with a newer version
   D. A damaged rocker box assembly was replaced

9. The Diesel Generator 1A was manually shutdown to allow for readjustment of valve lash following the push rod replacement.

10. The Diesel Generator 1A tripped on Low Low Lube Oil Pressure shortly after start. Suspect that operating error in swapping the Lube Oil Filters caused this problem.

11. The Diesel Generator 1A was manually shutdown to investigate possible water loss from the Jacket Water System and the reason for excessive outlet temperatures on Jacket Water and Lube Oil. These problems were subsequently resolved by determining that the water loss problem was attributed to misinterpretation of system instrumentation, and the outlet temperature problem was attributed to defective thermocouples.

12. The Diesel Generator 1A was manually shutdown to investigate excessive outlet temperatures on Jacket Water and Lube Oil. This was corrected by replacing the defective thermocouples.

13. While loaded to 7000 KW, the Left Front Turbocharger Lube Oil Drip Line failed at the ferrule. The engine was manually shutdown to prevent oil spray. The tubing was replaced by I&E under WR #8289OPS.

14. The Diesel Generator 1A was manually shutdown to repair a crack in the Right Front Turbocharger Aftercooler. The crack developed in the aftercooler casing at the inlet flange. The aftercooler casing was replaced under WR #3708MNT.

15. The Diesel Generator 1A was manually shutdown to prevent a fire hazard. The 7L Fuel Oil Injector Line had developed an indentation on the ferrule which allowed a fine mist of fuel oil to be sprayed out. The engine tubing assembly was replaced under WR #8318OPS.

16. The Diesel Generator 1A shutdown shortly after starting. The problem was a clogged fuel oil strainer. The strainers were swapped and this corrected the problem.

17. The Diesel Generator 1A failed to start after the Load Sequencer initiated a start signal. The problem was a short in one of the Load Sequencer's relays that failed to give a sustained start signal. The relay was replaced and the wiring checked. A temporary modification to the wiring had caused the short and this was corrected.

18. The Diesel Generator 1A was started in order to calibrate the visicorder for ESF Testing, when it shutdown after approximately 2 minutes. Investigations revealed several loose fittings on the Control Air System which caused the Spurious Trip. The fittings were retightened.

19. The Diesel Generator 1A would not stay running for longer than approximately 2 minutes. No trip indication was being received. Investigations revealed that the Timer/Not 9 module of the Shutdown Logic Board had drifted out of calibration. Timer/Not 9 allows the swap over from the Group II Alarm Lockout Circuit to the Group II Alarm Active Circuit. This pneumatic timer was recalibrated and the problem was corrected.

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. 1 (Diesel Generator 1B)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
1	11/17/83	Dana E. Smith	1 hour @ 7000 KW	X		1 hour	40 min. 7000 KW	X		No	Terminated Run intentionally due to spurious actuation of CO2 Alarm.	
2	11/29/83	Dana E. Smith	1 hour @ 7000 KW	X		1 hour	65 min. 7000 KW	X		No		
3	11/30/83	Dana E. Smith	Engine Start, No Load	X		5 min.	5 min.	X		No	Testing Trips	
4	11/30/83	Dana E. Smith	Engine Start, No Load	X		5 min.	5 min.	X		No	Testing Trips	
5	11/30/83	Dana E. Smith	Engine Start, No Load	X		5 min.	5 min.	X		No	Testing Trips	
6	11/30/83	Dana E. Smith	Engine Start, No Load	X		5 min.	5 min.	X		No	Testing Trips	
7	11/30/83	Dana E. Smith	Engine Start, No Load	X		5 min.	5 min.	X		No	Testing Trips	
8	11/30/83	Dana E. Smith	Engine Start, No Load	X		5 min.	5 min.	X		No	Testing Trips	
9	11/30/83	Dana E. Smith	Engine Start, No Load	X		5 min.	5 min.	X		No	Testing Trips	
10	11/30/83	Dana E. Smith	Engine Start, No Load	X		5 min.	5 min.	X		No	Testing Trips	
11	11/30/83	Dana E. Smith	Engine Start, No Load	X		5 min.	5 min.	X		No	Testing Trips	
12	11/30/83	Dana E. Smith	Engine Start, No Load	X		5 min.	5 min.	X		No	Testing Trips	

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. 017 (Diesel Generator 1B)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
13	11/30/83	Dana E. Smith	Engine Start, No Load	X		5 min.	5 min.	X		No	Testing Trips	
14	11/30/83	Dana E. Smith	Engine Start, No Load	X		5 min.	5 min.	X		No	Testing Trips	
15	11/30/83	Dana E. Smith	Engine Start, No Load	X		5 min.	5 min.	X		No	Testing Trips	
16	11/30/83	Dana E. Smith	Engine Start, No Load	X		5 min.	5 min.	X		No	Testing Trips	
17	11/30/83	Dana E. Smith	Engine Start, No Load	X		5 min.	5 min.	X		No	Testing Trips	
18	11/30/83	Dana E. Smith	Engine Start, No Load	X		5 min.	5 min.	X		No	Testing Trips	
19	12/1/83	Dana E. Smith	1 hour @ 7000 KW	X		1 hour	1 hour @ 7000 KW	X		No		
20	12/1/83	Dana E. Smith	Engine Start, No Load	X		5 min.	5 min.	X		No	Testing Controls	
21	12/1/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
22	12/2/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour 4000 KW	X		No		
23	12/2/83	Dana E. Smith	1 hour @ 5000 KW	X		1 hour	1 hour @ 5000 KW	X		No		
24	12/2/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	21 min. @ 4000 KW	X		No	Test Terminated due to schedule conflicts	
25	12/3/83	Dana E. Smith	1 hour @ 5000 KW	X		1 hour	75 min. @ 5000 KW	X		No		
26	12/3/83	Dana E. Smith	1 hour @ 7000 KW	X		1 hour	1 hour @ 7000 KW	X		No		

LOCATION CATAWP PREPARED BY: Dana E. Smi

TDI EMERGENCY DIESEL GENERATOR NO. 2017 (Diesel Generator 1B)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
27	12/4/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
28	12/4/83	Dana E. Smith	1 hour @ 5000 KW	X		1 hour	1 hour @ 5000 KW	X		No		
29	12/4/83	Dana E. Smith	1 hour @ 7000 KW	X		1 hour	1 hour @ 7000 KW	X		No		
30	12/5/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	62 min. @ 4000 KW	X		No		
31	12/5/83	Dana E. Smith	1 hour @ 7000 KW	X		1 hour	5 min.		X	No	Spurious Trip on Lo Turbc Oil Press	
32	12/6/83	Dana E. Smith	Trouble-Shooting	X		1 hour	1 hour @ 7000 KW	X		No		
33	12/7/83	Dana E. Smith	1 hour @ 5000 KW	X		1 hour	1 hour @ 5000 KW	X		No		
34	12/11/83	Dana E. Smith	1 hour @ 7700 KW	X		1 hour	1 hour @ 7700 KW	X		No		
35	12/13/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	61 min. @ 4000 KW	X		No		
36	12/14/83	Dana E. Smith	1 hour @ 7700 KW	X		1 hour	63 min. @ 7700 KW	X		No		
37	12/14/83	Dana E. Smith	1 hour @ 5000 KW	X		1 hour	62 min. @ 5000 KW	X		No		
38	12/14/83	Dana E. Smith	1 hour @ 5000 KW	X		1 hour	62 min. @ 5000 KW	X		No		
39	12/16/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	61 min. @ 4000 KW	X		No		
40	12/16/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	103 min. @ 4000 KW	X		No		
41	12/16/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
42	12/16/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. #17 (Diesel Generator 1B)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
43	12/17/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	62 min. @ 4000 KW	X		No		
44	12/17/83	Dana E. Smith	1 hour @ 5000 KW	X		1 hour	61 min. @ 5000 KW	X		No		
45	12/17/83	Dana E. Smith	1 hour @ 6000 KW	X		1 hour	1 hour @ 6000 KW	X		No		
46	12/17/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
47	12/17/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	61 min. @ 4000 KW	X		No		
48	12/18/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	61 min. @ 4000 KW	X		No		
49	12/18/83	Dana E. Smith	1 hour @ 5000 KW	X		1 hour	61 min. @ 5000 KW	X		No		
50	12/18/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	62 min. @ 4000 KW	X		No		
51	12/18/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
52	12/18/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	1 hour @ 4000 KW	X		No		
53	12/19/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	61 min. @ 4000 KW	X		No		
54	12/19/83	Dana E. Smith	1 hour @ 5000 KW	X		1 hour	62 min. @ 5000 KW	X		No		
55	12/19/83	Dana E. Smith	1 hour @ 5000 KW	X		1 hour	61 min. @ 5000 KW	X		No		
56	12/19/83	Dana E. Smith	Engine Start, Verification of Governor Settings	X		30 min.	30 min.	X		No		
57	12/21/83	Dana E. Smith	1 hour @ 4000 KW	X		1 hour	62 min. @ 4000 KW	X		No		
58	3/4/83	Dana E. Smith	1 hour @ 3500 KW	X		1 hour	Unknown run time, No Load	X		No	See Remarks #1 Details	

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. .7 (Diesel Generator 1B)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
59	3/5/83	Dana E. Smith	1 hour @ 3500 KW	X		1 hour	Unknown run time, No Load	X		No	See Remarks #1 Details	
60	3/5/83	Dana E. Smith	1 hour @ 3500 KW	X		1 hour	Unknown run time, No Load	X		No	See Remarks #1 Details	
61	3/5/83	Dana E. Smith	1 hour @ 7000 KW	X		1 hour	5 min. @ 7000 KW	X		No	See Remarks #2 Details	
62	3/5/83	Dana E. Smith	1 hour @ 7000 KW	X		1 hour	20 min. @ 7000 KW	X		No	See Remarks #2 Details	
63	3/6/83	Dana E. Smith	1 hour @ 3500 KW	X		1 hour	20 min. @ 3800 KW	X		No	See Remarks #1 Details	
64	3/7/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time, No Load	X		No		
65	3/9/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time, No Load	X		No		
66	3/9/84	Dana E. Smith	Trouble-Shooting	X		1 hour	< 1 min.		X	No	See Remarks #3 Details	
67	3/9/84	Dana E. Smith	Trouble-Shooting	X		1 hour	< 1 min.		X	No	See Remarks #4 Details	
68	3/9/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time, No Load	X		No	See Remarks #1 Details	
69	3/10/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time, No Load	X		No	See Remarks #5 Details	
70	3/10/84	Dana E. Smith	Trouble-Shooting		X	1 hour	< 1 min.		X	No	See Remarks #4 Details	
71	3/10/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 min. No Load	X		No	See Remarks #1 Details	
72	3/10/84	Dana E. Smith	Trouble-Shooting	X		1 hour.	5 min. No Load	X		No	See Remarks #1 Details	
73	3/10/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 min. No Load	X		No	See Remarks #1 Details	

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. 117 (Diesel Generator 1B)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
74	3/11/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time, No Load	X		No	See Remarks #1 Details	
75	3/11/84	Dana E. Smith	Trouble-Shooting	X		1 hour	3 min. @ @ 2000 KW	X		No	See Remarks #6 Details	
76	3/13/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 min. @ 3900 KW	X		No		
77	3/13/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 min. @ 5000 KW	X		No		
78	3/14/84	Dana E. Smith	1 hour @ 6800 KW	X		1 hour	760 min. @ 6800 KW	X		No		
79	3/15/84	Dana E. Smith	1 hour @ 7000 KW	X		1 hour	760 min. @ 7000 KW	X		No		
80	3/19/84	Dana E. Smith	1 hour @ 6500 KW	X		1 hour	12 hrs. @ 6500 KW	X		No		
81	3/22/84	Dana E. Smith	24 hour run (2 hrs. @ 7700 KW) 22 hrs. @ 7000 KW	X		24 hours	2 hrs. @ 7700 48 hrs. @ @ 7000 KW	X		No		
82	3/24/84	Dana E. Smith	ESF Test-ing		X	1 hour	4 mins.		X	No	See remarks #7 Details	
83	3/24/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time, No Load	X		No		
84	3/25/84	Dana E. Smith	Trouble-Shooting	X		1 hour	10 mins.	X		No		
85	3/25/84	Dana E. Smith	Trouble-Shooting	X		1 hour	1 min. @ 7000 KW	X		No		
86	3/25/84	Dana E. Smith	Trouble-Shooting	X		1 hour	20 mins. No Load	X		No		
87	3/25/84	Dana E. Smith	Trouble-Shooting	X		1 hour	30 mins. No Load	X		No		
88	3/25/84	Dana E. Smith	Trouble-Shooting	X		1 hour	10 mins. No Load			No		
89	3/25/84	Dana E. Smith	Trouble-Shooting	X		1 hour	30 mins. No Load	X		No		

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. 17 (Diesel Generator 1B)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
90	3/25/84	Dana E. Smith	Trouble-Shooting	X		1 hour	10 mins. No Load	X		No		
91	3/25/84	Dana E. Smith	Trouble-Shooting	X		1 hour	10 mins. No Load	X		No		
92	3/26/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
93	3/26/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
94	3/27/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
95	3/27/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
96	3/27/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
97	3/27/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
98	3/27/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
99	3/27/84	Dana E. Smith	ESF Test-ing	X		5 mins.	5 mins. No Load	X		No		
100	3/28/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
101	3/28/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
102	3/28/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
103	3/28/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. 7 (Diesel Generator 1B)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
104	3/28/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
105	3/28/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
106	3/28/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
107	3/29/84	Dana E. Smith	1 hr. @ 7000 KW	X		1 hour	212 mins. @ 7000 KW	X		No		
108	3/29/84	Dana E. Smith	1 hr. @ 7000 KW	X		1 hour	Unknown Run Time No Load	X		No	See Remarks #8 Details	
109	3/29/84	Dana E. Smith	1 hr. @ 7000 KW	X		1 hour	Unknown Run Time No Load	X		No	See Remarks #8 Details	
110	3/29/84	Dana E. Smith	1 hr. @ 7000 KW	X		1 hour	Unknown Run Time No Load	X		No	See Remarks #8 Details	
111	3/29/84	Dana E. Smith	1 hr. @ 7000 KW	X		1 hour	Unknown Run Time No Load	X		No	See Remarks #8 Details	
112	3/30/84	Dana E. Smith	1 hr. @ 7000 KW	X		1 hour	30 mins. @ 7000 KW	X		No		
113	3/31/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
114	3/31/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
115	3/31/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
116	3/31/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
117	3/31/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. 2 (Diesel Generator 1B)

Start No. Chronological	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
118	3/31/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
119	4/1/84	Dana E. Smith	Trouble-Shooting	X		1 hour	30 mins @ 7000 KW	X		No		
120	4/2/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 mins. @ 4000 KW	X		No		
121	4/2/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
122	4/2/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
123	4/3/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 mins. No Load	X		No		
124	4/3/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 mins. No Load	X		No		
125	4/3/84	Dana E. Smith	Trouble-Shooting	X		1 hour	15 mins. No Load	X		No		
126	4/3/84	Dana E. Smith	Trouble-Shooting	X		1 hour	10 mins. No Load	X		No		
127	4/3/84	Dana E. Smith	Trouble-Shooting	X		1 hour	10 mins. No Load	X		No		
128	4/3/84	Dana E. Smith	Trouble-Shooting	X		1 hour	30 mins. No Load	X		No		
129	4/3/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
130	4/4/84	Dana E. Smith	Trouble-Shooting	X		1 hour	30 mins. No Load	X		No		
131	4/4/84	Dana E. Smith	Trouble-Shooting	X		1 hour	30 mins. No Load	X		No		
132	4/4/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time @ 7000 KW	X		No		
133	4/5/84	Dana E. Smith	Trouble-Shooting	X		1 hour	34 mins. @ 2500 KW	X		No		

LOCATION CATAWBA PREPARED BY: Dana E. Smit[illegible]

TDI EMERGENCY DIESEL GENERATOR NO. 17 (Diesel Generator 1B)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
134	4/5/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
135	4/6/84	Dana E. Smith	Trouble-Shooting	X		1 hour	25 mins. No Load	X		No		
136	4/6/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 mins. No Load	X		No		
137	4/6/84	Dana E. Smith	Trouble-Shooting	X		1 hour	39 mins. @ 2500 KW	X		No		
138	4/6/84	Dana E. Smith	Trouble-Shooting	X		1 hour	8 mins. No Load	X		No		
139	4/6/84	Dana E. Smith	Trouble-Shooting	X		1 hour	8 mins. No Load	X		No		
140	4/6/84	Dana E. Smith	Trouble-Shooting	X		1 hour	64 mins. @ 2500 KW	X		No		
141	4/6/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
142	4/7/84	Dana E. Smith	Trouble-Shooting	X		1 hour	10 mins. @ 2500 KW	X		No		
143	4/7/84	Dana E. Smith	Trouble-Shooting	X		1 hour	3 mins. No Load	X		No		
144	4/7/84	Dana E. Smith	Trouble-Shooting	X		1 hour	10 mins. No Load	X		No		
145	4/7/84	Dana E. Smith	Trouble-Shooting	X		1 hour	9 mins. @ 2500 KW	X		No		
146	4/7/84	Dana E. Smith	Trouble-Shooting	X		1 hour	3 mins. No Load	X		No		
147	4/8/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 mins. @ 2500 KW	X		No		
148	4/8/84	Dana E. Smith	Trouble-Shooting	X		1 hour	20 mins. No Load	X		No		
149	4/8/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		

LOCATION CATAWBA

PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. 1 (Diesel Generator 1B)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
150	4/8/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
151	4/9/84	Dana E. Smith	Trouble-Shooting	X		1 hour	10 mins. No Load	X		No		
152	4/9/84	Dana E. Smith	Trouble-Shooting	X		1 hour	15 mins. No Load	X		No		
153	4/9/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
154	4/10/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
155	4/10/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
156	4/12/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
157	4/12/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
158	4/12/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
159	4/12/84	Dana E. Smith	1 hour @ 6800 KW	X		1 hour	2 Hrs. @ 6800 KW	X		No		
160	4/12/84	Dana E. Smith	Trouble-Shooting	X		1 hour	15 mins. No Load	X		No		
161	4/12/84	Dana E. Smith	Trouble-Shooting	X		1 hour	10 mins. No Load	X		No		
162	4/12/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
163	4/12/84	Dana E. Smith	Trouble-Shooting	X		1 hour	8 mins. No Load	X		No		
164	4/12/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 mins. No Load	X		No		

LOCATION CATAWBA

PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. 1 (Diesel Generator 1B)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
165	4/12/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 mins. No Load	X		No		
166	4/12/84	Dana E. Smith	Trouble-Shooting	X		1 hour	3 mins. No Load	X		No		
167	4/12/84	Dana E. Smith	Trouble-Shooting	X		1 hour	3 mins. No Load	X		No		
168	4/12/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
169	4/12/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 mins. No Load	X		No		
170	4/12/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
171	4/13/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
172	4/13/84	Dana E. Smith	Trouble-Shooting	X		1 hour	20 mins. @ 2000 KW	X		No		
173	4/13/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 mins. No Load	X		No		
174	4/13/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 mins. @ 2000 KW	X		No		
175	4/13/84	Dana E. Smith	Trouble-Shooting	X		1 hour	21 mins. @ 1200 KW	X		No		
176	4/13/84	Dana E. Smith	Trouble-Shooting	X		1 hour	30 mins. @ 1200 KW	X		No		
177	4/13/84	Dana E. Smith	Trouble-Shooting	X		1 hour	10 mins. @ 1200 KW	X		No		
178	4/13/84	Dana E. Smith	Trouble-Shooting	X		1 hour	20 mins. No Load	X		No		
179	4/13/84	Dana E. Smith	Trouble-Shooting	X		1 hour	25 mins. @ 1200 KW	X		No		
180	4/15/84	Dana E. Smith	Trouble-Shooting	X		1 hour	50 mins. @ 1200 KW	X		No		
181	4/15/84	Dana E. Smith	Trouble-Shooting	X		1 hour	10 mins. No Load	X		No		

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. ___ (Diesel Generator 1B)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
182	4/15/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
183	4/15/84	Dana E. Smith	Trouble-Shooting	X		1 hour	30 mins. @ 1200 KW	X		No		
184	4/15/84	Dana E. Smith	Trouble-Shooting	X		1 hour	30 mins. @ 4200 KW	X		No		
185	4/15/84	Dana E. Smith	Trouble-Shooting	X		1 hour	15 mins. @ 1200 KW	X		No		
186	4/15/84	Dana E. Smith	Trouble-Shooting	X		1 hour	15 mins. @ 4000 KW	X		No		
187	4/15/84	Dana E. Smith	Trouble-Shooting	X		1 hour	15 mins. @ 4000 KW	X		No		
188	4/15/84	Dana E. Smith	Trouble-Shooting	X		1 hour	10 mins. @ 2000 KW	X		No		
189	4/16/84	Dana E. Smith	Trouble-Shooting	X		1 hour	10 mins. @ 1750 KW	X		No		
190	4/16/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
191	4/26/84	Dana E. Smith	Trouble-Shooting	X		1 hour	10 mins. No Load	X		No		
192	4/26/84	Dana E. Smith	Trouble-Shooting	X		1 hour	29 mins. @ 6000 KW	X		No		
193	4/26/84	Dana E. Smith	Trouble-Shooting	X		1 hour	> 60 mins. @ 6000 KW	X		No		
194	4/30/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 mins. @ 3500 KW	X		No		
195	4/30/84	Dana E. Smith	Trouble-Shooting	X		1 hour	2 mins. @ 7000 KW	X		No		
196	5/2/84	Dana E. Smith	1 hr. @ 7000 KW	X		1 hour	90 mins. @ 7000 KW	X		No		
197	5/3/84	Dana E. Smith	1 hr. @ 7000 KW	X		1 hour	90 mins. @ 7000 KW	X		No		
198	5/3/84	Dana E. Smith	ESF Testing	X		1 hour	15 mins. @ 3000 KW	X		No		

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. ___ (Diesel Generator 1B)

tart No. hrono-ogical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
199	5/4/84	Dana E. Smith	ESF Test-ing	X		1 hour	Unknown Run Time @ 3700 KW	X		No		
200	5/16/84	Dana E. Smith	Trouble-Shooting	X		1 hour	Unknown Run Time No Load	X		No		
201	5/16/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 mins. @ 7700 KW	X		No		
202	5/17/84	Dana E. Smith	Trouble-Shooting		X	1 hour	< 1 Min.		X	No	See Remarks #9 Details	
203	5/17/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 mins. @ 2000 KW	X		No		
204	5/17/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 mins. No Load	X		No		
205	5/17/84	Dana E. Smith	Trouble-Shooting	X		1 hour	15 mins. No Load	X		No		
206	5/17/84	Dana E. Smith	Trouble-Shooting	X		1 hour	5 mins. No Load	X		No		
207	5/17/84	Dana E. Smith	Trouble-Shooting	X		1 hour	3 mins. No Load	X		No		
208	5/17/84	Dana E. Smith	Trouble-Shooting	X		1 hour	3 mins. No Load	X		No		
209	5/17/84	Dana E. Smith	Trouble-Shooting	X		1 hour	30 mins. @ 7000 KW	X		No		
210	5/17/84	Dana E. Smith	Trouble-Shooting	X		1 hour	10 mins. @ 1600 KW	X		No		
211	5/17/84	Dana E. Smith	Trouble-Shooting	X		1 hour	16 mins. @ 7000 KW	X		No		
212	5/29/84	Dana E. Smith	Trouble-Shooting		X	1 hour	< 1 min.		X	No	See Remarks #10 Details	
212	5/29/84	Dana E. Smith	Trouble-Shooting		X	1 hour	< 1 min.		X	No	See Remarks #10 Details	
213	5/29/84	Dana E. Smith	Trouble-Shooting		X	1 hour	< 1 min.		X	No	See Remarks #10 Details	
214	5/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	< 1 min.		X	No	See Remarks #10 Details	

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. 1 (Diesel Generator 1B)

Start No. Chronological	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
215	5/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	< 1 min.		X	No	See Remarks #10 Details	
216	5/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	< 1 min.		X	No	See Remarks #10 Details	
217	5/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	< 1 min.		X	No	See Remarks #10 Details	
218	5/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	< 1 min.		X	No	See Remarks #10 Details	
219	5/30/84	Dana E. Smith	Trouble-Shooting		X	1 hour	< 1 min.		X	No	See Remarks #10 Details	
220	5/30/84	Dana E. Smith	Trouble-Shooting	X		1 hour	15 mins. @ 7000 KW	X		No		
221	5/30/84	Dana E. Smith	Prep For Extended Run	X		1 hour	50 mins. @ 7000 KW	X		No		
222	5/30/84	Dana E. Smith	Extended Run	X			29.5 Hrs. @ 7000 KW	X		No	See Remarks #11 Details	
223	6/1/84	Dana E. Smith	Extended Run	X			54 Hrs. @ 7000 KW	X		No	See Remarks #12 Details	
224	6/12/84	Dana E. Smith	Extended Run	X			59.5 Hrs. @ 7000 KW		X	No	See Remarks #13 Details	
225	6/16/84	Dana E. Smith	Trouble-Shooting	X			Unknown Run Time No Load	X		No	See Remarks #14 Details	
226	6/16/84	Dana E. Smith	Trouble-Shooting	X			Unknown Run Time No Load	X		No	See Remarks #14 Details	
227	6/18/84	Dana E. Smith	Trouble-Shooting	X			Unknown Run Time No Load	X		No	See Remarks #14 Details	
228	6/19/84	Dana E. Smith	Trouble-Shooting	X			Unknown Run Time No Load	X		No	See Remarks #14 Details	
229	6/19/84	Dana E. Smith	Trouble-Shooting	X			Unknown Run Time No Load	X		No	See Remarks #14 Details	

LOCATION CATAWBA PREPARED BY: Dana E. Smith

TDI EMERGENCY DIESEL GENERATOR NO. ___ (Diesel Generator 1B)

Start No. Chrono-logical	Date	Technical Contact	Test Objective	Engine Response Sat	Engine Response Unsat	Run Duration Expected	Run Duration Actual	Normal Shutdown	Abnormal Shutdown	Reported To NRC	Remarks	Corrective Action
230	6/22/84	Dana E. Smith	Extended Run	X			27 Hrs. @ 7000 KW	X		No	See Remarks #15 Details	
231	6/22/84	Dana E. Smith	ESF Testing	X		1 hour	Unknown Run Time No Load	X		No		
232	6/22/84	Dana E. Smith	ESF Testing	X		1 hour	Unknown Run Time No Load	X		No		
233	6/22/84	Dana E. Smith	ESF Testing	X		1 hour	Unknown Run Time No Load	X		No		
234	6/22/84	Dana E. Smith	Extended Run	X			77 hrs. @ 7000 KW	X		No	See Remarks #16 Details	
235	6/26/84	Dana E. Smith	Extended Run	X			3.5 hrs. @ 7000 KW	X		No	See Remarks #17 Details	
236	6/26/84	Dana E. Smith	ESF Testing	X		1 hour	Unknown Run Time @ 7000 KW	X		No		
237	6/26/84	Dana E. Smith	Extended Run	X			5 hrs. @ 7000 KW	X		No	See Remarks #17 Details	
238	6/26/84	Dana E. Smith	ESF Testing	X		1 hour	46 mins. @ 7000 KW	X		No		
239	6/26/84	Dana E. Smith	Extended Run	X			103.5 hrs. @ 7000 KW	X		No	See Remarks #18 Details	
240	7/3/84	Dana E. Smith	Extended Run	X			69.5 hrs. @ 7000 KW		X	No	See Remarks #19 Details	
241	7/6/84	Dana E. Smith	Extended Run	X			70.5 hrs. @ 7000 KW	X		No	End of Extended Rum	

REMARKS DETAILS

For 75017 (Diesel Generator 1B)

1. Diesel Generator 1B Breaker opened due to reverse power relaying. First indications of possible governor/voltage regulator difficulties. Ultimately determined to be a defective voltage regulator and SCR. Not fully corrected until 6/21/84.

2. Diesel Generator 1B was manually shutdown because of excessive noise from the turbochargers. Upon investigation it was revealed that a gasket on the turbocharger had failed. Gasket was replaced later.

3. Diesel Generator 1B was started to troubleshoot the governor. Preliminary adjustments to the governor caused to engine to trip on overspeed.

4. Diesel Generator 1B was started to troubleshoot the governor. Preliminary adjustments to the governor caused to engine not to attain 427 RPM in < 11 seconds.

5. Diesel Generator 1B was started to troubleshoot the governor. Shortly after start a fuel oil leak developed. Engine was manually shutdown, subsequent operator error caused the Air Start Valves to open and bleed off the Starting Air System. The fuel oil leak was repaired.

6. Diesel Generator 1B was started to troubleshoot the governor. Shortly after start the operator noticed a low temperature reading on the 1L Cylinder. Engine was manually shutdown.

7. Diesel Generator 1B was started by the Diesel Generator Load Sequencer in response to an emergency start signal generated during the ESF Test. Investigations revealed that the oil level in the governor actuator was low which caused improper governor response. Oil was added to the normal level and the problem was corrected.

8. Diesel Generator 1B started and all attempts to close the breaker failed. As stated in Remarks Details #1 this was due to a defective voltage regulator and SCR. Adjustments made to the governor seemed to help for a short time. Problem finally resolved 6/21/84.

9. Diesel Generator 1B started for governor troubleshooting purposes. After start the engine tripped on overspeed. Investigations revealed that the oil level in the governor actuator was low. Refilling to normal oil level corrected the problem.

10. Diesel Generator 1B started for governor troubleshooting purpose. Engine would not attain speed in required time. Investigations revealed that a "Heim Joint" on the fuel racks was not adjusted properly causing the racks to become bound in the no-fuel position. Adjustments were made to the joint and engine response was satisfactory.

11. Diesel Generator 1B manually shutdown by the Shift Supervisor because of oscillations in the voltage regulator. After evaluations were performed, the oscillations were not considered to be detrimental, and the Diesel Generator was approved for restart.

12. Diesel Generator 1B was manually shutdown due to a leak on the right bank aftercooler inlet jacket water line coming from a crack between the casing and the flange. Preliminary estimations of the cause of the crack was vibration. The aftercooler was weld repaired and returned to service under Work Request No. 9822 OPS. In addition, both turbochargers were replaced because of excessively worn thrust bearings caused by the inadequate pre-lube during starting. (Work Request No. 9794 OPS) A redesign of the turbocharger pre-lube system is currently in progress, which will provide a greater flow to the turbocharger thrust bearings. Also, the 7R fuel pump was replaced due to low pyrometer readings on this cylinder (WR 2180 PRF). This corrected the low temperature problems when the engine was restarted.

13. Diesel Generator 1B tripped on low lube oil pressure. This occurred as operations personnel were attempting to change the lube oil strainers while the Diesel Generator was on line.

    While the engine was down, the 5L fuel injection pump was replaced due to low pyrometer readings on this cylinder (WR 2259 PRF). At the same time, the 5L fuel injector was checked under WR 2262 PRF. It was determined that the injector was the cause of the problem rather than the fuel injection pump. The injector was replaced. It was noted that a 1/2" capscrew on the right bank starting air distributor was sheared off. This capscrew was replaced under WR 10023 OPS. The probable cause of the capscrew failure was engine vibration.

14. Diesel Generator 1B was started and stopped several times during this period while repairing and adjusting the voltage regulator.

15. Diesel Generator 1B was manually shutdown for ESF test.

16. Diesel Generator 1B was manually shutdown to repair a fuel oil line leak at the filter. A damaged ferrule was replaced under WR 10152 OPS.

17. Diesel Generator 1B was manually shutdown for ESF test.

18. Diesel Generator 1B was manually shutdown because of jacket water leaks in cylinder heads 8R, 7R, and 4L. 8R cylinder head was replaced. Cylinder heads 7R and 4L were considered to be acceptable leaks, not detrimental to the engine. The cause of the crack in the 8R head is currently under investigation.

19. Diesel Generator 1B tripped on Low Turbo Oil Pressure. Investigations revealed that the Lube Oil Strainer was dirty. Upon swapping to the other strainer, pressures returned to normal.

To: MELANIE MILLER
5 PAGES

DUKE POWER COMPANY
P.O. BOX 33189
CHARLOTTE, N.C. 28242

HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

TELEPHONE
(704) 373-4531

August 1, 1984

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Ms. E.G. Adensam, Chief
Licensing Branch No. 4

Re: Catawba Nuclear Station
Docket Nos. 50-413 and 50-414

Dear Mr. Denton:

This letter is in reponse to several TDI emergency diesel engine issues raised by NRC and Battelle personnel during a visit to the Catawba Nuclear Station on July 26, 1984. The attachment contains responses promised by August 1, 1984 and commitment dates for responses to the remaining items.

Please call me if I can be of further service.

Very truly yours,

H.B. Tucker

Hal B. Tucker, Vice President
Nuclear Production

HBT:JG:rmm

Attachment

cc: Mr. James P. O'Reilly, Regional Administrator
U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta Georgia 30303

Palmetto Alliance
2135 1/2 Devine Street
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cc: NRC Resident Inspector
Catawba Nuclear Station

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Walt Laity
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Richland, Washington 99352

C.H. Berlinger
ONR, U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attachment 1
August 1, 1984

RESPONSES TO NRC QUESTIONS AND RECOMMENDATIONS AT JULY 26, 1984 MEETING AT CATAWBA NUCLEAR STATION CONCERNING DIESEL ENGINES

1. JACKET WATER SYSTEM DEPOSITS

Item: Battelle expressed concern regarding the deposits noted in the 1B diesel jacket water system in areas exposed by removal of cylinder liners. Duke Power agreed to review this concern and advise NRC of the action planned in regard to these deposits.

Discussion: Duke Power has reviewed the deposits in the jacket water system. We conclude that the type and amount of deposits in the system are normal and are not a cause for concern. Most of the deposits are covered with the same gray film that covers the surfaces of the system, which indicates that the deposits are not fresh. The amount of the deposits is small such that there appears to be no danger of the deposits interfering with proper cooling water flow or leading to cylinder liner sealing difficulties.

Jacket water system parameters have not shown any evidence of flow resistance increase, nor have engine temperatures. This supports our conclusion that the deposits are not a cause for concern.

We have also discussed this situation with TDI (Mr. M. Lowrey). TDI indicates that the deposits in the 1B diesel are normal and not a cause for concern. The deposits are believed to be due to original manufacture and not due to operation. TDI noted that quantity of deposits in the 1B diesel is less than normally observed.

Response: We will remove the deposits exposed by removal of the four cylinder liners that are now out of the 1B engine. We will also clean out deposits exposed by removal of any additional cylinder liners that are removed for other reasons. However, removal of cylinder liners specifically for the purpose of cleaning the jacket water system is not planned.

2. LUBE OIL SELECTION

Item: Battelle pointed out that improved grades of lubricating oil are available and are now recommended by TDI; Battelle recommended that one of these improved oils be used.

Response: We will use one of the improved grades of lubricating oil per TDI's latest lube oil recommendations. The specific grade we will use is Mobilgard 412.

Exxon Tro-mar SD

3. EXHAUST GAS TEMPERATURES

Item: Battelle recommended that one thermocouple be installed per turbocharger on each diesel to permit routine monitoring of exhaust gas temperatures at the location where the exhaust gas manifolds attach to the turbochargers. This should utilize a permanently installed system. In addition, Battelle wants to obtain, in the near future, exhaust gas temperature measurements at 25, 50, 75 and 100% of full power.

Response: Duke Power will measure exhaust gas temperatures at 25, 50, 75 and 100% power during return to service testing of the 1B diesel. This will be performed using temporary equipment which will be removed following completion of these tests. In addition, permanently installed equipment to measure exhaust gas temperatures at the turbocharger inlets will be installed at the first refueling.

4. LINK ROD BUSHINGS

Item: NRC consultants recommended that all 1B diesel link rod bushings be removed and examined to ensure that excessive scoring or other damage has not occurred.

Response: Duke Power will disassemble all 1B diesel link rod to master rod connections and inspect the link rod bushings.

5. CONNECTING ROD BEARINGS

Item: The NRC requested that the 1A DIESEL bearing shells that were replaced be identified.

Response: The upper and lower shells (6 total) were replaced on connecting rod bearings 5, 6, and 7. It should be noted that one of the 6 shells had not been rejected by RT, but was replaced as part of a set.

6. WRIST PIN BUSHINGS

Item: Battelle asked to be advised as to which specific bushings on diesel 1A had been found to be slightly oversize.

Response: Detailed review of the piston pin bushing to piston pin clearances has shown that all of the clearances meet the TDI technical manual limit of 0.015 inches for new parts, and have substantial margins to the clearance of 0.020 inches allowed for used parts in the engine. Four piston pin bushings were inspected, with the following results:

Cylinder No.	Piston Pin Bushing I.D., Inches	Piston Pin O.D., Inches	Measured Clearance Inches
1L	6.7618	6.7490	0.013
5R	6.7610	6.7498	0.011
8L	6.7611	6.7492	0.012
8R	6.7607	6.7491	0.012

In summary, the statement in Appendix A of our June 29, 1984 report for Part No. 02-340A that three piston pin bushings exceeded new part tolerances by 0.002 inches (but met TDI recommended wear allowances) was not completely correct. In fact, all of the four bushings which were inspected meet both new and used part tolerances.

7. LINK ROD BOLTS

Item: Battelle recommended that these bolts be retorqued on diesel 1B.

Response: These bolts will be retorqued. This will be done as part of reassembly following the link rod bushing inspections discussed in Section 5 above.

8. LOAD PICKUP

Item: NRC requested that they be provided with graphs showing the time history of load pickup by the diesel generators.

Response: Time history load profiles were provided to NRC in the handouts for the Duke/NRC meeting on March 21, 1984. We understand from recent telephone discussions with NRC (M. Miller) that further information is not required at this time.

NOTES

As agreed during the July 26, 1984 meeting, the following responses are scheduled for later transmittal to NRC :

Subject	Due Date
9. REPLACEMENT OF TURBOCHARGER BEARINGS (Notification that task has been completed)	October 31, 1984
10. REVISION TO LUBE OIL TEMPERATURE AND PRESSURE OPERATING VALUES	August 19, 1984
11. IDENTIFICATION OF SERIES (TYPE) OF CYLINDER HEADS USED	August 8, 1984

DUKE POWER COMPANY
P.O. BOX 33189
CHARLOTTE, N.C. 28242

HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

TELEPHONE
(704) 373-4531

April 5, 1984

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Ms. E. G. Adensam, Chief
Licensing Branch No. 4

Re: Catawba Nuclear Station
Docket Nos. 50-413 and 50-414

Dear Mr. Denton:

On March 21, 1984, representatives from Duke Power Company and the NRC Staff met at your offices in Bethesda, Maryland to discuss Duke's proposed program for resolution of the TDI diesel generator issue for Catawba. At the conclusion of this meeting, Duke committed to provide a written description of the Extended Operation Tests and the Inspection Plans for the 1A and 1B diesel generators. These descriptions are attached. Also attached is a description of the generic and site specific problems experienced at Catawba.

Very truly yours,

Hal B. Tucker /

Hal B. Tucker

ROS/php

Attachment

cc: Mr. James P. O'Reilly, Regional Administrator
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30303

NRC Resident Inspector
Catawba Nuclear Station

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Charlotte, North Carolina 28207

Catawba Nuclear Station
Extended Operation Tests and Inspections
of
Diesel Generators

Table of Contents

1. Introduction

Concerns have been raised regarding the design and component integrity of diesel engines manufactured by Transamerica Delaval, Incorporated (TDI). Catawba Nuclear Station employs TDI diesels as safety-grade power supplies. Specifically, Catawba has two TDI diesels, Model DSRV-16-4, per unit. In this report the Catawba Unit 1 diesels will be identified as "1A" and "1B".

Duke Power Company has developed a program to verify the reliability of the TDI diesels installed at Catawba. The overall purpose of the program is to demonstrate that the Catawba TDI diesels can reliably perform their intended safety function, and that no technical reasons exist for not licensing Catawba Nuclear Station for power operations. Specifically, the program consists of three basic parts:

- o Participation in a TDI Owners Group Program that was formed to investigate the concerns and formulate corrective action plans to address these concerns.
- o Successful completion of regulatory requirements relating to the diesels.
- o Successful completion of an extended operation test and an extensive inspection program of the Catawba diesels.

In reviewing the operating history of similar Model DSRV-16-4 diesels it was noted that few of the nuclear service engines have significant operating hours. In addition, it was noted that some of the commercial engines with significant operating hours had operating loads and duty cycles significantly more severe and damaging than those expected for the Catawba diesels. Therefore, in order to expand the nuclear service data base for Model DSRV-16-4 diesels Duke Power Company operated the 1A diesel generator at Catawba to accumulate over 810 hours of documented running time at loads well in excess of that needed for emergency power requirements.

The extended operation test was structured as an operational test run at loads equal to or greater than the required emergency power load to demonstrate the ability of the Catawba diesels to operate in a reliable fashion. The last operating period of the extended run test was a sustained run of over 7 days in duration. The disassembly and inspection of the 1A diesel following this extended operation test will confirm the adequacy of the engine parts' materials and critical dimensions or identify any deficient parts. The engines' ability to successfully start and pick up load has been extensively demonstrated during preoperational testing and there is no experience to date that suggests this ability is in question.

The extended operation test has also served to demonstrate the fatigue resistance of the Catawba diesel parts. The 810 hours of operation has subjected the major parts of the engine to greater than 10^7 stress cycles, and has served to demonstrate the fatigue life capability of the engine parts. A 4-cycle engine like the DSRV-16-4 is subject to a major stress cycle, compression and expansion, every 2 revolutions. The rated running speed for these engines is 450 RPM. Thus, to acquire 10^7 of these stress cycles, the engine had to run for approximately 740 hours; since about 810 operating hours have been accumulated, more than 10^7 cycles have been experienced. The ability to operate 10^7 stress cycles at the required load is generally accepted as a means to empirically demonstrate that mechanical parts made of carbon or low alloy steel have essentially indefinite fatigue lif time for the required load condition; thus, Catawba 1A diesel mechanical parts loaded by firing cycles can be considered as having proven acceptable fatigue lifetimes.

This report describes the diesel 1A extended operation test and its results, and describes the inspection plan to be used for the 1A diesel. The proposed extended operation test and inspection plan for the 1B diesel is also described.

2. Summary

The extended operation test demonstrated that the Catawba 1A diesel is capable of sustained operation at high loads. The extended operation test subjected the major parts of the engine to over ten million stress cycles to empirically demonstrate an adequate fatigue life for the engine parts. During the extended operation test the engine's operating parameters were closely monitored to detect any degradation in engine performance. No engine degradation was detected and the last test period involved continuous diesel engine operation for over 7 days.

An extensive inspection program is presently underway for the 1A diesel to verify the mechanical reliability of the Catawba engine. The scope of the inspection includes all engine parts that could cause failure of the diesel, degradation of diesel performance, or failure of a part that eventually would cause failure of the diesel. The inspection methods being employed include visual, nondestructive examination (liquid penetrant, magnetic particle, eddy current, ultrasonics, and radiography), dimensional, material properties (material comparison, verification and hardness), and other special methods (torsiograph, as-found bolt torque, reassembly bolt torque).

The inspection plan is based upon:

- o Inspection of engine parts identified as one of the generic problems by the TDI Owners Group.
- o Inspection of engine parts recommended by the TDI Owners Group.
- o Inspection of engine parts relating to Catawba engine specific failures.

o Inspection of general engine parts to evaluate wear patterns.

The Catawba inspections are being performed in accordance with written Catawba procedures and are being controlled under the Duke Power Quality Assurance Program.

The Catawba 1B diesel will begin an extended operation test to expand its running time under high load conditions to at least 750 hours in the near future. Following completion of the extended operation test an inspection program will be initiated. The scope and extent of that inspection will be based upon the results of the 1A diesel inspection and inspections of other TDI emergency diesels.

Successful completion of the extended operation tests and the extensive inspections of the Catawba 1A and 1B diesels will demonstrate their capability to serve as safety grade equipment for the Catawba Station.

3. Extended Operation Test Program

3.1 Purpose

The purposes of the extended operation test program are to:

- o Demonstrate that the Catawba 1A and 1B TDI Model DSRV-16-4 diesels are capable of sustained operation without major failures (e.g., failure of crankshaft, pistons, cylinder liner).
- o Subject the major engine parts to over 10^7 stress cycles to empirically demonstrate the fatigue capability of those parts.
- o Identify any beginning of life engine or break-in type failures that will occur with this type of diesel. These "break-in" failures typically occur early in life in all machinery, even well designed and constructed machinery.
- o Expand the data base for DSRV-16-4 operation in emergency power service.
- o Verify the suitability of modifications made to the Catawba diesel.

3.2 Extended Operation Test Description

The test run for diesel 1A extended its documented run time to over 810 hours. The controlling Catawba plant procedure for surveillance of the 1A diesel test was TP/1/B/1100/03, "Diesel Generator 1A Extended Run". The Catawba Nuclear Station procedures that control diesel operation are:

- o OP/1/A/6350/02, "Diesel Generator Operation"
- o OP/1/A/6550/02, "D/G Lube Oil"
- o OP/1/A/6550/01, "Diesel Generator Fuel Oil System Operation"

The extended operation test planned for diesel 1B will extend its documented run time to at least 750 hours. Its controlling surveillance and operation procedures are the same as identified above for diesel 1A. The surveillance procedure used during the extended run provides for the following data collection:

- o Vibration data from thirty points around the engine base and near the turbochargers taken daily.
- o Lubricating oil samples taken daily from the Lube Oil Sump System before filtering. Daily tests to be made for percent water and viscosity.
- o Fuel samples taken from each tanker unloaded (approximately 2 to 3 tanker trailers every two days). Each sample is tested for water and sediment content, and specific gravity. Samples are drained from the day tank hourly to visually inspect for water.
- o Engine parameters such as load, exhaust temperatures, lube oil pressure, etc., monitored continuously and recorded hourly.
- o Problems encountered during engine operation are documented listing immediate action taken, proposed long term action, and to what extent the run was interrupted.

3.2.1 Vibration Analysis

Vibration data is taken at the following thirty points using either the Nicolet Spectrum Analysis System or the TEC Monitoring System, or both systems every day until the run is completed. Data is not taken unless the engine has been running a minimum of six continuous hours during a normal work day.

Point	Description
H01	Horz Generator Pedestal Bearing
V02	Vert Generator Pedestal Bearing
A03	Axial Generator Pedestal Bearing
H04	Horz Base LB at Cylinder-8L
H05	Horz Cam Cover Base at Cylinder-8L
H07	Horz Cam Cover Base Between Cylinders 4L & 5L
H08	Horz Base LB at Cylinder-1L
H09	Horz Cam Cover Base at Cylinder-1L
A10	Axial LB Cam Cover Housing (Engine Front)
A11	Axial RB Cover Housing (Engine Front)
A12	Axial Crankshaft Gear Housing (Engine Front)
T13	Turbocharger LB Horzontal on Turbo
T14	Turbocharger LB Vertical on Support Base
T15	Turbocharger Front Support Bar LB at Intercooler
T16	Turbocharger RB Horizontal on Turbo
T17	Turbocharger RB Vertical on Support Base
T18	Turbocharger Front Support Bar RB at Intercooler
H19	Horz Sub-Base RB at Cylinder-8R
H20	Horz Cam Cover Base RB at Cylinder-8R
H21	Horz Sub-Base RB Between Cylinders 4R & 5R
H22	Horz Cam Cover Base RB Between Cylinders 4R & 5R
H23	Horz Sub-Base RB at Cylinder-1R
H24	Horz Cam Cover Base at Cylinder-1R
V25	Vert Block RB at Cylinder-1R
V26	Vert Block RB Between Cylinders 4R & 5R
V27	Vert Block RB at Cylinder-8R
V28	Vert Block LB at Cylinder-8L
V29	Vert Block LB Between Cylinders 4L & 5L
V30	Vert Block LB at Cylinder-1L

Base line vibration data were established for both the Nicolet and TEC systems.

On a daily basis the TEC system is used to monitor all 30 points. This data is reviewed by a Maintenance Engineer trained in vibration analysis. If a significant change is detected in any of the parameters, then the Nicolet system is used to monitor the point in question to confirm the significant change. A comparison plot is then prepared between the Nicolet Baseline Data and the Nicolet Data to document the significant change.

The vibration monitoring test equipment consists of:

- o Nicolet System

  Nicolet Scientific Corporation Model 446A "Mini Ubiquitous" FFT Computing Spectrum Analyzer with a range of 1 Hz to 100,000 Hz.

- o TEC System

  TEC Monitor Model 1310 (EXP) Smart Meter System consisting of:

  - TEC Accelerometer Model 154 (S/N 113) with a range of 5 Hz to 10,000 Hz and a 100 Hz sensitivity of 103 millivolts/"g".
  - Comparison and plots are provided by the "INTELLI-TREND" software package written by TEC (January 1984) for an IBM Personal Computer.

- o Teac R-61 Digital Data Acquisition System using three (3) IRD 544 Velocity Pickup Probes with a range of 12 Hz to 1000 Hz and an output of 764 ± 10 millivolts RMS/per inch per second.

3.2.2 Lube Oil Samples

Lube oil samples are taken to show that the oil still has those properties necessary to provide proper lubrication. Daily samples are taken from the lube oil sump system at some point after the oil leaves the engine but before it is filtered. These samples are tested for percent water content and for viscosity per Catawba procedures CP/0/A/8100/23 and CP/0/A/8100/24 (Opaque Method), respectively. A log of the results copied from the chemistry lab results log book is included in the surveillance procedure documentation package.

3.2.3 Fuel Oil Samples

Fuel oil samples are taken to show that the fuel meets industry and company standards for Number 2 Diesel Fuel Oil.

Because the main fuel oil storage tanks cannot be recirculated while the fuel oil system is lined up for engine runs and because of the inventory turnover required for this continuous run, the samples taken from the tanker for delivery acceptance will very closely represent the contents of the main storage tank and therefore provide a suitable means for monitoring fuel oil supply to the diesel.

Fuel oil samples are taken from each tanker to be unloaded. The samples are a composite of all compartments of the tanker. The fuel is tested on site for specific gravity and water and sediment per Catawba procedures CP/0/A/8100/10 and CP/0/A/8100/26, respectively. The test results are obtained and found satisfactory before the fuel oil is unloaded. A log of the results copied from the chemistry lab results log book is included in the surveillance procedure documentation package.

Fuel oil is drawn from the bottom of the day tank once during each hour the engine is running and is inspected for obvious water and sediment. If significant quantities are found, the Test Coordinator is notified for evaluation.

3.2.4 Engine Parameters

Engine operating parameters are monitored throughout the extended operation test. A number of engine operating temperatures are recorded on strip charts as part of normal diesel operation. Other parameters are recorded hourly.

The temperatures recorded on the strip chart are:

- o Exhaust Temperature of each of the 16 Cylinders
- o Jacket Water Temperature In and Out of the Engine
- o Lube Oil Temperature In and Out of the Engine
- o Intake Air Temperature In and Out of the Right Bank Aftercooler
- o Intake Air Temperature In and Out of the Left Bank Aftercooler

The parameters recorded hourly are:

- o Generator Volts
- o Generator Amps
- o Power Factor
- o Generator Load
- o Generator Stator Temp.
- o Lube Oil Pressure
- o Lube Oil Filter Differential Pressure
- o Right Bank Turbocharger Lube Oil Pressure
- o Left Bank Turbocharger Lube Oil Pressure
- o Fuel Oil Pressure
- o Fuel Oil Filter Differential Pressure
- o Jacket Water Pressure
- o Right Bank Intake Manifold Pressure
- o Left Bank Intake Manifold Pressure
- o Lube Oil Tank Level
- o Exhaust Temperature of each of the 16 Cylinders (Same as recorded on strip chart)
- o Right Bank Exhaust Temperature
- o Left Bank Exhaust Temperature

The engine operating parameters are reviewed on a daily basis by the Operations Shift Supervisor and the Test Coordinator to identify any significant changes in operating parameter values. All significant changes are documented in problem reports.

3.2.5 Problems Encountered

Any problems encountered during operation are documented in Significant Problem Reports. As appropriate, a "Non-Conforming Item" (NCI) report may also be initiated for the problem as covered by the Duke Power Quality Assurance Program. The Significant Problem Report will contain, as appropriate, a description of the problem, the immediate action taken, proposed long term action, the extent the run was interrupted, and the NCI report number.

4. Results of Diesel 1A Extended Operation Test

The 1A diesel extended operation test was initiated on January 25, 1984, and was successfully completed on March 9, 1984. During that time period the engine operated about 613 hours of documented run time. That time added to the 197 hours of run time accumulated prior to the extended run test results in a total documented run time of about 810 hours for the 1A diesel. The following information summarizes the test run results.

4.1 Operating Profile

The Catawba TDI DSRV-16-4 diesels have a rated load of 7000kw. The maximum calculated emergency diesel generator load under blackout conditions is 5714kw (the engines have about an 18.4% margin in load capability). During the extended operation test, the engine was operated at loads in excess of the required 5714kw approximately 97% of the test period. Specifically, during the last 390 hours of documented extended run test period the generator load was in excess of 5800kw 96% of the operating time. Figure 4-1 illustrates, for the last 390 hours, the diesel 1A operating profile with a bar chart that indicates the percent of diesel operating time the diesel generator load was in excess of the specified load. The diesel load was calculated based on generator volts, amps and power factor.

4.2 Vibration Analysis

The daily vibration plots were compared to the baseline plot to identify any abnormal or significant changes in vibration levels, any longer term trends in vibration levels, or any other anomalies. During the extended operation test period no abnormal or significant changes in vibration levels or trends were identified.

4.3 Lube Oil Analyses

The daily samples of lube oil were tested for viscosity and water content. All analyses showed acceptable values for lube oil water content and viscosity.

4.4 Fuel Oil Analyses

The samples of fuel oil from the delivery tankers were tested for specific gravity and percent of water and sediment. All analyses showed acceptable values for fuel oil specific gravity and percent of water and sediment.

The hourly samples of the fuel oil day tank typically showed no water was present. Any small amount of water present was drained by the operator.

4.5 Operating Parameters

The diesel operating parameters, both on the strip charts and log sheet, were reviewed each day to ascertain significant or abnormal changes and to look for trends in the data indicating gradual degradation of the engine. With the exception of two cases, no significant or abnormal changes or data trends were detected in the operating parameter reviews. The two cases of significant trends in data were:

- o A slowly increasing jacket water discharge temperature was detected starting just past midnight on February 18, 1984. The jacket water temperature increased from a normal value of about 170°F to about 200°F. In addition, the temperature would sometimes jump from 200°F to 250°F rapidly. After an investigation, a defective thermocouple was found and replaced. This resulted in the indicated jacket water temperature returning to a normal value of about 170°F.

- Over about a 20 hour period on February 27, 1984, the lube oil pressure to both the right bank and left bank turbochargers slowly decreased from a normal value of about 22 to 23 psig to about 18.5 to 19 psig. After an investigation, the lube oil pump inlet strainer was found to be plugging. Cleaning the strainer resulted in an immediate return to normal lube oil pressures. No damage to the turbochargers was sustained.

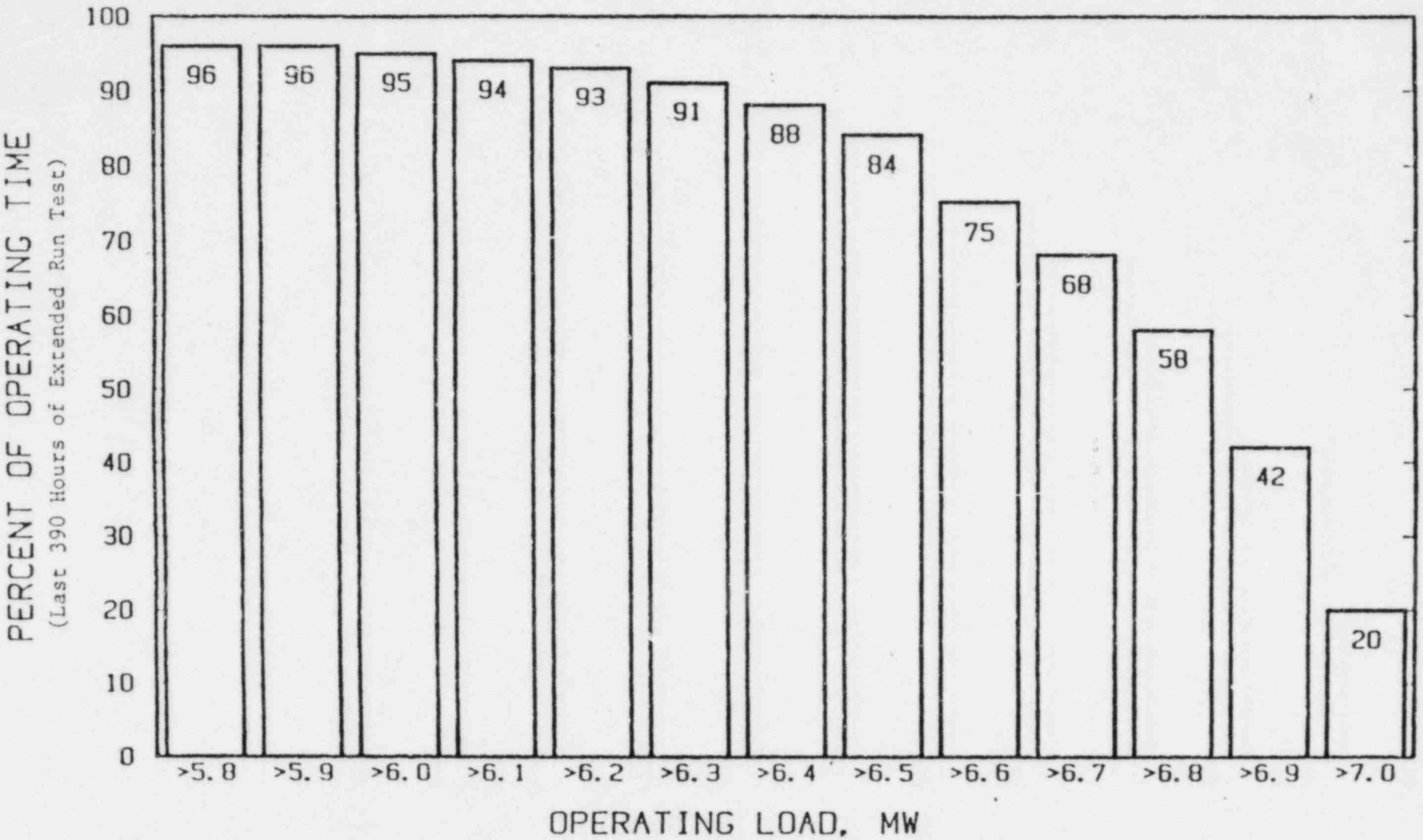
4.6 Problem Reports

Several problem reports were generated during the course of the extended run test. These reports covered the following engine parts:

- Pushrods
- Fuel line fitting
- Turbocharger thrust bearings
- Cylinder head
- Fuel injection pump valve holder
- Turbocharger prelube oil lines
- Turbocharger adapter (to the intercooler)
- Lube oil and jacket water thermocouples
- Crankcase cover capscrews
- Subcover (rockerarm) assembly
- Turbocharger lube oil drain line
- Turbocharger exhaust mainfold mounting bolts

Further discussion of these problems is given in section 7.

FIGURE 4-1



CATAWBA NUCLEAR STATION DIESEL GENERATOR 1A	PERCENT DIESEL OPERATING TIME VS. DIESEL GENERATOR LOAD

5. Inspection Plan for Catawba Diesel 1A

A comprehensive inspection plan has been developed for the Catawba Diesel 1A. The inspections follow the extended operation test of diesel 1A and were started on April 4, 1984.

5.1 Objective of Inspection Plan

The primary objective of the Catawba 1A diesel inspection plan is to verify the mechanical reliability of the specific parts and components of the Catawba 1A diesel following approximately 810 hours of diesel operation at high loads. This objective will be met by verifying the following:

- The parts are free from deleterious conditions, such as cracks, excessive wear, pitting, distortion, etc.
- The parts have critical dimensions in agreement with the original design (taking into account normal wear).
- The materials of construction are suitable for their intended use.

5.2 Bases for Inspection Plan

The Catawba 1A diesel inspection plan is based upon the following:

- Inspection of engine parts relating to the 16 generic TDI diesel problems identified to the Nuclear Regulatory Commission. These engine parts will be inspected to either verify that no similar problems exist with the Catawba DSRV-16-4 diesel, or identify and quantify the nature and extent of the the 1A diesel problems.
- Inspection of engine parts recommended by the TDI Diesel Owners Group. These recommended inspections cover the critical parts of the diesel, i.e., those parts whose failure could result in failure

or degradation of the diesel. The type and extent of inspection methods are based upon TDI diesel operating and failure experience.

- o Inspection of engine parts relating to the Catawba engine specific failures and problems based on past Catawba operating experience. In some cases they involve engine parts that are not considered critical (i.e., Class C as defined in section 5.3).
- o Inspection of engine parts based on engineering judgement and evaluation of wear patterns.

5.3 Scope of Inspection Plan

The 1A diesel inspection plan will include all of the critical components and parts of the diesel and associated systems that were supplied by TDI to Catawba. The TDI Owners Group has classified engine components according to the following:

Class	Importance of Component Failure
A	Failure can result in shut down of the diesel.
B	Failure can result in reduced capacity of the diesel or result in eventual failure in a Class A component
C	Failure does not significantly impact the ability of the diesel to meet its load requirements

The Catawba 1A diesel inspection plan includes all Class A and Class B components. In some cases Class C components are also included in the inspection plan.

Table 5-1 identifies all the parts in the Catawba DSRV-16-4 diesel, the part's classification, and extent of inspection. The extent of inspection of each part is dependent upon the part's importance to operation and to its failure history in Catawba's and other TDI diesels.

5.4 Inspection Methods

A variety of inspection methods will be employed to examine the Catawba DSRV-16-4 diesel parts. Each inspection method is selected based upon:

- The probable failure mode of the part and the probability of the inspection method to detect it.
- The attribute being determined.
- Results of previous inspections.

The specific inspection methods to be employed include the following:

Visual - Examine for:

- Wear and wear patterns
- Surface distress
- Cracks
- Freedom of motion
- Corrosion/erosion
- Foreign material
- Proper fitup
- Gasket leaks
- Proper lubrication
- As-built verification of system piping configuration and support

Dimensional Measurements - Examine for:

- Absolute value of critical dimensions
- Clearances
- Comparative values of identical parts
- Verification that proper parts are used
- Proper fitup of mating parts

Nondestructive Examinations

- Liquid penetrant and magnetic particle - Examine for:
  - Cracks and discontinuities
  - Material distress
  - Material integrity

- o Eddy current - Examine for:
  - Cracks and discontinuities not inspectable by liquid penetrant or magnetic particle because of physical configuration or surface condition
- o Ultrasonics - Examine for:
  - Wall thickness of parts
  - Depth of cracks (as appropriate)
  - Volumetric examination of material integrity
- o Radiography - Examine for:
  - Volumetric examination of material integrity

Material Properties - Examine for:

- o Comparison of engine materials to materials of known composition and properties by use of a material comparitor
- o Verification that proper non-metallic materials are being used for gaskets, seals and couplings by visual methods and documentation review
- o Material hardness

Special Inspections

- o Torsiograph
- o As-found torque values for bolted or screwed connections
- o Proper torque values are used during reassembly of bolted, screwed or compression connections

5.5 Inspection Test Plan

A summary of the inspection test plan for the Catawba 1A diesel is given in Table 5-1. Each engine part or component to be inspected is listed together with the part number, part classification and the sample size to be inspected for each inspection method being employed. All Class A and B bolted or screwed connections will have their as-found and reassembly torque values verified and documented, hence this is not listed separately in Table 5-1. Also not listed in Table 5-1 is the general visual inspection of all parts during disassembly and reassembly of the diesel.

The Duke Power Company, Nuclear Production Department Administrative Policy Manual will be used to control all work done on-site at Catawba Nuclear Station. Specific Catawba Station procedures have been developed for all disassembly, inspection, testing and reassembly operations and are listed below. The Duke Power Quality Assurance Program will be used to control and audit all phases of the diesel inspection program.

Disassembly and Reassembly

MP/0/A/1000/01	Cylinder Head and Associated Parts
MP/0/A/1000/02	Pistons, Rods and Cylinder Liners
MP/0/A/1000/03	Main Crankshaft Bearing
MP/0/A/7400/01	Fuel Pump
MP/0/A/7400/40	Turbocharger

Inspection

MP/0/A/1000/04	Cylinder Heads and Associated Parts
MP/0/A/1000/05	Pistons, Rods, Bushings and Shells
MP/0/A/1000/06	Crankshaft, Main Bearings and Turning Gear
MP/0/A/1000/07	Idler Gears and Pump Drive Gears
MP/0/A/1000/08	Gear Case Gasket and Bolting
MP/0/A/1000/09	Fuel Pump and Fuel Pump Linkage
MP/0/A/1000/10	Lube Oil System, Piping and Sump
MP/0/A/1000/11	Cylinder Block, Liner and Jacket Water
MP/0/A/1000/12	Starting Air Distributor
MP/0/A/1000/13	Jacket Water Pump
MP/0/A/1000/14	Camshaft and Gear
MP/0/A/1000/15	Intake and Exhaust Manifold
MP/0/A/1000/16	Governor and Overspeed Trip
MP/0/A/1000/17	Flywheel and Bolting
MP/0/A/1000/18	Turbocharger and Intercooler

5.6 Inspection Team

The inspection team will consist of primarily Duke Power Company (DPC) personnel supplemented by others as necessary. DPC craftsmen will perform the actual engine disassembly and reassembly. DPC technicians and engineering staff personnel will perform the inspections and provide the administrative support for the inspection program. Other members of the inspection program team include:

- Failure Analysis Associates - Eddy current testing and torsiograph installation and testing.
- Stone and Webster - Provide interface between DPC and Owners Group and materials comparison testing.
- Dominion Engineering, Inc. - Provide on-site assistance in the inspection effort and prepare final summary inspection report.
- Gustafson Associates - Provide on-site assitance in the inspection effort.

Table 5-1. Catawba Diesel 1A Inspection Plan Matrix

Part Name	Class	Part No.	Sample Size, Percent of Engine Parts Inspected Dimen.	Visual	Surface NDE	Vol. NDE	Material	Hardness	Notes
Lube Oil Pressure Regulating Valve	A	00-420	To be developed (Note 8)						
Main Bearing Cap Base Assembly	A	02-305A	-	30	-	-	-	-	-
Main Bearing Studs and Nuts	A	02-305C	10	30	-	-	-	-	-
Main Bearing Caps	A	02-305D	-	30	30	-	-	-	-
Lube Oil Internal Headers	A	02-307A	-	100	-	-	-	-	-
Lube Oil Tubing and Fittings-Internal	A	02-307B	-	100	-	-	-	-	-
Lube Oil Line Supports-Internal	B	02-307D	-	100	-	-	-	-	-
Crankshaft and Turning Gear	A	02-310A	100	100	38	-	-	-	3,4
Crankshaft Bearing Shell	A	02-310B	30	30	-	-	-	-	-
Crankshaft Thrust Bearing Ring	A	02-310C	100	-	-	-	-	-	4
Crankcase Assembly	A	02-311A	-	100	-	-	-	-	-
Crankcase Seal	B	02-311B	To be developed						
Crankcase Mounting Hardware	B	02-311C	To be developed						
Cylinder Block	A	02-315A	25	-	100	-	-	-	-
Cam Bearing Caps and Dowels	B	02-315B	To be developed						
Cylinder Liner	A	02-315C	100	100	-	-	20	20	-
Cylinder Block Jacket Water Manifold	B	02-315D	-	100	-	-	-	-	-
Cylinder Block Studs	B	02-315E	-	31	-	-	3	-	-
Cyl Block Jacket Wtr Manifold Nuts	B	02-315F	-	100	-	-	-	-	-
Cylinder Block Seals and Gaskets	B	02-315G	To be developed						
Jacket Water Inlet Manifold Assembly	B	02-316A	To be developed						
Jacket Water Inlet Manifold Coupling	B	02-316B	To be developed						
Jacket Water Inlet Manifold Vent Line	B	02-316C	To be developed						
Jacket Water Discharge Manifold	B	02-317A	To be developed						
Jacket Water Disc, Man. Coupling	B	02-317B	To be developed						
Jacket Water Disc. Man. Supports	B	02-317C	To be developed						
Flywheel	A	02-330A	To be developed						
Flywheel Bolting	A	02-330B	-	100	-	-	-	-	-
Front Gear Case Bolting	C	02-335B	-	100	-	-	-	-	-
Connecting Rods and Bushings	A	02-340A	100	100	100	-	25	25	-
Connecting Rod Bearing Shells	A	02-340B	100	100	100	100	-	-	-
Piston	A	02-341A	100	100	25	-	-	-	5
Piston Rings	A	02-341B	25	100	-	-	25	-	-

Table 5-1. Catawba Diesel 1A Inspection Plan Matrix

Part Name	Class	Part No.	Sample Size, Percent of Engine Parts Inspected						
			Dimen.	Visual	Surface NDE	Vol. NDE	Material	Hardness	Notes
Piston Pin Assembly	A	02-341C	25	25	-	-	25	25	-
Intake Tappets	A	02-345A	-	25	-	-	-	-	-
Fuel Tappets	A	02-345B	-	25	-	-	-	-	-
Fuel Pump Base Assembly	B	02-345C	To be developed						
Camshaft Assembly	A	02-350A	-	100	-	-	-	-	-
Camshaft Bearing	B	02-350B	-	-	-	-	-	-	7
Camshaft Supports, Bolting and Gear	A	02-350C	-	100	-	-	100	100	-
Idler Gear Assembly (Crank to Pump)	A	02-355A	-	100	-	-	-	-	-
Idler Gear Assembly	A	02-355B	-	100	-	-	-	100	-
Air Start Valve	A	02-359	100	100	-	-	-	-	-
Cylinder Head	B	02-360A	100	100	100	100	-	-	2
Intake and Exhaust Valves	B	02-360B	25	100	-	-	25	-	-
Cylinder Head Bolting	B	02-360C	To be developed						
Cylinder Head Gaskets	B	02-360C	-	100	-	-	-	-	-
Valve Springs	B	02-360D	-	100	-	-	-	-	1
Subcover Assembly	B	02-362A	-	100	100	-	-	-	-
Fuel Injection Pump	B	02-365A	-	-	-	100	-	100	-
Fuel Injection Tips	B	02-365B	To be developed						
Fuel Injection Tubing	B	02-365C	To be developed						
Fuel Injection Tubing Supports	B	02-365D	To be developed						
Fuel Pump Linkage and Control Shaft	A	02-371A	-	-	-	-	100	100	-
Fuel Pump, Linkage, Bearings and Shaft	A	02-371B	-	100	-	-	-	-	-
Intake Manifolds	B	02-375	100	100	-	-	-	-	-
Exhaust Manifold	B	02-380A	To be developed						
Exhaust Manifold Bolting	B	02-380B	9	9	-	-	-	-	-
Cylinder Block Cover, Gaskets & Bolts	C	02-385B	To be developed						
Crankcase Cover Assembly	C	02-386A	-	100	-	-	-	-	-
Crankcase Cover Gaskets & Hardware	C	02-386B	To be developed						
Intake & Intermediate Rocker Arm Assy	B	02-390A	100	100	100	-	100	100	-
Exhaust Rocker Arm Assembly	B	02-390B	100	100	100	-	100	100	-
Intake & Exhaust Pushrods	B	02-390C	-	100	100	-	-	-	-
Connector Pushrod	B	02-390D	-	100	100	-	-	-	-
Rocker Arm Bushings	B	02-390E	-	100	-	-	-	-	-
Rocker Arm Bolting	B	02-390G	-	100	25	-	-	-	-
Overspeed Trip Governor	A	02-410A	-	100	-	-	-	-	-

Table 5-1. Catawba Diesel 1A Inspection Plan Matrix

Part Name	Class	Part No.	Dimen.	Visual	Surface NDE	Vol. NDE	Material	Hardness	Notes
			Sample Size, Percent of Engine Parts Inspected						
Gov Overspeed Trip & Accessory Drive	A	02-410B	-	100	100	-	100	100	-
Overspeed Trip Couplings	A	02-410C	-	100	-	-	100	-	-
Overspeed Trip Vent Valves	A	02-410D	To be developed						
Governor & Tach Drive Gear & Shaft	A	02-411A	-	100	100	-	100	100	-
Governor Drive Couplings	A	02-411B	-	100	-	-	100	-	-
Governor Linkage	A	02-413	-	100	-	-	-	-	-
Speed Regulating Governor	A	02-415A	-	100	-	-	-	-	-
Governor Booster Servomotor	B	02-415B	To be developed						
Governor Heat Exchanger Assembly	A	02-415C	-	100	-	-	-	-	-
Lube Oil Pump	A	02-420	To be developed						
Jacket Water Pump	A	02-425A	-	100	-	-	100	100	-
Jacket Water Pipe and Fittings	B	02-435A	To be developed						
Jacket Water Pipe Supports	B	02-435B	To be developed						
Intercooler Piping Assembly	B	02-436A	To be developed						
Intercooler Piping-Coupling, Bolt, Gskt	A	02-436B	To be developed						
Turbo Cooling Water Pipe & Fittings	B	02-437A	To be developed						
Turbo Cooling Water Pipe Supports	A	02-437B	To be developed						
Start Air Manifold Pipe, Tubing & Ftg	A	02-441A	To be developed						
Start Air Manifold Vlvs, Strners, Fltrs	A	02-441B	To be developed						
Start Air Manifold Pipe Supports	A	02-441C	To be developed						
Starting Air Distributor Assembly	A	02-442A	100	100	-	-	-	100	6
Start Air Dstrbtor Tubing, Ftg, Gskts	A	02-442B	To be developed						
Fuel Oil Booster Pump	A	02-445	To be developed						
Fuel Oil Piping and Tubing	A	02-450B	To be developed						
Fuel Oil Filters and Strainers	B	02-450C	To be developed						
Fuel Oil Piping Supports	A	02-450D	To be developed						
Fuel Oil Filters	B	02-455A	To be developed						
Fuel Oil Strainers	B	02-455B	To be developed						
Fuel Oil Filter Mounting Hardware	A	02-455C	To be developed						
External Lube Oil Lines	A	02-465A	-	100	-	-	-	-	-
External Lube Oil Line Supports	A	02-465B	-	100	-	-	-	-	-
Turbocharger Lube Oil Piping	B	02-467A	-	100	-	-	-	-	-
Turbocharger Lube Oil Piping Supports	B	02-467B	-	100	-	-	-	-	-
Turbocharger Bracket	B	02-475A	-	100	-	-	-	-	-

Table 5-1. Catawba Diesel 1A Inspection Plan Matrix

Part Name	Class	Part No.	Dimen.	Visual	Surface NDE	Vol. NDE	Material	Hardness	Notes
			Sample Size, Percent of Engine Parts Inspected						
Turbocharger Air Butterfly Valve	A	02-475B	-	100	-	-	100	100	-
Turbocharger Air Intake Piping	B	02-475C	To be developed						
Turbocharger Bracket Bolting	B	02-475D	-	8	-	-	8	-	-
Control Panel Cabinet	A	02-500A	To be developed						
Control Panel Annunciators	B	02-500B	To be developed						
Control Air Accumulator	A	02-500F	To be developed						
Control Air System Valves	A	02-500G	To be developed						
Control Air System Pressure Switches	B	02-500H	To be developed						
Control System Relays	A	02-500J	To be developed						
Control System Solenoid Valves	A	02-500K	To be developed						
Control Air System Piping, Tubing, Ftngs	B	02-500M	To be developed						
Control Panel Wiring	A	02-500N	To be developed						
Lube Oil Sump Tank	B	02-540A	-	100	-	-	-	-	-
Lube Oil Sump Tank Ftngs, Pipe, Valves	B	02-540B	-	100	-	-	-	-	-
Lube Oil Sump Tank Mounting Hardware	B	02-540C	-	100	-	-	-	-	-
Foundation Bolts and Anchors	B	02-550	To be developed						
Instrumentation Thermocouples	B	02-630D	To be developed						
Engine & Aux Module Wiring Conduit	A	02-688A	To be developed						
Engine and Aux Module Wiring	A	02-688B	To be developed						
Engine and Aux Module Wiring Boxes	A	02-688C	To be developed						
Engine Alarm Sensors	A	02-690	To be developed						
Engine Shutdown Tubing and Fittings	B	02-695A	To be developed						
Engine Shutdown Valves, Regs, & Orific	A	02-695B	To be developed						
Engine Shutdown Trip Switches	A	02-695C	To be developed						
Jacket Water Standpipe, Ftngs, Gasket	B	00-700A	To be developed						
Jacket Water Standpipe Valves	B	00-700B	To be developed						
Jacket Water Standpipe Supports	B	00-700C	To be developed						
Jacket Water Standpipe Switches	B	00-700E	To be developed						
Jacket Water Standpipe Bolting Materials	B	00-700F	To be developed						
Fuel Oil Duplex Strainer	A	02-825D	To be developed						
Intercooler	B	F-068	-	100	100	-	-	-	-
Turbocharger	A	MP-022/3	100	100	-	-	-	-	-

Notes to Table 5-1

1. Intake and exhaust valve springs have proper color code.
2. Ultrasonic wall thickness measurement of fire deck area and fuel nozzle area.
3. A torsiograph will be developed of the crankshaft.
4. Crankshaft web deflections and thrust clearance will be measured with the diesel both hot and cold.
5. Measure torque on belleville spring loaded bolts.
6. Hardness of the spools will be measured only if excessive wear is measured on one or more of the spools.
7. If inspection of camshaft lobes show no abnormal wear, then no inspections of the camshaft bearings will be performed.
8. All inspections noted as "To be developed" will involve visual inspections or functional tests

6. Inspection Plan for Catawba Diesel 1B

A specific inspection plan for Catawba diesel 1B has not yet been developed. As previously identified an extended operation test is underway for diesel 1B to extend its high load operating time to 750 hours. Prior to the extended operation test the following inspections were performed on two engine cylinders:

- o Liquid penetrant examination of cylinder block top surface around the cylinder and between the head studs and cylinder liner.
- o Ultrasonic wall thickness measurements of cylinder head.

The following inspections were performed on all 16 cylinders:

- o Visual inspection of subcover assembly.
- o Visual inspection of all intake, exhaust and connector pushrods.
- o Visual inspection of all rocker arm assemblies.
- o Visual inspection of all intake and exhaust valve springs.

Following the extended operation test additional inspections will be performed. The extent of those inspections will be based upon the results of the inspections on the Catawba 1A diesel and other TDI emergency diesels. An appropriate sampling plan will be developed at that time.

7. Catawba Generic and Specific Problems

This section of the report lists the generic problems that have and have not occurred at Catawba along with other specific problems. Attachment 1 lists the "Generic problems not experienced at Catawba." Attachment 2 lists the "Generic problems experienced at Catawba" along with the specific diesels that experienced the problem, and the number of occurrences per diesel. Attachment 3 lists the "Catawba Specific Problems", the specific diesels that experienced the problem, and the number of occurrences per diesel. The problems listed do not include enhancements to the diesels resulting from 10CFR Part 21 reports, such as piston skirt enhancements.

The remaining portion of this section reviews each Catawba problem in more detail, and addresses the "cause", "consequences" and "corrective action" for each.

7.1 TDI Generic Problems Experienced at Catawba

Pushrods

A number of pushrods have been observed to have cracks on diesel 1A. Similar cracks are expected to occur on diesel 1B pushrods. The pushrods originally furnished had ball to tube welding defects. The cracked pushrods operated in 1A and 1B with no adverse affects to either engine's operation. The 1A pushrods have been replaced with an improved design that uses a friction weld between the spherical part and the tube. Diesel 1B is scheduled to have its pushrods replaced by April 1984.

Fuel Line Fitting

A fuel line fitting on the 1A diesel leaked due to a dented ferrule on the inside of the compression nut which secures the fuel line to the injector. The dented ferrule resulted from an unknown impact. During an emergency condition, this leaky fitting would not have adversely affected the engine's operation. The injection line and fitting were replaced. No further failures of this type have been experienced.

Turbocharger Thrust Bearings

The turbocharger thrust bearings have experienced excessive wear on diesels 1A and 1B. This wear is believed to be due to a lack of prelube oil during multiple fast starts of the diesels. The excessive wear of the turbocharger bearings did not adversely affect the diesels' operation during the extended run test. The bearings were replaced and the prelube oil flow rate was increased to prevent excessive wear on the replacement bearings.

A recent 10CFR21 has been issued by TDI addressing this situation, and as a result, Catawba expects to have the improved prelube oil system installed by June 1984.

Cylinder Heads

One cylinder head on diesel 1A developed a minor jacket water leak (approximately 4 gals/24 hours) within the injector bore and above the injector seat. One cylinder head on diesel 1B also developed minor jacket water leak similar to the leak on 1A. The causes of both cylinder head leaks are under investigation. Both diesels operated several days with the leaks and with no adverse affects to the engine's operation. The 1A cylinder head has been replaced, and the 1B cylinder head will be replaced prior to the start of the diesel 1B extended run test.

7.2 Catawba Specific Problems

Fuel Injection Pump

One fuel injection pump nozzle valve holder cracked as a result of a material defect. This was confirmed by a metallurgical analysis. In an emergency condition, the injector pump failure would not have adversely affected the engine's operation. The failed fuel injection pump was replaced. All pump nozzle valve holders at Catawba will be inspected to verify that material defects do not exist in the other valve holders.

Turbocharger Prelube Oil Lines

Two turbocharger prelube oil line fatigue failures occurred at the ferrule of a compression fitting during the 1A extended run test. Both failures are considered to be due to improper installation (i.e., over-tightening) of the tubing compression nut and excessive vibration. During an emergency condition this situation would not have adversely affected the engine's operation. The prelube oil lines have been replaced using an approved nut tightening procedure and additional clamps. Vibration dampening devices were installed on the tubing to decrease the vibration amplitude. As previously noted, the improved prelube oil system will be installed by June 1984.

Turbocharger Adapter

A turbocharger to intercooler adapter cracked at the flange weld. This was evaluated to be due to a misalignment between the two components. This situation had no adverse affects on the engine's operation. The adapter was replaced. In the future, Catawba will take extra care to ensure proper flange alignment prior to torquing any turbocharger flange bolts.

Lube Oil and Jacket Water Thermocouples

Incorrect temperature indications were noted on the lube oil and jacket water systems during the extended run test. These were found to be due to thermocouple lead failures (i.e., an intermittant short). This situation did not adversely affect the engine's operation. The engine was shut down at the operator's discretion to resolve the problem and replace thermocouples.

Crankcase Cover Capscrews

A 1/2 inch capscrew head was found to be missing from the 1A diesel crankcase access cover. During replacement of the capscrew, a second capscrew sheared off with less than 15 ft-lb of applied torque. This situation is under investigation, and is suspected to be due to an improper installation (i.e., over torque) of the capscrews prior to the extended run test. This situation did not adversely affect the engine's operation. The failed capscrews were replaced. Once the cause is confirmed, all affected capscrews will be replaced.

Subcover (Rockerbox) Assembly

One subcover assembly was observed to be damaged while replacing the diesel 1A pushrods. The damage is felt to have resulted from work performed during the reinstallation of the heat treated piston skirts, in 1983. At that time, it is suspected that the subcover assembly was installed with a misaligned rocker shaft dowel pin which caused the observed damages. This situation did not adversely affect the engine's operation during the extended run test. The subcover assembly was replaced. In the future, Catawba will ensure proper dowel pin alignment prior to torquing bolts.

Turbocharger Lube Oil Drain Line

A temporary turbocharger lube oil drain line leaked on diesel 1A. This temporary modification was made because the original drain line furnished by TDI did not completely seal at the couplings. The temporary drain line fatigued and failed prior to completion of the extended run test. This situation would not have adversely affect the engine's operation in an emergency condition. The drain line was replaced. In addition, an improved permanent design will be installed by May 1984.

Turbocharger Exhaust Manifold Mounting Bolts

Four 1/2 inch stainless steel turbocharger exhaust manifold mounting bolts were found broken. The cause of this failure is under investigation. The bolt failures did not adversely affect the engine's operation. The failed bolts have been replaced. When the cause of failure is determined, appropriate action will be taken to prevent reoccurrence of the failure.

Exhaust Valve Tappet (Rocker Arm Adjusting Screw Swivel Pad)

One exhaust valve tappet cracked on diesel 1B. The failure is presently under investigation (the failure appears to be due to improper seating of the internal ball and socket of the tappet). This situation had no adverse affects to the engine's operation. The failed tappet was replaced.

ATTACHMENT 1

GENERIC PROBLEMS NOT EXPERIENCED AT CATAWBA

- o Crankshaft
- o Connecting Rod Bearings
- o Pistons
- o Cylinder Liners
- o Cylinder Block
- o Enginer Base
- o Head Studs
- o Rocker Arm Capscrews
- o Connecting Rods
- o Electrical Cables
- o Fuel Injection Lines
- o Jacket Water pumps
- o Air Start Valve Capscrews

ATTACHMENT 2

GENERIC PROBLEMS EXPERIENCED AT CATAWBA

	DG1A	DG1B
o Push Rods	x	x
o Fuel Line Fittings	x(1)	
o Turbocharger Bearings	x(2)	x(2)
o Cylinder Heads	x(1)	x(1)

Note: Number of occurrences are noted in parenthesis.

ATTACHMENT 3

CATAWBA SPECIFIC PROBLEMS

	DG1A	DG1B
o Fuel Injection Pump	x(1)	
o Turbocharger Pre Lube Oil Lines	x(2)	
o Turbocharger Adapter	x(1)	
o Lube Oil and Jacket Water Thermocouples	x(6)	
o Side Cover Capscrews	x(2)	
o Rocker Box Subassembly	x(1)	
o Turbocharger Lube Oil Drain Line	x(1)	
o Turbocharger Exhaust Manifold Mounting Bolts	x(4)	
o Exhaust Valve Tappet		x(1)

Note: Number of occurrences are noted in parenthesis.

DUKE POWER COMPANY
P.O. BOX 33189
CHARLOTTE, N.C. 28242

HAL B. TUCKER

TELEPHONE
(704) 373-4531

July 6, 1984

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Ms. E. G. Adensam, Chief
Licensing Branch No. 4

Re: Catawba Nuclear Station
Docket Nos. 50-413 and 50-414

Dear Mr. Denton:

The purpose of this letter is to submit Duke Power Company plans for the inspection of the Catawba 1B diesel engine and the return to service testing of the Catawba 1A engine following reassembly after inspection. The Duke Power Company plans for these two items appear below:

A. Catawba 1B Diesel Engine Inspections

Our letter of April 5, 1984 forwarded a report entitled "Catawba Nuclear Station Extended Operation Tests and Inspections of Diesel Generators." Section 6 of this report noted that the extent of inspections to be carried out of the Catawba 1B diesel would be based upon the results of the Catawba 1A diesel inspections and other TDI emergency diesels. The Catawba 1A diesel inspections are now complete. The Catawba 1A diesel inspection results as well as the Owners Group inspection requirements for the second diesel at a nuclear station have been reviewed and an inspection plan matrix for the Catawba 1B diesel has been developed from this review. The Catawba 1B inspection plan matrix is shown in a revised Table 5-1 to the above mentioned report and is included as an enclosure to this letter. Referring to the revised Table 5-1, sample size of components to be inspected on the Catawba 1B diesel will be the same as the Catawba 1A diesel except as noted by parentheses. Where parentheses are included, sample size of inspection for the Catawba 1B diesel appears in the parentheses.

B. Catawba Diesel 1A Return to Service Testing

In accordance with a commitment made in "Catawba Nuclear Station Diesel Engine 1A Component Revalidation Inspection, Final Report," of June 29, 1984, the following is the Duke Power Company plan for return to service testing of the Catawba 1A diesel.

1. Run-In Operation:

This will be in accordance with TDI Instruction Manual, Chapter 6, Part C (page 6-C-18). The runs are mainly for seating new rings in the cylinder liner and consist of running the engine at various speeds and loads, inspections of the engine following various runs, hot crankshaft web deflection checks, and cold compression checks. In addition, during these runs, control systems, vital engine parameters, and auxiliary services will be monitored to assure proper operation.

2. Modified Load Tests:

Ten modified load tests will be run at a load of at least 3500 KW. Pertinent parameters that will be adhered to are as follow:

a. A test will be of one hour minimum duration followed by at least one and a half hours with the engine secured prior to the next modified load test.

b. All test starts will be performed with a pre-lube of the engine.

c. During a test, the load will be increased to a minimum of 3500 KV in a period less than five minutes.

d. Vital engine parameters will be monitored on a fifteen minute basis during the one hour run at power to assure proper operation.

3. 24-Hour Run:

A twenty-four hour run test will be conducted. This test will consist of twenty-two hours at 7000 KW and two hours at 7700 KW. Pertinent parameters that will be adhered to are as follow:

a. The engine test starts will be performed after the engine has been pre-lubed.

b. During the test, all load changes will be accomplished in five minutes or less.

c. Vital engine parameters will be monitored on a one-hour basis to assure proper operation.

4. Fast Start Test:

Two fast start tests will be conducted. Pertinent parameters that will be adhered to are as follow:

a. Diesel engine will come up to speed and voltage within eleven seconds.

b. Diesel engine will be loaded with accelerated blackout loads in the period of eleven seconds to thirty seconds. Peak load will be about 4100 KW. This is the highest load obtainable with the load sequencer under ESF or blackout conditions.

c. After the engine has achieved 4100 KW, each test will last for a period of one hour followed by a shutdown of at least one and a half hours. The one hour duration at load is set so that auxiliary cooling devices will not have to be cut in for some of the respective loads which would place an undue burden on the plant for the performance of these tests.

d. One of these tests will be conducted under pre-lube conditions. The other of these tests will be performed with the engine in ready standby status without pre-lube.

e. Vital engine parameters will be monitored on a 15-minute basis. Further, visacorder tracings of diesel generator voltage and frequency will be made during starting and loading transients.

5. Trip Device Verification:

There are ten trips which cause the engine to shut down under normal operation and three trips which cause shutdown under emergency operation. To verify proper operation of these trip devices, shutdown from the tests outlined in B-2 through B-4 above will be accomplished by sequentially introducing these trips for each of the thirteen tests.

6. Load Rejection:

To assure that the diesel generator does not go over five hundred RPM on a load rejection of 7000 KW, visacorder tracings of frequency will be made during the trip from 7000 KW outlined in B-3 above.

Criteria used to judge the tests outlined above as to what is a successful test, as opposed to a failed test, will be according to the following plan:

o The operation runs outlined in B-1 above are for break-in and grooming. As such, there are not any pass/fail criteria applied to them. In addition to break-in, this run will be to assure that the diesel generator is ready for tests B-2 through B-6.

o Tests outlined in B-2 through B-6 will be conducted in accordance with the pass/fail criteria of NRC Regulatory Guide 1.108.

We trust the above information is keeping you fully informed of the status of the Catawba Unit 1 diesels. Please call me if I can be of any further service.

Very truly yours,

Hal B. Tucker

HAR/php

cc: Mr. James P. O'Reilly, Regional Administrator
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Sample Size, Percent of Engine Parts Inspected

Part Name	Part No.	Class	Dimen.	Visual	Surf. NDE	Vol. NDE	Material	Hardness	Eng Ev	Notes
Lube Oil Pressure Regulating Valve	00-420	A	-	-	-	-	-	-	X	9
Jacket Water Standpipe, Plugs, Gasket	00-700A	B	-	100	-	-	-	-	-	-
et Water Standpipe Valves	00-700B	B	-	-	-	-	-	-	X	9
ket Water Standpipe Supports	00-700C	B	-	100	-	-	-	-	-	-
Jacket Water Standpipe Switches	00-700E	B	-	-	-	-	-	-	X	9
Jacket Water Standpipe Bolting Materials	00-700F	B	-	100	-	-	-	-	-	-
Main Bearing Cap Base Assembly	02-305A	A	-	50(0)	50(0)	-	-	-	-	-
Main Bearing Studs and Nuts	02-305C	A	10(0)	30(0)	-	-	-	-	-	-
Main Bearing Caps	02-305D	A	-	50(0)	50(0)		-	-	-	-
Lube Oil Internal Headers	02-307A	A	-	100	-	-	-	-	-	-
Lube Oil Tubing and Fittings-Internal	02-307B	A	-	100	-	-	-	-	-	-
Lube Oil Line Supports-Internal	02-307D	B	-	100	-	-	-	-	-	-
Crankshaft	02-310A	A	100	100	33(0)	-	-	-	-	3,4
Crankshaft Bearing Shell	02-310B	A	50(0)	50(0)	-	-	-	-	-	-
Crankshaft Thrust Bearing Ring	02-310C	A	100	-	-	-	-	-	-	4
Crankcase Assembly	02-311A	A	-	100	-	-	-	-	-	-
Cam Bearing Caps and Dowels	02-311B	B	-	-	-	-	-	-	X	9
Crankcase Mounting Hardware	02-311D	B	-	-	-	-	-	-	X(0)	9
Cylinder Block	02-315A	A	40(25)	-	100(25)		-	-	-	-
Cylinder Liner	02-315C	A	100	100	-	-	20(0)	20(0)	-	-
Cylinder Block Jacket Water Manifold	02-315D	B	-	100	-	-	-	-	-	-
Cylinder Head Studs	02-315E	B	-	25	-	-	3(0)	-	-	-
Cyl. Block Jacket Wtr. Manifold Nuts	02-315F	B	-	100	-	-	-	-	-	-
Cylinder Block Seals and Gaskets	02-315G	B	-	-	-	-	-	-	X(0)	9
Jacket Water Inlet Manifold Assembly	02-316A	B	-	100	-	-	-	-	-	-
Jacket Water Inlet Manifold Coupling	02-316B	B	-	100	-	-	-	-	-	-
et Water Discharge Manifold	02-317A	B	-	100	-	-	-	-	-	-
ket Water Disch. Manifold Coupling	02-317B	B	-	100	-	-	-	-	-	-
Jacket Water Disch. Manifold Supports	02-317C	B	-	100	-	-	-	-	-	-
Flywheel	02-330A	A	-	-	-	-	-	-	X(0)	9
Flywheel Bolting	02-330B	A	-	100	-	-	-	-	-	-
Front Gear Case Bolting	02-335B	C	-	100	-	-	-	-	-	-
Connecting Rods and Bushings	02-340A	A	100(0)	100	100	-	25(0)	25(0)	-	-
Connecting Rod Bearing Shells	02-340B	A	100	100	100	100	-	-	-	-
Piston	02-341A	A	100(0)	100	100(0)	-	-	-	-	5,10
Piston Rings	02-341B	A	25(0)	100(0)	-	-	25(0)	-	-	11
Piston Pin Assembly	02-341C	A	25(0)	100	-	-	25(0)	25(0)	-	-
Intake Tappets	02-345A	A	-	25	-	-	-	-	-	-
Fuel Tappets	02-345B	A	-	25	-	-	-	-	-	-
Fuel Pump Base Assembly	02-345C	B	-	-	-	-	-	-	X(0)	9
Camshaft Assembly	02-350A	A	-	100	-	-	-	-	-	-
Camshaft Bearing	02-350B	B	-	100	-	-	-	-	-	7
Camshaft Supports, Bolting and Gear	02-350C	A	-	100(0)	-	-	100(0)	100(0)	-	-
Crankshaft Gear	02-355A	A	-	100	-	-	-	-	-	-
Idler Gear Assembly	02-355B	A	-	100	-	-	-	100(0)	-	-
Air Start Valve	02-359	A	100	100	-	-	-	-	-	-
Cylinder Head	02-360A	B	100	100	100	100	-	-	X	2,9
Intake and Exhaust Valves	02-360B	B	25(0)	100	-	-	25(0)	-	-	-
Cylinder Head Bolting and Gaskets	02-360C	B	-	-	-	-	-	-	X(0)	-
Valve Springs	02-360D	B	-	100	-	-	-	-	-	1
cover Assembly	02-362A	B	-	100	100	-	-	-	-	-
l Injection Pump	02-365A	B	-	100	-	100(0)	-	100(0)	X	9
Fuel Injection Tips	02-365B	B	-	-	-	-	-	-	X(0)	9

Sample Size, Percent of Engine Parts Inspected

Part Name	Part No.	Class	Dimen.	Visual	Surf. NDE	Vol. NDE	Material	Hardness	Eng Ev	Notes
Fuel Injection Tubing	02-365C	B	-	100	100	-	-	-	-	8
Fuel Injection Tubing Supports	02-365D	B	-	100	-	-	-	-	-	-
Fuel Pump Linkage and Control Shaft	02-371A	A	-	-	-	-	100(0)	100(0)	-	-
Fuel Pump, Linkage, Bearings and Shaft	02-371B	A	-	100	-	-	-	-	-	-
Intake Manifolds	02-375	B	-	100	-	-	-	-	-	-
Exhaust Manifold	02-380A	B	-	100	100	-	100(0)	100(0)	-	8
Exhaust Manifold Bolting	02-380B	B	9	9	-	-	-	-	-	-
Cylinder Block Cover, Gaskets and Bolts	02-385B	C	-	-	-	-	-	-	X(0)	9
Crankcase Cover Gaskets and Bolting	02-386B	C	-	100	-	-	-	-	-	-
Intake & Intermediate Rocker Arm Assmbly.	02-390A	B	-	100	100(0)	-	100(0)	100(0)	-	-
Exhaust Rocker Arm Assembly	02-390B	B	-	100	100(0)	-	100(0)	100(0)	-	-
Intake and Exhaust Pushrods	02-390C	B	-	100	100	-	-	-	-	-
Connector Pushrod	02-390D	B	-	100	100	-	-	-	-	-
Rocker Arm Bushings	02-390E	B	-	100	-	-	-	-	-	-
Rocker Arm Bolting	02-390G	B	-	100	100	-	100(0)	100(0)	-	-
Overspeed Trip Governor	02-410A	A	-	-	-	-	-	-	X(0)	9
Overspeed Trip & Accessory Drive	02-410B	A	-	100(0)	100(0)	-	100(0)	100(0)	-	-
Overspeed Trip Couplings	02-410C	A	-	100	-	-	-	-	-	-
Overspeed Trip Vent Valves	02-410D	A	-	-	-	-	-	-	X(0)	9
Speed Regulating Governor Drive	02-411A	A	-	100(0)	100(0)	-	100(0)	100(0)	-	-
Governor Drive Couplings	02-411B	A	-	100	-	-	100	-	-	-
Governor Linkage	02-413	A	-	100	-	-	-	-	-	-
Fuel Pump Linkage-Auto Shutdown Cylinder	02-413B	B	-	100	-	-	-	-	-	-
Speed Regulating Governor	02-415A	A	-	-	-	-	-	-	X(0)	9
Governor Booster Servomotor	02-415B	B	-	-	-	-	-	-	X	9
Governor Heat Exchanger Assembly	02-415C	A	-	-	-	-	-	-	X(0)	9
Oil Pump	02-420	A	-	-	-	-	-	-	X(0)	9
Jacket Water Pump	02-425A	A	-	100(0)	-	-	100(0)	100(0)	-	-
Intercooler Piping-Coupling, Bolt, Gskt.	02-436B	A	-	100	-	-	-	-	-	-
Turbo Cooling Water Pipe and Fittings	02-437A	B	-	100	-	-	-	-	-	-
Turbo Cooling Water Pipe Supports	02-437B	A	-	100	-	-	-	-	-	-
Start Air Manifold Pipe, Tubing & Fttng.	02-441A	A	-	100	-	-	-	-	-	-
Start Air Manifold Vlvs, Strners, Fltrs.	02-441B	A	-	-	-	-	-	-	X(0)	9
Start Air Manifold Pipe Supports	02-441C	A	-	100	-	-	-	-	-	-
Starting Air Distributor Assembly	02-442A	A	100(0)	100(0)	-	-	-	100(0)	-	6
Start Air Distributor Tbg., Ftg., Gskts.	02-442B	A	-	100	-	-	-	-	-	-
Fuel Oil Booster Pump	02-445	A	-	-	-	-	-	-	X(0)	9
Fuel Oil Piping and Tubing	02-450B	A	-	100	-	-	-	-	-	-
Fuel Oil Piping Supports	02-450D	A	-	100	-	-	-	-	-	-
Fuel Oil Filters	02-455A	B	-	-	-	-	-	-	X(0)	9
Fuel Oil Strainers	02-455B	B	-	-	-	-	-	-	X(0)	9
Fuel Oil Filter Mounting Hardware	02-455C	A	-	100	-	-	-	-	-	-
External Lube Oil Lines	02-465A	A	-	100	-	-	-	-	-	-
External Lube Oil Line Supports	02-465B	A	-	100	-	-	-	-	-	-
External Lube Oil Valves	02-465C	A	-	-	-	-	-	-	X	9
Turbocharger Lube Oil Piping	02-467A	B	-	100	-	-	-	-	-	-
Turbocharger Lube Oil Piping Supports	02-467B	B	-	100	-	-	-	-	-	-
Turbocharger Bracket	02-475A	B	-	100	-	-	-	-	-	-
Turbocharger Air Butterfly Valve	02-475B	A	-	100(0)	-	-	100(0)	100(0)	-	-
Turbocharger Bracket Bolting	02-475D	B	-	8(0)	-	-	8(0)	-	-	12
Control Panel Cabinet	02-500A	A	-	-	-	-	-	-	X	9
Control Air Accumulator	02-500F	A	-	-	-	-	-	-	X	9
Control Air System Valves	02-500G	A	-	-	-	-	-	-	X	9

Sample Size, Percent of Engine Parts Inspected

Part Name	Part No.	Class	Dimen.	Visual	Surf. NDE	Vol. NDE	Material	Hardness	Eng Ev	Notes
Control Air System Pressure Switches	02-500H	B	–	–	–	–	–	–	X	9
Control System Relays	02-500J	A	–	–	–	–	–	–	X	9
Control System Solenoid Valves	02-500K	A	–	–	–	–	–	–	X	9
Control Air System Piping, Tubing, Ftgs	02-500M	B	–	100	–	–	–	–	–	–
Control Panel Wiring	02-500N	A	–	–	–	–	–	–	X	9
Lube Oil Sump Tank	02-540A	B	–	100	–	–	–	–	–	–
Lube Oil Sump Tank Bolting	02-540B	B	–	100	–	–	–	–	–	–
Lube Oil Sump Tank Mounting Hardware	02-540C	B	–	100	–	–	–	–	–	–
Foundation Bolts and Anchors	02-550	B	–		–	–	–	–	X(0)	9
Instrumentation Thermocouples	02-630D	B	–	–	–	–	–	–	X	9
Engine & Auxiliary Module Wiring Conduit	02-688A	A	–	100	–	–	–	–	–	–
Engine and Auxiliary Module Wiring	02-688B	A	–	–	–	–	–	–	X	9
Engine and Auxiliary Module Wiring Boxes	02-688C	A	–	–	–	–	–	–	X	9
Engine Alarm Sensors	02-690	A	–	–	–	–	–	–	X	9
Off Engine Safety Alarm Sensors-Switches	02-691A	B	–	–	–	–	–	–	X	9
Engine Shutdown Tubing and Fittings	02-695A	B	–	100	–	–	–	–	–	–
Engine Shutdown Valves, Regs. & Orifice	02-695B	A	–	–	–	–	–	–	X	9
Engine Shutdown Trip Switches	02-695C	A	–	–	–	–	–	–	X	9
Fuel Oil Duplex Strainer	02-825D	A	–	–	–	–	–	–	X	9
Turbocharger Thrust Bearing Lube System	02-CFR	C	–	100	–	–	–	–	–	–
Thermostatic Valve	C 106-40	B	–	–	–	–	–	–	X	9
Intake Air Filter	CN-106	B	–	–	–	–	–	–	X	9
Intake Air Silencer	CN-107	B	–	–	–	–	–	–	X	9
Before and After Lube Oil Pump	CN-109	A	–	–	–	–	–	–	X	9
Full Flow Lube Oil Filter	CN-110	A	–	–	–	–	–	–	X	9
Lube Oil Heat Exchanger	CN-111	B	–	–	–	–	–	–	X	9
Generator Shaft and Bearings	CN-119A	A	–	–	–	–	–	–	X	9
Jacket Water Heat Exchanger	CN-120	B	–	–	–	–	–	–	X	9
Oil Prelube Filter	CN-122	A	–	–	–	–	–	–	X	9
Lube Oil Keepwarm Strainer	CN-131	A	–	–	–	–	–	–	X	9
Intercooler	F-068	A	–	100	100	–	–	–	–	–
Turbocharger	HP-022/3	A	100	100	–	–	–	–	–	–
Lube Oil Full Pressure Strainer	SE-025	A	–	–	–	–	–	–	X	9

Notes to Table 5-1

1. Intake and exhaust valve springs have proper color code.
2. Ultrasonic wall thickness measurement of fire deck area and fuel nozzle area.
3. A torsiograph will be developed of the crankshaft.
4. Crankshaft web deflections and thrust clearance will be measured with the diesel both hot and cold.
5. Measure torque on belleville spring loaded bolts.
6. Hardness of the spools will be measured only if excessive wear is measured on one or more of the spools.
7. If inspection of camshaft lobes shows no abnormal wear, then no inspections of the camshaft bearings will be performed.
8. Eddy current test to determine if there are cracks.
9. Engineering validation (Eng Ev) of diesel 1A part including visual inspection to determine that part is per bill of materials and review of unscheduled maintenance reports associated with part. For diesel 1B, engineering validation consists of reviewing unscheduled maintenance reports.
10. Piston skirts will be replaced on the 1B diesel. Surface NDE and hardness were performed in receipt inspection.
11. New piston rings will be installed on the new skirts.
12. All bolting will be replaced.
13. Catawba 1B frequency of inspections same as Catawba 1A except as noted by parentheses. Where parentheses are included, frequency of inspection for Catawba 1B appears in the parentheses.

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VICE PRESIDENT
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TELEPHONE
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July 16, 1984

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Ms. E. G. Adensam, Chief
Licensing Branch No. 4

Re: Catawba Nuclear Station
Docket Nos. 50-413 and 50-414

Dear Mr. Denton:

The purpose of this letter is to submit Duke Power Company's plans for the periodic maintenance, inspection and surveillance of the Catawba 1A and 1B diesel engines. The plan is based on an engineering evaluation of the results of the Catawba 1A diesel engine post extended operating test inspections (reference 1), TDI Owner's Group recommendations, and NRC comments regarding diesel engine maintenance, inspection, and surveillance (reference 2). Inspection of the Catawba 1B diesel, following its extended operating test has just begun; if shown to be necessary by these inspections, changes will be developed to the maintenance, inspection and surveillance plan contained herein and submitted to the NRC.

A. Planned Program

Planned maintenance, inspection, and surveillance of the Catawba diesels is outlined in the attached Table 1, except that diesel engine periodic testing required by technical specifications is not shown since it is thoroughly described in the Catawba technical specifications (reference 3). It is considered that the maintenance, inspection and surveillance required by Table 1 satisfactorily addresses:

- The intent of NRC comments in reference 2.
- Periodic maintenance recommended by TDI in their technical manual.
- Results of inspections of the Catawba 1A diesel and other TDI diesels in nuclear service.

B. NRC Comments

The NRC comments of reference 2 relative to items warranting special attention in the periodic maintenance, inspection and surveillance of nuclear plant diesels, and how Duke Power plans to resolve these comments, are discussed below.

B.1 Cylinder Heads

a. NRC Comment. Following engine shutdown, the engine should be rolled over with air pressure after four hours (during cooldown) with the indicator cocks open. Subsequent to cooldown, engines should be air rolled every 24 hours. Any cylinder heads discovered leaking must be replaced. The utility should confirm that written procedures are adequate to ensure that the cocks are closed following each air roll.

b. Discussion. All cylinder head leaks in Catawba diesels have been associated with welded-in repair plugs. Inspections have been performed of the Catawba 1A diesel, and will be performed of the 1B diesel, to identify and replace any cylinder heads with such welded-in repair plugs. Elimination of heads with welded-in repair plugs is expected to minimize the potential for future cylinder head leakage problems. In this regard, it should be noted that no cracks were noted in the Catawba 1A cylinder heads of the type which would be expected to lead to leakage of cooling water into the cylinders (cracks associated with welded-in plugs lead to leaks into the fuel injector cavities, not into the cylinders). The types of cracks which could lead to water leakage into the cylinders include radial cracks in the fire deck emanating from valve seats; this type of crack was not detected in diesel 1A.

   Because of the absence of any history of water leakage into Catawba diesel cylinders, it is considered that daily air rolling of the diesels is not warranted. In addition, air rolling involves placing diesels out of service a significant amount of time, approaching an hour per day, which is undesirable. Moreover, if any difficulty should arise with the air roll operation, it is likely to cause the one hour time limit on having a diesel out of operation to be approached; because of technical specification requirements (reference 3), this would require an unnecessary start of the other diesel.

c. Duke Power Planned Action. The engines will be rolled within 4 hours after shutdown and weekly thereafter with indicator cocks open to check for water leakage into the cylinders. Air rolling of the diesels is also performed prior to routine engine starts. The operating procedures covering air rolling require that the cocks be closed after each roll.

B.2 Engine Block and Base

a. NRC Comment. Inspect the engine block and base every month or 24 hours of operation, whichever comes first. The inspection should be an external visual inspection requiring no disassembly. No other special maintenance is required if any defects found are "non-critical." Non-critical indications are defined as not causing oil or water leakage; not propagating; and not adversely affecting cylinder liners or stud holes.

b. Duke Power Planned Action Visual inspections of the block and base, as well as numerous other areas will be performed routinely during engine operation, i.e., every month or more often. These inspections will be directed at detecting signs of water or oil leakage at joints and similar areas, and at verifying that dangerous cracks are not propagating from stud holes in the block. The inspections will be performed and documented by operations personnel as part of normal operational checks and will be limited to those inspections which can be performed without disassembly of any parts.

B.3 Connecting Rods

a. NRC Comment. After each interval of 25 starts, 50 hours of operation or 6 months, whichever occurs first, all connecting ods should be visually inspected and all connecting rod bolts should be retorqued and the results recorded.

b. Discussion. Inspection of the Catawba 1A diesel connecting rods after over 800 hours of operation and 120 starts showed no signs of degradation and showed that the torques of the 1 1/2" connecting rod bolts had not relaxed. Accordingly, checks of bolt torques after 24 hours of operation or 25 starts appears to be excessively conservative. The NRC suggestion of a time period of 6 months for bolt preload checks appears to have no relation to processes which might cause bolt relaxation and is not warranted. In addition, inspection at 6 month intervals would result in significant loss of diesel availability, which is undesirable, and would require several additional starts of the other engine.

Checks of connecting rod bolt torques by ultrasonic length measurements have recently been completed for diesel 1A, and are considered to be a superior method of checking the preload in these bolts, as compared to use of torque measurements.

It should be noted that, if no significant loss of preload of these bolts occurs, then there is no chance of the joint degrading and no need to visually inspect the bolts. As noted above, relaxation of these bolts has not been experienced at Catawba, nor have the bolts experienced damage.

c. Duke Power Planned Action. All the 1 1/2" connecting rod bolt preloads will be checked at the first refueling outage. It is expected that about 25 starts and 50 hours of operation will have been accumulated at that time and that the maximum would be 50 starts and 200 hours of operation.

B.4 Lube Oil Checks

a. NRC Comment. The lube oil should be checked for water following pre-operational testing and then weekly and after each 24 hours of operation, whichever comes first. It should also be checked on a monthly basis for particulates and chemical contaminants associated with wear of bushings and bearings. Also, at intervals of one month, a sample should be collected from the bottom of the sump to check for water. All filters and strainers should also be checked monthly.

b. Discussion. The clean lube oil tank and the sump tank are checked for water on a monthly basis. No problems with water accumulation have been noted. Performing this check on a weekly basis is not warranted considering that the diesels are operated on a monthly basis and considering the lack of problems in this area.

A monthly check of lube oil for particulates and chemical contaminants associated with wear of bushings and bearings is not considered warranted since the diesel will accumulate only about 1 hour of operation per month. Accordingly, this type of check is planned to be performed each 6 months.

c. Duke Power Planned Actions.

- The lube oil will be checked for water following pre-operational testing and then monthly or after 24 hours of operation, whichever comes first.

- A sample will be collected from the bottom of the lube oil sump tank and checked for water each month.

- The lube oil will be checked by ferrographic and spectrographic means every 6 months to check for contaminants and particulates.

- The differential pressures across all filters and strainers will be checked during diesel operation, and filters and strainers will be cleaned or replaced as necessary.

B.5 Cylinder Head Studs, Rocker Arm Cap Screws, Air Start Valve Capscrews

a. NRC Comment. Each month 25% of the capscrews should be spot checked or torqued.

b. Discussion. Results of the Catawba 1A post extended operation test inspection reported in reference 1 showed that no problems with loss of bolt torque occurred in over 800 hours of operation. Subsequent to completion of pre-operational tests, only about 1 or 2 hours of operation are expected to be accumulated each month, which is not considered to be significant in regard to causing bolt preload relaxation. In addition, it should be noted that performance of preload checks would involve making the engine inoperable for extensive periods of time while the covers, subcovers and push rods are removed to provide access.

c. Duke Power Planned Action. Twenty-five percent of the head studs, rocker arm capscrews, and air start valve capscrews will be checked for preload relaxation during each refueling outage. The preloads checks will be performed either by torque measurements or by ultrasonic length measurements.

B.6 Push Rods

a. NRC Comment. Following pre-operational testing and then subsequently after each 24 hours of operation, cams, tappets, pushrods, etc. should be visually checked. This can be done at a time with the engine shutdown but without affecting its availability for service.

b. Discussion. Inspection of these parts requires removal of top covers and side covers and this involves having the diesel inoperable for extended periods of time. Accordingly, this inspection should be performed during an outage. Duke Power has friction welded push rods that have seen over 890 hours of operation and 1.2 x 10^7 cycles with no evidence of cracking.

c. Duke Power Planned Action. All cams, tappets, push rods, and rocker arms will be visually checked each refueling outage.

B.7 Lube Oil Filter Pressure Drop

a. NRC Comment. During standby, the lube oil pressure drop should be checked daily.

b. Discussion. During standby, the diesel lube oil system is in a steady state condition with a low flow rate. Since the diesel is not operating, production and release of particulates is minimal. Accordingly, weekly checks provide fully satisfactory monitoring of filter pressure drop.

c. Duke Power Planned Action. The prelube oil filter pressure drop will be checked on a weekly basis.

B.8 Crankshaft Deflection Tests

a. NRC Comment. Perform hot and cold crankshaft deflection checks every 6 months with the hot deflection tests performed within 15 minutes of engine shutdown.

b. Discussion. Hot and cold deflection tests performed to date up to over 810 hours of operation for diesel 1A have revealed no problems. Performance of these checks every 6 months, i.e. every 6 to 12 hours of operation, is not considered warranted. In addition, it would involve making the diesels inoperable for significant periods of time, which is not desirable.

Performing hot deflection tests within 15 minutes of shutdown is not permissible because of the need to let possibly explosive vapors escape from the crankcase. TDI indicates that hot deflection checks may be performed up to 4 hours after shutdown.

c. Duke Power Planned Action. Hot and cold web deflection tests will be performed at least once each refueling cycle. The hot deflection tests will be performed as expeditiously as possible and within the time period specified by the manufacturer, i.e., within 4 hours of engine shutdown.

B.9 Monitoring of Temperatures, Pressures and Vibrations

a. NRC Comment. During engine operation, the exhaust temperature for each cylinder should be monitored continuously by the operator and recorded on a log at hourly intervals, as should the temperatures entering and exiting the turbocharger. Other temperature and pressure readings for which the engine is instrumented should also be monitored continuously, and recorded hourly, or more frequently if specified by the manufacturer. These should at least include lube oil, jacket water, intercooler temperature, and air pressure. If the engine is equipped with an accelerometer on the main bearings and turbocharger, these should also be monitored continuously and recorded at hourly intervals. If the engine is not equipped with an accelerometer at these points, main bearing oil temperature should be monitored continuously and recorded hourly. Also, lube oil filter pressure should be monitored daily during engine operation.

b. Discussion. During diesel operation the following parameters are monitored:

- Cylinder Exhaust Temp.*
- Generator Stator Temp.
- Turbocharger Inlet Air Temp. (at Intercooler Inlet)*
- Turbocharger Outlet Air Temp. (at Intercooler Outlet)*

- Engine Lube Oil Temp.*
- Crankcase Vacuum
- Lube Oil Filter Delta P
- Lube Oil Pressure
- Lube Oil Tank Level
- Fuel Oil Filter Delta P
- Fuel Oil Pressure
- Fuel Oil Tank Level
- Jacket Cooling Water Temp.*
- Jacket Cooling Water Pressure
- Jacket Cooling Tank Level
- Control Air Pressure
- Lube Oil Pressure at Turbocharger Inlet
- Manifold Air Pressure
- Starting Air Pressure

The parameters marked with asterisks are continuously recorded as well as monitored.

The following parameters are recorded hourly on operating logs:

- Load - Watt Meter
- Power Factor
- Generator Volts
- Generator Amps
- Stator Temp.
- Lube Oil Pressure
- Lube Oil Filter D/P
- RB Turbo Oil Pressure
- LB Turbo Oil Pressure

- Fuel Oil Pressure
- Fuel Oil Filter D/P
- Jacket Water Pressure
- R&L Intake Manifold Pressure
- Lube Tank Level
- Cylinder Exhaust Temps.

Vibration switches located on the turbocharger are set to trip if excessive vibration levels are encountered. Vibration levels are also measured at various locations on the diesels on a semi-annual basis using hand-held probes.

It is considered that monitoring and recording the above parameters as discussed above provides a fully satisfactory program for monitoring the condition of the diesels.

c. <u>Duke Power Planned Action</u>. Pertinent diesel operating parameters will be monitored and recorded during diesel operation as described above.

C. Significant Features of Planned Program

C.1 Piston Skirt Inspection

The plan in Table 1 includes inspection of all piston skirts after about 10 years of operation to verify the absence of cracking at stud bosses and internal reinforcing rib - wrist pin boss junctions. This inspection would require extensive disassembly, which would not be warranted by the expected number of hours of operation. Accordingly, it is intended to monitor the performance of AE pistons in other TDI diesels during the next 10 years. If the accumulated experience provides confidence, as expected, that AE pistons are not subject to serious cracking concerns, then this inspection may be deleted or changed to a sample basis inspection.

C.2 Bearing Inspections

The plan in Table 1 is based on not disassembling connecting rods or main bearings for inspection until 10 years unless this is indicated to be prudent by ferrographic or spectrographic analyses of lube oil. At that time, a sample of the bearings will be inspected. The bases for this approach are as follows:

- TDI recommends bearing inspections be performed about every 5,000 hours (connecting rod bearings) to 10,000 hours (main bearings) of diesel operation. It is expected that, in 40 years, the Catawba diesels will accumulate less hours than TDI's recommended inspection periods of 5,000 and 10,000 hours.

- Ferrographic and spectrographic analyses provide a reliable method of ensuring that unusual or excessive bearing wear is not occurring.

- Extensive disassembly of the diesel exposes the engine to factors which can reduce reliability.

D. Summary Observations and Comments

D.1 The maintenance and inspections recommended by TDI for various time periods are based on the assumption that the diesels will accumulate hours at the rates normal for marine or utility diesels, e.g., 5,000 hours per year. However, in fact, the Catawba diesels are expected to accumulate less than 50 hours per year. Accordingly, the TDI recommendations are excessively conservative for the Catawba diesels. For this reason, TDI's recommended schedule has been relaxed in Table 1 for some items; however, the schedule in Table 1 still calls for much more frequent inspection and maintenance than would be required by the hours of operation.

D.2 The maintenance, inspection, and surveillance program of Table 1 applies to both the Catawba 1A and the 1B diesels.

D.3 The TDI Owners Group is preparing a recommended maintenance, inspection, and surveillance program. When it is issued, the Catawba program will be re-evaluated and revised as appropriate.

D.4 The enhanced inspections requested by the NRC regarding bolt preload checks require extensive amounts of work and appear to be not warranted based on there being no observed loss of preload in the Catawba 1A diesel after over 800 hours of operation. Accordingly, if initial preload checks after continued operation continue to show no loss of preload, Duke Power may request relaxation or elimination of these enhanced requirements.

D.5 The routine periodic maintenance, inspection, and surveillance covered in Table 1 should be considered preliminary and subject to change. As experience is gained with diesel operation, maintenance and test, these requirements may be adjusted. However, any changes to the enhanced requirements discussed in Section B above will be transmitted to the NRC prior to being implemented.

E. References

References used in this letter are listed below:

1. Duke Power Company report, Catawba Nuclear Station, Diesel Engine 1A Component Revalidation Inspection, Final Report, June 29, 1984.

2. NRC letter dated April 25, 1984, Docket No. 50-416, NRC Evaluation of the TDI Diesel Generator Reliability for Power Operation at Grand Gulf Nuclear Station, Unit 1.

3. Catawba Nuclear Station Technical Specifications

We trust that the information provided herein satisfies NRC needs regarding planned maintenance, inspection, and surveillance of the Catawba diesel engines. Please call me if I can be of any further service.

Very truly yours,

Hal. B. Tucker, Vice President
Nuclear Production

HBT:JG:rmm

Enclosures

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Table 1

Catawba 1A and 1B Diesel Engines

Periodic Inspection, Maintenance and Surveillance Schedule

Planned periodic inspection, maintenance, and surveillance for the Catawba 1A and 1B diesel engines is described in this table. It should be noted that additional inspection, maintenance, and surveillance will be performed on an as-required basis to correct or investigate actual or potential problems and as required by the plant technical specifications.

The periodic inspection, maintenance, and surveillance program is based on the plant following an 18 month refueling cycle. The anticipated operation of the diesels is as follows:

1 to 2 hours of operation per month of plant operation.

1 start per month of plant operation.

1 non prelube start per year.

The planned periodic maintenance, inspection, and surveillance is categorized below by the planned frequency of the work.

SCHEDULE

DURING OPERATION

PART NO.	PART NAME	REMARKS
--	TOTAL DIESEL AND SUPPORT SYSTEMS INCLUDING ENGINE BLOCK & BASE	GENERAL VISUAL CHECKS FOR LEAKAGE AND CHECKS OF COMPONENT PERFORMANCE PARAMETERS
02-500B	CONTROL PANEL ANNUNCIATORS	TEST ANNUNCIATOR LIGHTS VIA TEST BUTTON
02-500I	CONTROL PANEL PYROMETERS	CONTINUOUSLY MONITORED, CALIBRATED AS REQUIRED
--	STARTING AIR SYSTEM	DRAIN LOW POINTS, STRAINERS AND TANKS
--	LUBE OIL SYSTEM	CHECK LEVELS IN SUMP TANK, GOVERNOR AND PEDESTAL BEARING
02-371A	FUEL OIL PUMP RACK	CHECK FREEDOM OF PUMP RACK

WEEKLY

PART NO.	PART NAME	REMARKS
02-361	INDICATING COCKS	CHECK FOR WATER LEAKAGE, AND WITHIN 4 HRS OF SHUTDOWN
CN-115	BATTERY CHARGER	VERIFY BATTERY VOLTAGE

MONTHLY

PART NO.	PART NAME	REMARKS
CN-119	GENERATOR	MEGGAR TEST ROTOR AND STATOR
--	LUBE OIL SYSTEM	CHECK SYSTEM AND SUMP TANK FOR WATER, PARTICULATES, NEUTRALIZATION, AND SIMILAR CHARACTERISTICS
--	JACKET WATER SYSTEM	CHECK pH
CN-110	FULL FLOW LUBE OIL FILTER	DRAIN WATER & SLUDGE
--	SPACE HEATERS	CHECK OPERATION OF SPACE HEATERS IN CABINET

SEMI-ANNUAL

PART NO.	PART NAME	REMARKS
02-371A	FUEL RACK LINKAGE AND CONTROL SHAFT	LUBRICATE BEARINGS ON CONTROL SHAFT
--	LUBE OIL SYSTEM	CHECK LUBE OIL BY SPECTROGRAPHIC AND FERROGRAPHIC MEANS
--	DIESEL	VIBRATION MONITORING USING MANUAL PROBES

EACH REFUELING

PART NO.	PART NAME	REMARKS
—	LUBE OIL JETS	CHECK FOR PLUGGED OR BROKEN LINES
—	CYLINDERS	MEASURE COLD COMPRESSION & FIRING PRESSURE
00-700D	JACKET WATER STANDPIPE GAUGES	PER STATION CALIBRATION SCHEDULE
00-700E	JACKET WATER STANDPIPE SWITCHES	PER STATION CALIBRATE TEST SCHEDULE
02-310A	CRANKSHAFT	HOT AND COLD WEB DEFLECTION MEASUREMENTS
02-310C	CRANKSHAFT THRUST BEARING RING	MEASURE THRUST BEARING RING CLEARANCE
02-311A	CRANKCASE ASSEMBLY	REMOVE DOORS AND EXAMINE ENGINE
02-315E	CYLINDER HEAD STUDS	CHECK PRELOAD OF 25% OF STUDS
02-340A	CONNECTING RODS AND BUSHINGS	CHECK PRELOAD OF BOLTS
02-345A	INTAKE TAPPETS	VISUAL & PERFORM MEASUREMENT/ADJUSTMENT
02-345B	FUEL TAPPETS	VISUAL & PERFORM MEASUREMENT/ADJUSTMENT
02-350A	CAMSHAFT ASSEMBLY	VISUAL INSPECTION OF CAM LOBES
02-359	AIR START VALVE (BOLTING)	VERIFY TORQUE OF 25% OF BOLTS
02-365B	FUEL INJECTION TIPS	REMOVE, CLEAN, RESET, & REINSTALL
02-390G	ROCKER ARM BOLTING	VERIFY TORQUE
02-410A	GOVENOR OVERSPEED TRIP	PERFORMANCE TEST AND RECALIBRATE
02-411A	GOVENOR DRIVE GEAR AND SHAFT	VISUAL INSPECTION WHERE ACCESSABLE W/ELASTOMER REPLACEMENT
02-411B	GOVENOR DRIVE COUPLING	REPLACE ELASTOMER IN COUPLING
02-413A	GOVENOR LINKAGE	INSPECT FOR LOOSE PARTS ON LINKAGE
02-415A	SPEED REGULATING GOVENOR	CHANGE OIL, VERIFY SETTINGS
02-475B	TURBOCHARGER AIR BUTTERFLY VALVE	PERFORMANCE TEST, MAINTAIN AS REQUIRED
02-500D	CONTROL PANEL PRESSURE GAUGES	CALIBRATE PER STATION PROCEDURE
02-500F	CONTROL AIR ACCUMULATOR	PRESSURE TEST PER STATION CALIBRATION PROCEDURE
02-500G	CONTROL AIR SYSTEM VALVES	PRESSURE TEST PER STATION CALIBRATION PROCEDURE
02-500H	CONTROL AIR SYSTEM PRESSURE SWITCHES	CALIBRATE PER STATION PROCEDURE
02-500J	CONTROL SYSTEM RELAYS	TEST PER STATION SYSTEM PROCEDURE
02-500K	CONTROL SYSTEM SOLENOID VALVES	CALIBRATE PER STATION SYSTEM PROCEDURES
02-500L	CONTROL PANEL TACHOMETER	CALIBRATE PER STATION PROCEDURE
02-540D	LUBE OIL SUMP TANK HEATER	SET THERMOSTATS PER STATION PROCEDURE
02-630D	INSTRUMENTATION THERMOCOUPLES	FUNCTIONALLY TEST
02-689	OFF ENG. SAFETY ALARM SENSORS-WIRING	FUNCTIONALLY TEST
02-690	ENGINE ALARM SENSORS	FUNCTIONALLY TEST & CALIBRATE
02-691A	OFF ENG. SAFETY ALARM SENSORS-SWITCHES	FUNCTIONALLY TEST AND CALIBRATE PER STATION PROCEDURE
02-695B	ENG SHUTDOWN VALVES,REGULATORS,ORIFICES	SET OR CALIBRATE PER STATION SYSTEM PROCEDURE
02-695C	ENGINE SHUTDOWN TRIP SWITCHES	TEST PER STATION SYSTEM PROCEDURE
GN-115	BATTERY CHARGER	TEST CAPACITANCE
GN-117/8	GENERATOR CONTROL	TEST AND ALIGN SEQUENCER PER STATION PROCEDURE
GN-128	MISC. EQUIP.-HEATER, JACKET WATER	SET THERMOSTATS PER STATION PROCEDURE
GN-119A	GENERATOR SHAFT AND BEARINGS	CHANGE LUBE OIL

EVERY OTHER REFUELING

PART NO.	PART NAME	REMARKS
02-365A	FUEL INJECTION PUMP	DISASSEMBLE & CLEAN, INSPECT ONE REPRESENTATIVE PUMP

EVERY FIVE YEARS

PART NO.	PART NAME	REMARKS
00-491B	TURBO INLET ADPTR-MTG HDWE & FLEX CONN	GENERAL VISUAL INSPECTION W/TURBO DISASSEMBLY
02-350C	CAMSHAFT SUPPORTS, BOLTING AND GEAR	VISUALLY INSPECT GEAR, MEASURE BACKLASH
02-355A	IDLER GEAR ASSEMBLY (CRANK TO PUMP)	VISUALLY INSPECT GEAR, MEASURE BACKLASH
02-355B	IDLER GEAR ASSEMBLY	VISUALLY INSPECT GEAR, MEASURE BACKLASH
02-410C	OVERSPEED TRIP COUPLING	REPLACE ELASTOMER, INSPECT FOR LOOSENESS ON SHAFT WHILE ASSEM.
MP22/23	TURBOCHARGER	CLEAN & POLISH SNAIL & VANES, MEASURE THRUST CLEARANCE

EVERY TEN YEARS

PART NO.	PART NAME	REMARKS
02-305A	MAIN BEARING CAP BASE ASSEMBLY	PT OR MT OF TWO SADDLES
02-305D	MAIN BEARING CAPS	GENERAL VISUAL INSPECTION W/ DISASSEMBLY (TWO CAPS)
02-305F	MAIN BEARING CAP SEALS, GASKETS, & COVER	GENERAL VISUAL INSPECTION W/DISASSEMBLY (TWO CAPS)
02-307A	LUBE OIL INTERNAL HEADERS	GENERAL VISUAL INSPECTION W/DISASSEMBLY
02-307B	LUBE OIL TUBING AND FITTINGS	GENERAL VISUAL INSPECTION W/DISASSEMBLY
02-307C	LUBE OIL INTERNAL SEALS	GENERAL VISUAL INSPECTION W/DISASSEMBLY
02-307D	LUBE OIL LINE SUPPORTS	GENERAL VISUAL INSPECTION W/DISASSEMBLY
02-310B	CRANKSHAFT BEARING SHELLS	VISUAL & RT OF SAMPLE IN CONJUNCTION WITH DISASSEMBLY
02-315A	CYLINDER BLOCK	PT ACCESSABLE AREAS W/CYL HEAD DISASSEMBLY
02-315C	CYLINDER LINER	VISUAL INSPECTION IN CONJUNCTION WITH DISASSEMBLY
02-340B	CONNECTING ROD BEARING SHELLS	DIMENSIONAL, VISUAL, & RT OF BEARING SHELLS
02-341A	PISTONS	VISUAL AND MT INSPECTIONS
02-341B	PISTON RINGS	REPLACEMENT RINGS INSTALLED DURING REASSEMBLY
02-341C	PISTON PIN ASSEMBLY	VISUAL INSPECTION OF CHROME PLATING
02-359	AIR START VALVE	REMOVE, CLEAN & VISUALLY INSPECT W/DISASSEMBLY
02-360A	CYLINDER HEAD	PT SELECTED AREAS OF FIRE DECK
02-360B	INTAKE AND EXHAUST VALVES	VISUALLY INSPECT SEATS & CHROME PLATING
02-360D	VALVE SPRINGS	VISUAL INSPECTION W/DISASSEMBLY
02-380B	EXHAUST MANIFOLD BOLTING	5% VISUAL INSPECTION W/TURBO DISASSEMBLY
02-390A	ROCKER ARM ASSEMBLY	VISUAL INSPECTION OF SOCKETS
02-390B	EXHAUST ROCKER ARM ASSEMBLY	VISUAL INSPECTION OF SOCKETS
02-390C	PUSHRODS	VISUAL INSPECTION OF WELDS
02-390D	CONNECTOR PUSHROD	VISUAL INSPECTION OF WELDS
02-390E	ROCKER ARM BUSHING	VISUAL INSPECTION WHERE ACCESSABLE
02-442A	STARTING AIR DISTRIBUTOR ASSEMBLY	VISUALLY INSPECT POPPET VALVES SPOOL END & TIMING CAM
02-550	FOUNDATION BOLTS AND ANCHORS	VERIFY TORQUE, CHECK FOUNDATION BOND
CN-111	LUBE OIL HEAT EXCHANGER	INSPECT FOR FOULING, EROSION, ETC.
CN-120	JACKET WATER HEAT EXCHANGER	INSPECT FOR FOULING, EROSION, ETC.
F-068	INTERCOOLER	VISUAL INSPECTION OF WATER SIDE

AS REQUIRED

PART NO.	PART NAME	REMARKS
02-387D	CRANKCASE VENTILATORS & FLUID MANOMETER	MONITOR DURING OPERATION AND CALIBRATE AS REQUIRED
02-441B	START AIR STRAINERS AND FILTERS	CLEANING/REPLACEMENT GOVERNED BY D/P
02-455A	FUEL OIL FILTERS	REPLACEMENT GOVERNED BY D/P
02-455B	FUEL OIL STRAINERS	REPLACEMENT GOVERNED BY D/P
02-540A	LUBE OIL SUMP TANK	BASED ON OIL CHANGE REQUIREMENT
02-825D	FUEL OIL DUPLEX STRAINER	CLEANING GOVERNED BY D/P
02-835A	AIR DRYER	CHANGE DESSICANT
CN-106	INTAKE AIR FILTER	REPLACEMENT GOVERNED BY D/P
CN-110	FULL FLOW LUBE OIL FILTER	REPLACEMENT GOVERNED BY D/P
CN-122	OIL PRELUBE FILTER	CHANGE GOVERNED BY D/P
CN-131	LUBE OIL KEEPWARM STRAINER	CLEANING GOVERNED BY D/P
SE-025	LUBE OIL FULL PRESSURE STRAINER	CLEANING GOVERNED BY D/P

INSPECTION, MAINTENANCE AND SURVEILLANCE PLAN NOTES

Note 1: Time intervals listed should be understood as meaning the indicated period +/- 50% for time intervals shorter than a refueling interval.

Note 2: Items requiring 5 and 10 year inspections may be performed at the refueling either before or after the indicated period.