322

APPLICANTS' EXHIBIT ___

UNITED STATES OF AMERICAN
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

TESTIMONY OF G. WAYNE HALLMAN, RUSSELL P. MUSCHICK, S. ROBERT WARD, JEFFERY A. GORMAN, CLIFFORD A. WELLS, LEE A. SWANGER, SIMON K. CHEN, JESSE O. BARBOUR, J. MALCOLM CURTIS, AND ROBERT C. GAMBERG RELATING TO PROBLEMS ENCOUNTERED IN THE CATAWBA DIESEL GENERATOR QUALIFICATION PROGRAM.

1. Q. PLEASE STATE YOUR NAMES, EMPLOYERS AND BUSINESS ADDRESSES.

A. My name is G. Wayne Hallman. I am employed by Duke Power Company, 422 South Church Street, Charlotte, North Carolina. (GWH)

My name is Russell P. Muschick. I am employed by Duke Power Company, 422 South Church Street, Charlotte, North Carolina. (RPM)

My name is S. Robert Ward. I am a Principal Engineer employed by Dominion Engineering, Inc., 6862 Elm Street, McLean, Virginia. (SRW)

DS03

My name is Jeffrey A. Gorman. I am a Principal Engineer employed by Dominion Engineering, Inc., 6862 Elm Street, McLean, Virginia. (JAG)

My name is Clifford H. Wells. I am Vice President, Research and Development, Failure Analysis Associates (FaAA), 2225 East Bayshore Road, Palo Alto, California 94303. (CHW)

My name is Lee A. Swanger. I am employed by FaAA, 2225 East Bayshore Road, Palo Alto, California 94303. (LAS)

My name is Simon K. Chen. I am President, Power and Energy International, Inc. (PEI), P. O. Box 1054, 555 Lawton Ave., Beloit, Wisconsin 53511. (SKC)

My name is Jesse O. Barbour. I am employed by Duke Power Company, 422 South Church Street, Charlotte, North Carolina. (JOB)

My name is J. Malcolm Curtis. I am employed by Duke Power Company, 422 South Church Street, Charlotte, North Carolina. (JMC)

My name is Robert C. Gamberg. I am employed by Duke Power Company, 422 South Church Street, Charlotte, North Carolina. (RCG)

2. Q. PLEASE STATE YOUR RESPONSIBILITIES IN YOUR CURRENT EMPLOYMENT RELEVANT TO THE CATAWBA DIESEL ENGINE QUALIFICATION PROGRAM AND YOUR EDUCATIONAL AND PROFESSIONAL BACKGROUNDS.

A. I am Nuclear Maintenance Manager in the Nuclear Production Department at Duke Power Company. I have been assigned overall responsibility for the Catawba diesel engine qualification program. Aside from QA personnel, those Duke Power employees and consultants engaged in work related to the qualification program report to me. My educational and professional backgrounds are detailed in my resume, Attachment 1 to this testimony. (GWH)

I am a Maintenance Engineer in the Nuclear Production Department at Duke Power Company. I have been assigned overall responsibility for the test, disassembly, inspection and reassembly elements of the Catawba diesel engine qualification program. In this capacity I report to G. Wayne Hallman. My educational and professional backgrounds are detailed in my resume, Attachment 2 to this testimony. (RPM)

I am a Principal Engineer of Dominion Engineering, Inc. and a registered professional engineer. I have been retained by Duke Power Company to assist in developing the inspection procedures used in the revalidation inspections of the Catawba diesel engines, to assist in the engineering evaluation of inspection results, and to assist in writing the reports of inspection results. In this capacity, I report to Russell Muschick. My educational and professional backgrounds are detailed in Attachment 3 to this testimony. (SRW)

I am a Principal Engineer of Dominion Engineering, Inc. I hold a Ph.D in Engineering Science and I am a registered professional engineer. I have been retained by Duke Power Company to assist in the engineering evaluation of inspection results, to accomplish metallurgical and failure analysis of specific components, and to assist in writing the reports of inspection results. In this capacity, I report to Russell Muschick. My educational and professional backgrounds are detailed in Attachment 4 to this testimony. (JAG)

I am Vice President, Research and Development, Failure Analysis Associates (FaAA). I hold a D. Eng. in Applied Mechanics. I have been retained by Duke Power Company to perform analyses of critical diesel engine components and to assist in the engine inspection and the evaluation of the inspection results. In that capacity, I report to G. Wayne Hallman. My educational and professional backgrounds are detailed in Attachment 5 to this testimony. (CHW)

I am a Managing Engineer specializing in materials science employed by FaAA. I hold a Ph.D. in Materials Science and Engineering. I have been retained by Duke Power Company to perform analyses of critical diesel engine components, to assist in the preparation of the inspection plans and to assist in the evaluation of the inspection results. In that capacity, I report to G. Wayne Hallman. My educational and professional backgrounds are detailed in Attachment 6 to this testimony. (LAS)

I am President of PEI. I hold a Ph.D. in Mechanical Engineering and I am a registered professional engineer. I have been retained by Duke Power Company to evaluate the operability and reliability of the Catawba Standby diesel generator engines. I have performed an independent review of critical engine components and the surveillance program. My educational and professional backgrounds are detailed in Attachment 7 to this testimony. (SKC)

I am Quality Assurance Manager, Operations, in the Duke Power Company Quality Assurance Department. I am a registered professional engineer. I have been assigned responsibility to assure that desired inspections of the engines and replacement parts were conducted according to procedures on-site at Catawba. My educational and professional backgrounds are detailed in my resume, Attachment 8 to this testimony. (JOB)

I am Quality Assurance Manager, Vendors, in the Duke Power Company Quality Assurance Department. I have been assigned responsibility to assure that surveillances and witnessing of desired non-destructive examination (NDE) of replacement parts were performed at the TDI (Trans America DeLaval, Inc.) facility. My educational and professional backgrounds are detailed in my resume, Attachment 9 to this testimony. (JMC)

I am a Design Engineer in the Mechanical Systems Group of the Duke Power Company Design Engineering Department. This group is responsible for the design of fluid systems that are required to maintain the plant in a safe condition and mitigate the effects of postulated accidents. I have analyzed the electrical loads that the diesel generators are required to provide. My educational and professional backgrounds are detailed in my resume, Attachment 10 to this testimony. (RCG)

3. Q. WHAT ISSUES HAVE YOU BEEN ASKED TO ADDRESS IN YOUR TESTIMONY?

A. In my testimony, I provide an overview of the diesel engine qualification program by describing the events that led to the development of the TDI diesel engine qualification program at Catawba, describing the program itself, describing how the program was carried out, describing the results which have demonstrated the adequacy of these engines and describing the post-inspection preoperational tests. (GWH)

In my testimony, I provide the details of the test, disassembly, inspection, inspection result analyses, replacement of parts, reassembly and post-inspection preoperational tests. I address the Catawba-specific problems and their resolution. (RPM)

In my testimony, I address the inspection procedures and results of the Catawba diesel engine qualification program. (SRW)

In my testimony, I address the inspection results and selected metallurgical and failure analyses. (JAG)

In my testimony, I address the suitability of critical diesel engine components for use in the diesel generators at Catawba. Such suitability is based upon design reviews and analyses of individual components, inspection results, and testing of the diesel generator systems. (CHW)

In my testimony, I address the suitability of critical diesel engine components for use in the diesel generators at Catawba. Such suitability is based upon design reviews and analyses of individual components, observation of inspections, inspection results, and testing of the diesel generator systems. (LAS)

In my testimony, I address the effect upon operability and reliability of the Catawba diesel engines of the problems which have arisen in those engines. (SKC)

In my testimony, I address the role of the QA Operations Division of the QA Department in the disassembly and inspection program and in replacing parts. (JOB)

In my testimony, I address the role of the QA Vendors Division of the QA Department in the replacement of parts. (JMC)

In my testimony, I have provided a description of how the required diesel generator loads have been determined and which equipment could be disconnected during a loss of offsite power event without affecting the ability of the plant to be shut down safely. (RCG)

4. Q. MR. HALLMAN, ARE YOU RESPONSIBLE FOR THE MAINTENANCE PROGRAM FOR THE CATAWBA DIESEL GENERATORS?

A. Yes. I am responsible for providing technical direction in the establishment of an appropriate maintenance program for the Transamerica Delaval, Inc. (TDI) diesel generators at Catawba. This role is separate from my role in the diesel engine qualification program. (GWH)

5. Q. DESCRIBE THE CATAWBA TDI DIESEL ENGINES. WHAT IS THEIR FUNCTION?

A. The Catawba Nuclear Station has four (two per unit) TDI diesel engines, each of which drives an electric generator to supply emergency power. These engines have 16 cylinders arranged in a "V" configuration, two banks of 8 cylinders. Each cylinder is rated at 610 horsepower at 450 rpm. Each engine has an electrical generator associated with it; each generator has a nameplate rating of 7000 KW (225 BMEP) and 7700 KW (247.5 BMEP) overload.

Each nuclear unit at Catawba is equipped with an Engineered Safety Feature (ESF) system that automatically actuates certain backup systems in case of a loss of core cooling event. In order to assure that the ESF system is always available, even when normal power supplies are lost, each unit is equipped with two emergency diesel generators. The diesels are automatically actuated in two ways: 1) loss of coolant accident (LOCA) and 2) loss of offsite power (LOOP). If a LOCA event occurs, both diesels are started and remain running at idle in an unloaded condition. If, during a LOCA, there is also a LOOP, the diesels are automatically loaded with ESF loads which amount to a maximum of 5256 KW. If there is no LOCA condition but a LOOP event occurs, the diesels are automatically started and loaded with plant loads which amount to a maximum of 5714 KW. Consequently, the maximum requirement in an emergency situation is only 81.6% of the continuous capacity of one diesel generator. The other provides complete redundancy in the event of an emergency situation. (GWH, RCG, RPM)

6. Q. HOW FREQUENTLY ARE THE CATAWBA DIESELS RUN?

A. The Catawba diesels are run for routine testing and surveillance in accordance with plant Technical Specifications and procedures and NRC regulatory requirements and guidance. Such usage totals approximately 50 hours per year. However, as explained in question no. 5, the intended use of these engines is to provide power in an emergency situation. In such a situation, the normal operational considerations which generally relate to operation of large diesel engines would not apply to the emergency diesel engines at Catawba. (GWH, RPM, SKC)

7. Q. WHAT DO YOU MEAN BY "NORMAL OPERATIONAL CONSIDERATIONS"?

A. These would be considerations that would normally apply to operation of diesel engines in marine or stationary applications, or to operation of nuclear emergency diesels during routine testing and surveillance. Commercial marine and stationary power plant applications require engines to run for thousands of hours per year for twenty to forty years. In addition it is not uncommon for such engines to run continuously at high loads with no operator in the engine room to monitor operations.

However, emergency diesels in nuclear applications are safety-related equipment. They are inspected and operated to stringent standards and criteria, and when they do operate (whether under emergency conditions or under conditions of testing and surveillance) operators are present. In addition, procedures call for operators to be present in the engine rooms in the event they are needed in an emergency. Operation of the emergency diesels under emergency conditions will be unusual.

For commercial applications, such as marine usage and stationary power plants, or during nuclear diesel testing and surveillance, the consequences of component failure and the impact upon the engine take precedence. The operator makes the judgment, when running the engine, based on considerations of engine protection, whether to shut down when he sees indications such as were observed at Catawba during the extended operation test. Thus on occasion during the extended operation test run, engines 1A and 1B were shut down for investigation and correction of observed problems. These steps were taken for extra conservatism and in accordance with good engineering practice. However, this fact does not mean that in the event of an emergency, the engines would have been shut down. To the contrary, none of the problems reported at Catawba affected the ability of either diesel engine 1A or 1B to start on signal or to carry the required load in an emergency situation. (GWH, SKC, RPM)

8. Q. WHAT IS DIFFERENT ABOUT DIESEL ENGINE OPERATION UNDER EMERGENCY CONDITIONS?

A. Under emergency conditions, the concern is that the engine produce power for a relatively short period of time. Therefore, so long as the engine keeps running and produces the power required during the emergency situation, normal engine operational considerations do not apply. In short, emergency operation focuses upon those situations which would cause complete failure of a component, which in turn would result either in failure of the engine to operate or a reduction in its output below that necessary to carry the required load. It should be kept in mind that during the 40-year life of the plant, the total anticipated running time of of the emergency diesels (exclusive of any emergency that might arise) is something less than 2000 hours. (GWH, SKC, RPM)

9. Q. HAVE YOU EXPERIENCED PROBLEMS WITH THE TDI DIESEL ENGINES AT CATAWBA?

A. Yes. (GWH)

10. Q. WHAT HAS DUKE POWER DONE TO ADDRESS THESE PROBLEMS?

A. Duke has developed a program to qualify the Catawba diesel engines to provide reasonable assurance that they will perform their intended safety function, as described in the body of the testimony. This Catawba Diesel Engine Qualification Program (hereinafter, the "qualification program") includes a test and inspection program which is designed to run each engine a sufficient number of hours to reveal latent engine defects, followed by a detailed inspection to catalogue defects, if any, so that corrective action, if required, can be taken. Therefore, the qualification program includes: an extended operation test run for diesel engines 1A and 1B (the diesels associated with Unit 1); disassembly and inspection of the components of those engines; analyses of any indications found as a result of the inspections; corrective action, if any;

verification of the adequacy of replacement parts required as a result of the inspections; post-inspection preoperational startup testing; and an enhanced long-term maintenance and surveillance program. (GWH, RPM, SRW, JAG, CHW, LAS)

11. Q. MR. HALLMAN, PLEASE DESCRIBE YOUR INVOLVEMENT WITH THE QUALIFICATION PROGRAM FOR THE CATAWBA DIESEL ENGINES.

A. I am the leader of the Catawba Diesel Generator Task Force which is responsible for the qualification program. My responsibilities include coordinating the development of the extended run program, the inspection program, the return to service program and the long term maintenance program. I am also responsible for preparing reports on the diesel engine qualification program for submittal to the NRC. These include the following documents, all of which were prepared under my direct supervision.

- April 5, 1984 — Report to H. R. Denton (as a followup to Duke's March 21 meeting with NRC) describing the extended operation test and inspection plans for the Catawba 1A and 1B engines. (Attachment 11.)

- June 29, 1984 — Final report to H. R. Denton describing the results of the Catawba 1A engine inspection. (Attachment 12.)

- July 6, 1984 — Report to H. R. Denton describing the scope of the Catawba 1B engine inspection and the return to service test program for the 1A engine. (Attachment 13.)

- July 16, 1984 — Report to H. R. Denton describing the periodic maintenance, inspection and surveillance program for the Catawba 1A and 1B engines. (Attachment 14.)

- August 1, 1984 — Report to H. R. Denton in response to questions raised by NRC and Battelle personnel during a visit to Catawba on July 26, 1984. (Attachment 15.)

- August 3, 1984 — Letter to NRC addressing loads on engine 1B during its extended operation test run. (Attachment 16.)

- August 8, 1984 — Letter to NRC addressing questions raised by NRC and Battelle personnel during a visit to Catawba on July 26, 1984 and amending August 1, 1984 letter. (Attachment 17.)

- August 20, 1984 — Table showing loads on engine 1A during its extended operation test runs. (Attachment 18.)

Based on my involvement with the diesel engine qualification program, I have become knowledgeable about the problems experienced on the Catawba diesel engines. (GWH)

12. Q. DESCRIBE THE EVENTS WHICH LED TO THE NECESSITY FOR THE DIESEL ENGINE QUALIFICATION PROGRAM.

A. On August 12, 1983 a crankshaft failure occurred at the Shoreham Nuclear Station on one of the TDI emergency diesel engines. An investigation by the NRC revealed a number of problems being experienced in various applications related to TDI diesel engines. The NRC expressed its concern over the capability of TDI engines to perform in nuclear service and advised those owner utilities seeking operating licenses that steps had to be taken to restore confidence in their TDI engines.

As a consequence of the problems, the TDI Owners' Group, consisting of thirteen utilities (including Duke Power), was formed to address this issue. The primary objective was to develop a program that would qualify each engine component through analyses, tests and inspections.

The TDI Owners' Group program consists of the following:

- review of nuclear and industrial experience
- individual component design review and/or quality revalidation
- engine tests and inspections

From the experience data review, sixteen components were selected as having significant known problems that potentially could affect engine operability. The program to requalify these components through review of service history, design analysis, test and inspections is known as Phase 1 of the Owners' Group Program. Successful completion of Phase 1 was to be the NRC's basis for licensing near term plants. The sixteen components are:

1. Cylinder Liners
2. Cylinder Blocks
3. Crankshafts
4. Engine Bases
5. Cylinder Head Studs
6. Rocker Arm Capscrews
7. Connecting Rods
8. Jacket Water Pump Shafts
9. Air Start Valve Capscrews
10. Fuel Injection Lines
11. Push Rods
12. Electrical Cable Insulation
13. Turbocharger Thrust Bearings
14. Connecting Rod Bearing Shells
15. Piston Skirts
16. Cylinder Heads

Phase 2 of the Owners' Group Program is plant-specific, addresses other engine components, and includes a design review and quality revalidation by tests, inspections, and documentation review.

Components selected for the Owners' Group Program are categorized on a three part classification system described as class A, B, or C. These classifications are based on the effect of the component's failure on diesel engine startability and operability. Class A components are those whose failure could result in diesel generator shutdown or inability to start. Class B components include those whose failure, if not detected, could result in reduced capacity of the diesel engine or the eventual failure of a Class A component. Components whose failure has little or no bearing on the effective use or operation of the diesel engines are classified as Class C.

The Owners' Group has now completed detailed design reviews for all 16 generic problems and has submitted them to the NRC.

Because of the near term licensing schedule for Catawba, Duke decided to initiate an advanced extended operation and inspection program that would stand alone and not depend upon completion of the Owners' Group effort, but would also complement the Owners' Group Program. By following this course, Duke's program could be accomplished in a sufficiently timely fashion so as not to impact the plant operational schedule. (GWH, LAS, CRW, RPM, SRW)

13. Q. PLEASE EXPLAIN HOW THE PARTICULAR COMPONENTS OF THE ENGINE WHICH WERE INSPECTED IN DUKE'S QUALIFICATION PROGRAM WERE CATEGORIZED.

A. In developing our detailed inspection procedures, we independently assessed which components were important to diesel operability, using as a basis the classification presented by the Owners' Group, and included inspection of them if we considered them important or if there was some history of problems with them, even if the parts were not identified as class A or B parts by the Owners' Group. However, we included all parts classified as A or B by the Owners' Group.

A categorization of the Catawba diesel engine parts is set forth in table 3.1 of Duke's June 29, 1984 Final Report. (Attachment 12 to this testimony). (GWH, RPM, SRW, JAG)

14. Q. PLEASE DESCRIBE THE TEST AND INSPECTION PROGRAM FOR THE CATAWBA DIESEL ENGINES.

A. The test and inspection program is based on running each engine a sufficient number of hours to reveal latent engine defects (the extended operation test run). Following the extended run the engine would be disassembled and a detailed inspection would be conducted to detect any defects which might exist.

On March 21, 1984, Duke presented its program to the NRC. In that presentation Duke committed both engines

1A and 1B to be run no less than 750 hours (10 million stress cycles) to demonstrate individual component endurance. The specific loads at which the 1A and 1B engines were run and the number of hours for these loads are set forth in Attachments 18 and 16, respectively. Duke also committed to a full disassembly of engine 1A after its extended run for detailed examination of all appropriate components. A commitment was also made to inspect the 1B engine after its extended run. The scope of the 1B inspection is based on the results of the 1A inspection. (GWH, RPM, SRW)

15. Q. DESCRIBE THE OBJECTIVES OF THE DIESEL ENGINE QUALIFICATION PROGRAM AND EXPLAIN HOW THE PROGRAM ACCOMPLISHED THOSE OBJECTIVES.

A. The diesel engines' ability to start successfully and pick up load has been successfully demonstrated during preoperational testing. Therefore, the main objective of the qualification program was to demonstrate the engines' ability successfully to operate continually under full load (7000 KW/225 psi BMEP) in the nuclear station environment.

In reviewing the operating history of similar TDI V-16 diesels, it was noted that few nuclear service engines had significant operating hours. Therefore, in order to gain additional operating experience directly applicable to the Catawba diesels' intended function, Duke committed to run the 1A and 1B engines for extended periods. The commitment also included an extensive inspection of the internal components of each engine to verify their adequacy, and to make appropriate corrections to components, if necessary, in the event of unsatisfactory performance. In addition, the program includes post-inspection and preoperational testing as well as an enhanced maintenance and surveillance plan.

Completion of this program will provide reasonable assurance that these engines will perform reliably throughout their intended service life. (GWH, SKC, RPM, SRW)

16. Q. PLEASE EXPLAIN IN DETAIL HOW THE EXTENDED OPERATION TEST WAS CONDUCTED. WHAT WERE THE RESULTS OF THE PROGRAM?

A. The extended operation test was structured to demonstrate the reliability of the Catawba diesels. The extended operation tests have demonstrated the fatigue resistance of the Catawba diesel components. The 810 hours of operation of diesel 1A and 755 hours of operation of diesel 1B have subjected the major components of the engines to greater than ten million firing cycles. More than eight million of those firing cycles were at or above 225 BMEP. The ability to operate ten million stress cycles is generally accepted as establishing the endurance limits of mechanical components made of iron or steel, i.e., unlimited fatigue lifetime under the imposed load condition.

Thus, the components of the Catawba diesel which exhibited no fatigue failure can be considered as having demonstrated unlimited fatigue lifetimes. It is generally accepted that the difference in fatigue behavior between eight million and ten million stress cycles is insignificant.

The extended operation tests served to demonstrate the reliability of each diesel as a unit. The disassembly inspection performed after the tests served to verify the satisfactory condition of individual parts in terms of freedom from cracks, excessive wear, etc.

The only major condition found in these inspections which had the potential eventually to limit diesel operability under emergency conditions were fatigue cracking of the AN piston skirts and severely worn turbocharger bearings. The piston skirt cracking has been resolved by replacement with a proven design while the turbocharger bearing problem is being resolved by installation of a proven and improved lubrication system. Some other conditions were detected and corrected, but these would not have affected diesel startability or operability under emergency conditions. In summary, the extended operation tests, subsequent inspections, and replacement of the piston skirts and turbocharger bearings have served to put the diesels in a condition where there is a high level of assurance of integrity of diesel parts and of diesel operability. It is our opinion that the results of the diesel engine qualification program demonstrate the ability of the Catawba diesel engines to operate satisfactorily at 225 BMEP. (GWH, RPM, CHW, LAS, SKC, JAG, SRW)

17. Q. PLEASE DESCRIBE WHAT THE INSPECTION PROGRAM WAS INTENDED TO ACCOMPLISH.

A. The intent of the inspection program was to verify the mechanical reliability of the Catawba engines following extended periods of operation. The scope of the program includes all engine components that could result in the inability of the diesel to start or continue to operate, or to degrade diesel performance below that necessary to meet the required load. Inspection methods were selected which were sensitive to the possible types of degradation that might occur with each component, and included visual, magnetic particle, eddy current, ultrasonic, and radiographic methods. In addition, dimensional checks, material property checks, crankshaft torsiograph tests, and bolt torque checks were conducted. (GWH, RPM, JAG, SRW)

18. Q. DESCRIBE THE INSPECTION METHODS FOR PARTICULAR COMPONENTS AND EXPLAIN HOW THEY WERE DETERMINED.

A. A variety of inspection methods was employed to examine the diesel parts. Inspection methods were selected based on:

- The probable failure mode of the component, for example initiation of cracks in the piston skirt.
- The attribute being determined, for example, bearing wear.
- Results of previous inspections.

The specific inspection methods employed included:

- Visual inspection for wear and wear patterns, cracks, corrosion/erosion, gasket leaks, verification of as-built system piping configurations, pipe support conditions, etc.
- Dimensional measurements for critical dimensions, proper fits and clearance of mating parts, etc.
- Liquid penetrant and magnetic particle tests for cracks and discontinuities.
- Eddy current tests for cracks and discontinuities not detectable by liquid penetrant or magnetic particle because of physical configuration or surface condition.
- Ultrasonic tests for critical wall thickness of components and volumetric examination to detect relevant discontinuities.
- X-ray tests for volumetric examination to detect relevant discontinuities.

- Material hardness and material comparitor tests to check material properties.
- Torsiograph test to confirm calculated crankshaft torsional stresses and verify critical speeds.
- Breakaway torque values for bolted connections to verify that uniform bolt preload existed.

These well accepted inspection methods were selected by Duke upon review of Owners' Group recommendations and Duke Power engineering evaluation of the parts to be inspected.

These inspection methods were implemented through detailed inspection procedures. The procedures were developed by Duke Power metallurgical and mechanical engineering staff and then subjected to additional station internal reviews and approvals. (GWH, RPM, JAG, SRW)

19. Q. WHAT SAMPLE SIZE WAS USED BY DUKE IN ITS INSPECTION EFFORT?

A. Sample size varied from component to component depending on the operating condition for the component and its operational history. Where there was a history of component problems considered applicable to the Catawba diesel, the sample size was 100% (i.e., all of these components were inspected). Included in this group were the 16 generic problems addressed by the TDI Diesel Generator Owners' Group effort.

For those components determined to be critical to engine operation, but with no history of operational problems, inspections were performed on the basis of selected samples. In those cases, the areas or parts of those components subjected to the most severe stresses were inspected. In the majority of instances, 100% inspection of components was performed. The sampling approach was used in only a few instances for parts with no history of problems. The justification for doing a selective inspection of these few components was based upon engineering evaluations for each component application. (GWH, RPM, JAG, SRW, SKC)

20. Q. WHAT TECHNICAL SUPPORT WAS AVAILABLE TO CARRY OUT THE INSPECTION PROGRAM?

A. A qualified technical group was assembled to support the inspection program. This group included Duke Power mechanical and metallurgical personnel, who were responsible for implementing the program as well as assuring that analyses of failed parts were carried out. Procedures were written with the assistance of consultants (Dominion Engineering, Inc.). In addition, mechanical design and metallurgical personnel were used from consulting organizations with experience in diesels (Gustafson Associates), and nondestructive testing and failure analysis (Dominion Engineering, Inc. and Failure Analysis Associates). The disassembly and mechanical inspection of the diesel engine was performed by the plant maintenance staff, with review by the Duke QA/QC program. Nondestructive inspections have been performed pursuant to the Duke QA/QC program.

Analyses of those parts with reportable test results were performed or supervised by the Duke Power engineering staff, FaAA and Dominion Engineering, Inc. Where appropriate, as determined by the above engineering analysis, detailed mechanical and metallurgical analyses were performed. The results of these analyses have been used to determine if any additional inspections are appropriate and what they should be, if any. In addition, the analyses are used to determine the appropriate action to assure reliable engine operation in the future.

Any modifications which may be made to the engine will be accomplished using the existing procedures and controls appropriate for safety-related plant equipment. (GWH, RPM)

21. Q. PLEASE DESCRIBE THE INVOLVEMENT OF THE QA OPERATIONS DIVISION WITH THE CATAWBA DIESEL GENERATOR QUALIFICATION PROGRAM.

A. The Operations Division of the Quality Assurance Department, which I manage, has been involved with the Catawba diesel generator program in that certified inspectors within the Division performed all of the inspections involved during the qualification run and disassembly and inspection which were not contracted to outside consultants, including receipt inspections of replacement parts.

Some radiographic inspections were done by outside contractors; in those instances, certified inspectors in the Division read and interpreted the results. Eddy current testing was also performed by FaAA inspectors who were approved by the QA Vendors Division.

Inspections and interpretations of radiographs were performed under my supervision and control. I have examined pertinent inspection reports on the diesel generator qualification program and believe that these activities were performed in accordance with established procedures. (JOB)

22. Q. DESCRIBE BRIEFLY THE QUALITY ASSURANCE DEPARTMENT'S ROLE IN THE TEST AND INSPECTION PROGRAM.

A. The role of the Quality Assurance Department, Operations Division, in the test and inspection program is four-fold:

The first role is to verify that applicable maintenance procedures have been followed in the disassembly and reassembly of the engines by maintenance personnel in the Nuclear Production Department. QC inspectors monitor work in progress and are present at specified hold points during the disassembly and reassembly process. The purpose of this role is to assure that the diesel engines are properly disassembled, so as not to damage parts and to preserve evidence of conditions resulting from operation. Furthermore, it is necessary that these procedures are followed during reassembly to assure that no damage occurs on reassembly and the engines are properly reassembled. QA personnel reviewed these procedures prior to use and inserted hold points and QC sign-offs where deemed necessary to indicate verification of specific steps. During the disassembly and reassembly, procedural checklists and data sheets are filled in. Appropriate blanks on these documents are signed by both a QA inspector and the craftsmen performing the disassembly or reassembly.

The second role is to verify that certain dimensions are taken during the disassembly process so as to document the "as-found" conditions. The as-found conditions indicate the extent of any wear or distortion that may be present as a result of operation. The items to be dimensionally checked were incorporated into the maintenance procedures generated by the Nuclear Production Department. QC inspectors observe measurements taken by craftsmen.

The third role is to perform any visual or other nondestructive tests on component parts of the engines removed during disassembly to determine their suitability for continued service. The NDE is performed by QC inspectors who also record the results of the inspections. NDE conducted by QC inspectors included dye penetrant testing, magnetic particle testing, and ultrasonic testing. Radiographic examination is conducted by Duke Power inspectors and outside contractors who have been approved by the QA Vendors Division. All radiographs are examined by qualified Duke Power personnel. Visual inspection is performed by both craftsmen and QC inspectors. Eddy current inspection was performed by FaAA inspectors who were approved by the QA Vendors Division.

The first three roles are performed onsite at Catawba by certified QA Operations Division inspectors. As added assurance, these activities are reviewed periodically on a random basis by QA Operations Division surveillance personnel and QA Audit Division auditors.

The fourth role, performed in conjunction with the QA Vendors Division, is to assure that the replacement parts used during the reassembly of the engines are adequate for their intended use. This role is carried on at the vendor's manufacturing facilities, in the QA Department offices in Charlotte and onsite at Catawba. (JOB)

23. Q. PLEASE DESCRIBE THE RESULTS OF THE INSPECTION PROGRAM AS IT RELATES TO THE SPECIFIC COMPONENTS INSPECTED.

A. This point is specifically addressed in detail in subsequent testimony. For overview purposes, however, the most significant results of the Catawba 1A and 1B diesel engine post extended operation test inspections are as follows:

- Many of the major problems experienced with other TDI diesel engines did not occur in the Catawba 1A and 1B diesel engines. These problems not occurring at Catawba include, but are not limited to, failed crankshafts, cracked connecting rod-crankpin bearing shells, connecting rod box cracks, and cracked cylinder blocks.

Only two problems which potentially could have affected diesel operability occurred.

- 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. Even though these cracks had not affected performance of the diesel during the extended operation test run, all of the 1A and 1B diesel type AN piston skirts will be replaced with improved design type AE skirts.

- The turbocharger thrust bearings were found to be severely worn on both engines, even though they had continued to function satisfactorily during the tests. This condition was anticipated since similar problems have been experienced earlier at Catawba and at other installations. As a result of this history, a modification to improve the prelube system, which is expected to prevent recurrence of the problem has been developed. It will be installed on 1A and 1B before they are returned to service after their inspections.

All damaged bearings will be replaced prior to return to service. In addition the NRC Staff is considering amending some of its test requirments which were significant contributors to turbocharger bearing wear.

- Two other problems of lesser consequence were noted as follows:

    - Five subcover castings (three on 1A and two on 1B) were found to have cracks in an intake rocker arm pedestal. These cracks did not affect diesel startability or operability and are not service related, but rather were caused by installation errors by Duke Power personnel. The affected castings have been replaced and installation procedures improved to prevent recurrence.

    - Four Catawba cylinder heads (one on diesel 1A and three on 1B) experienced small jacket water leaks into the fuel injector cavity. Metallographic examinations of the head removed from the 1A diesel indicated that the leak was due to a fatigue crack emanating from a welded plug used to repair the casting. All heads with this type of repair are being replaced. It should be noted that the problem did not affect diesel operability since the water leaks to the exterior of the cylinder head and not into the cylinder. One cylinder head on 1B experienced a crack in the overlaid weld area of the valve seat area. There was no leakage through this crack and, thus, no effect on diesel operability.

- A variety of routine minor conditions were noted. None of these conditions impact the operability or structural integrity of the diesel. Typical conditions of this type include:

  - Chipped and cracked edges of rocker arm sockets.
  - Flaked off valve stem chrome plate.
  - Galled air start valve adjusting nut.

- Heads of small bolts broken off, due to under- or over-torquing.
- Fuel injection pump delivery valve holder cracked.
- Fuel injection pump delivery valve block cracks.
- Fuel line fittings leaks.
- Push rod end weld cracks.
- Lube oil and jacket water thermocouple failures.
- Turbocharger lube oil drain line leaks.
- Turbocharger exhaust manifold mounting bolt failures.
- Exhaust valve tappet swivel pad cracks.
- Triple clamp bolts failures.

In summary, the only conditions found which could potentially have impacted diesel operability under emergency conditions were the piston skirt cracks and turbocharger thrust bearing wear problems. Neither of these problems prevented the diesels from successfully completing their extended operation test runs. These problems are being corrected by installation of improved components and a modification to an existing system. A number of other minor conditions were detected and corrected, but would not have affected emergency diesel operation. (GWH, RPM, SKC, JAG SWR)

24. Q. DID ANY OF THE PROBLEMS EXPERIENCED AT CATAWBA HAVE AN ADVERSE EFFECT ON THE ABILITY OF THE DIESEL ENGINE TO MEET ITS REQUIRED LOAD?

A. No. None of these problems caused the engine to fail to start, to shutdown or to reduce its output below the level necessary to meet its load.

To demonstrate this, we have classified the problems seen on the Catawba engines into classes by their observed effects on the operability of the diesels. The classes are:

(1) Prevented startup or required shutdown of engine;

(2) Reduction of output of engine such that the load would be reduced below 5714 KW (Loss of offsite power load);

(3) No effect on performance or engine starting, but problem should be corrected at earliest date; and

(4) No effect on performance or engine starting, correct when convenient.

When the problems seen on the Catawba engines are classified in this manner, we find none in categories 1 and 2; 15 in category 3; and 10 in category 4. (CHW, LAS, SKC, RPM, SRW)

25. Q. LIST THE TDI GENERIC PROBLEMS AND IDENTIFY THOSE THAT WERE NOT FOUND AT CATAWBA NUCLEAR STATION UNIT 1.

A. Inspections related to determining whether the 16 TDI generic problems existed on the Catawba Unit 1 diesels were performed. The results of these inspections indicated that 10 of the TDI generic problems were not in evidence on the Catawba diesels. These potential generic problems were:

- Cylinder Liner Degradation
- Cylinder Block Cracking
- Crankshaft Cracks
- Engine Base Cracking at Main Bearing Studs
- Cylinder Head Stud Fatigue Failures & Improper Torquing
- Rocker Arm Capscrew Fatigue Failure
- Connecting Rod Bolt and Bolt Hole Cracks
- Jacket Water Pump Shaft Failure
- Air Start Valve Capscrew Length Interference
- Fuel Injection Line Leaks Due to Draw Seams

The Six TDI generic problem areas found on the Catawba diesels were:

- Cylinder head cracks
- Piston skirt cracks
- Turbocharger Thrust Bearing Wear
- Electrical Cable Insulation Grade
- Connecting Rod Bearing Indications
- Push Rod End Weld Cracks

(RPM, SRW, JAG)

26. Q. WHAT PROBLEMS HAVE YOU EXPERIENCED WITH THE CATAWBA DIESEL ENGINES?

A. These problems are discussed in detail in the testimony below. However, for overview purposes, the components for which problems have been experienced at Catawba are as follows:

1. Cylinder Head
2. Piston Skirt
3. Turbocharger Bearings
4. Electrical Cable Insulation
5. Connecting Rod Bearings
6. Push Rods
7. Fuel Injection Pump Delivery Valve Holder
8. Fuel Line Fittings
9. Fuel Injection Pump Delivery Valve Block
10. Turbocharger Adapter
11. Intercooler Jacket Water Line

12. Turbocharger Lube Oil Drain Line
13. Turbocharger Prelube Oil Lines
14. Rocker Box (Subcover) Subassembly
15. Exhaust Valve Tappet (Rocker Arm Adjusting Screw Swivel Pad)
16. Intermediate Rocker Arm Sockets
17. Exhaust Valve Stems
18. Lube Oil and Jacket Water Thermocouples
19. Crankcase and Camshaft Cover Capscrews
20. Turbocharger Exhaust Gas Inlet Bolts
21. Clamp Bolts
22. Turbocharger Bolting
23. Fuel Injector Nozzle Holder Studs
24. Starting Air Distributor Cover Capscrew
25. Spring Retaining Nut and Roll Pin on Air Start Valves

(RPM, SRW, JAG)

27. Q. WOULD YOU DISCUSS THE CATAWBA SPECIFIC PROBLEMS?

A. Yes. The discussion will include the problems which were experienced on the Catawba diesels; the effect of those problems on the ability of the diesels to meet emergency requirements; the analyses performed on those problems and the results of the analyses; the corrective action taken to eliminate the problems to assure that the problems will not recur; and the effect that the problems have on replacement components. Reference will be made to the "Catawba Nuclear Station Diesel Engine 1A Component Revalidation Inspection, Final Report" (Final Report), dated June 29, 1984. (Attachment 12 to this testimony.) (Where a section of this report is referenced, it will appear as ref. followed by the appropriate section, for example, ref. 3.1.1). (RPM, SRW, JAC)

1. Cylinder Heads

a. Problem and Effect on Operability

The cylinder heads house the starting, intake, and exhaust valves and the fuel injector nozzle. Cooling water passes through internal passages in the cylinder head to remove heat arising from the compression, firing, and exhaust cycles of the engine. The fire deck of the cylinder heads is the area exposed to the pressure forces and thermal stresses associated with the diesel cycle. The fire deck contains the valve seats, injector port and air start port. The fire deck is supported by the fuel injector installation boss, the air start valve bore and the intake and exhaust valve ports which transfer load to the center deck and upper deck.

Older TDI cylinder heads have exhibited a variety of cracking problems in service, including cracks in the fire deck area, and cracks in the exhaust valve sea s, ports and ducts. These problems are primarily attributable to manufacturing processes.

During the extended operation test runs on the 1A and 1B diesels at Catawba, cracking was noted on four cylinder heads, one on 1A and three on 1B. This cracking was evidenced by water leakage to the exterior of the engine. The engines were run for several days with these leaking heads.

There was no leakage of water into a cylinder bore at Catawba as a result of the cracked cylinder heads. Consequently the cracked cylinder heads at Catawba did not affect, nor would they have affected, startability or operability at Catawba.

In addition, during the inspection following the extended operation test run, one cylinder head on the 1B engine was found to have a crack in the exhaust valve seat area. No water leakage resulted from this crack. Because there was no leakage from the crack in the valve seat area on the one head on 1B, there was no potential for adversely affecting engine operability or startability. (CHW, LAS, SKC, RPM)

The cylinder head concern is a category 3 item.

b. Analyses

FaAA has performed extensive analyses into the generic problems reported with TDI cylinder heads including valve seat cracking. In addition, FaAA has performed analyses of the cause of leakage into the injector nozzle cavity. These analyses incorporated metallurgical and stress/fatigue analyses, as well as analysis of the manufacturing practices. (FaAA-84-5-12; ref. 3.1.16) (CHW, LAS)

c. Results of Analyses

The analyses indicate:

- Inadequate preheat during the application of valve seat weld overlay and insufficient post weld heat treatment to properly relieve valve seat residual stresses may lead to cracking of the valve seat weld overlay.

- External jacket water leakage was due to use of welded-in plugs to repair castings at the fuel injector nozzle port in the fire deck. Fatigue cracks from these plugs resulted in jacket water leaks to the outside of the cylinder head. (CHW, LAS)

d. Corrective Action Taken

The valve seats were liquid penetrant inspected to verify absence of cracking. The 1A heads were all satisfactory in this area. The 1B heads had one cracked valve seat. This head is being replaced.

All Catawba cylinder heads have been visually inspected to determine if any have welded-in repair plugs. All heads with welded-in repair plugs are being replaced with heads without welded-in repair plugs to prevent further external jacket water leaks. (RPM, SRW, JAG)

e. <u>Assurance that the Problem has been Corrected</u>

Liquid penetrant examination has assured that there are no defects in the surface of the fire decks in the cylinder heads now on the Catawba engines. Additionally, the visual inspections have assured that welded-in plugs have been identified and will be replaced. The foregoing assures that cylinder head cracks should not be a problem at Catawba in the future. In addition, Duke and the NRC Staff have agreed on procedures for systematic "barring-over"*/ of the engines to assure that water leakage into cylinders will be detected in the unlikely event it does occur. This provides assurance that, even if cracks were to exist, and leakage into cylinder bores were to occur, the situation will be detected and corrected in a timely fashion so as not to affect the ability of the diesel to start in an emergency situation. (RPM, SKC)

---

*/ "Barring-over" describes the process of slowly rotating the engine crankshaft and associated components with cylinder indicating cocks open and the fuel supply cut-off.

f. Effect of Replacement

Replacement heads will meet the same inspection requirements as have recently been performed on the installed heads. Hence, replacement heads will be free of problems which existed in the heads originally installed. (RPM)

2. Piston Skirts

a. Problems and Effect on Operability

The piston skirt is a cylindrical barrel-shaped casting bolted to the piston crown. It slides up and down within the cylinder and transmits the forces resulting from the combustion cycle of the engine from the crown to the wrist pin and connecting rod, thereby exerting forces that provide driving torque to the crankshaft. The mechanical link between the crankshaft and the piston is the connecting rod and the wrist pin.

Four of the Catawba 1A diesel piston skirts (Type AN) cracked at the reinforcing rib to wrist pin boss fillet. This cracking was found during the inspections following the extended operation test run which lasted more than 800 hours, and included over 660 hours at and above 225 psi BMEP (or 7000 KW). The largest crack observed which was the only one to penetrate the skirt wall, reached a vertical length of 3 inches. None of these cracks affected operability or startability.

This concern is a category 3 item. (CHW, LAS, SKC)

b. Analyses Performed

A metallurgical and stress analysis of the failed AN piston skirts was performed to determine the cause of cracking. This analysis included experimental determination of the distribution of the residual stresses in the circumferential reinforcing rib by the strain gauge rosette/center hole method, and metallographic examination of the fracture surfaces of two cracks using a scanning electron microscope. In addition, an AN piston skirt was instrumented with strain gauges, including a gauge in the critical area where cracking was observed to initiate in the Catawba AN piston skirts. This skirt was assembled with a crown and connecting rod and was hydrostatically loaded in a test rig to simulate the peak firing pressure.

The new Type AE skirt design, which has now been installed in the Catawba engines to replace the original AN skirts, has been tested and analyzed in order to compare the stresses in the AE and AN piston skirts. Specifically, a replacement AE piston skirt was instrumented and hydrostatically tested in a manner similar to that described above for the AN piston skirt. (LAS, CHW)

c. Results of Analyses

The cracking of the AN skirts at Catawba, in the fillets between the reinforcing rib and wrist pin bosses, was attributed to high-cycle fatigue. Because the replacement AE skirts have a significantly increased cross section and a gradual taper in the reinforcing ribs, the stress level is substantially lower than in the Type AN skirts. As measured by experimental stress analysis, the stress in AN skirts is two times that in AE skirts. In other words, there is a 50% reduction in stress level from the original AN skirts to the replacement AE skirts.

Based on this comparison, the ribs of the replacement AE skirts are concluded to be adequate for unlimited operation at full load (225 BMEP). The extended endurance run showed that 12 of the 16 AN piston skirts in Catawba 1A diesel were operated below their endurance limit, i.e., the stress levels in the AN skirts were in the scatter band of the endurance limit stress. Based on engineering experience, the 50 percent decrease in the stress level from the AN skirt to the AE skirt will result in reducing stresses to well below the endurance limit, providing an infinite fatigue life at 225 BMEP for the AE skirt. (CHW, LAS, SKC)

d. Corrective Action Taken

The type AN Catawba 1A and 1B diesel piston skirts have been replaced with improved Type AE skirts even though the uncracked AN skirts have been qualified for unlimited operation at full load (225 BMEP). This was done because of schedule constraints associated with analyses of the original AN skirts. We believe that the AE piston skirt is a superior design and we also note that this approach is in accordance with recommendations of the NRC Staff. (RPM)

e.&f. <u>Assurance that the Problem has been Corrected and Effect of Replacement</u>

The replacement AE piston skirts at Catawba underwent liquid penetrant and magnetic particle tests to assure that they are free from cracklike indications.

In addition to the analyses described above, the AE piston skirt design has been inspected and found to be free of fatigue cracking after significant operating times:

- Over 6000 hours at an average 185 BMEP at Kodiak, Alaska;
- Over 600 hours at or above 300 BMEP in the TDI R-5 development engine;
- Over 300 hours in each of three engines at Shoreham, including 100 hours at or above 225 BMEP in each engine.

Based on the analyses and operating experience described above, it is our opinion that the replacement AE piston skirts at Catawba eliminate the problem of fatigue cracking and are fully capable of operating satisfactorily at their design level of 225 psig BMEP. (CHW, LAS, SKC, RPM, JAG, SRW)

3. Turbocharger Bearings

a. Problem and Effect on Operability

The turbochargers on diesel engines, such as those at Catawba, compress ambient air which is fed into the intake manifold so that the engine receives higher density air for combustion. This allows the engine to produce more power (BMEP) than it would if it were normally aspirated. The turbocharger functions by using exhaust energy to compress intake air. This is accomplished by a rotating assembly composed of an exhaust turbine and an inlet air compressor. This rotating assembly is supported by radial and thrust bearings at both ends.

As originally designed, prelubrication of the turbine end thrust bearing was inadequate to meet the demands of the NRC's fast start test procedures. Therefore, the starts conducted under the NRC's fast start test procedures were "dry" (essentially unlubricated) starts from the standpoint of turbocharger thrust bearing prelubrication. Once the engine reaches normal operating conditions, lubrication is supplied to the turbocharger bearings from the engine driven lube oil pump. Because of the inadequate prelubrication prior to start, excessive wear of turbocharger thrust bearings occurred at Catawba as well as at other nuclear sites.

On the Catawba diesels, this distress of the thrust bearing was evidenced gradually over about 200 hours of operation up to 174 starts. Wear of the turbocharger bearing can be detected by monitoring lube oil pressures to the turbocharger bearings. The wear of the turbocharger bearings would not cause a sudden failure; instead it is a gradual phenomenon whose progress can be monitored. At Catawba, engines were shut down and turbochargers replaced when lube oil pressure fell to alarm points. Because the turbocharger bearing wear evidences itself over a period of time, and can be monitored, it will not affect either the ability of the diesel engine to start on command or its ability to carry the required load.

This item is a category 3 matter. (LAS, RPM, SKC)

b. Analyses

FaAA has performed engineering analyses of this problem (reference FaAA-84-5-7, May 1984). These analyses have demonstrated that the design and manufacture of the turbocharger bearing is adequate; only the lack of prelubrication to the thrust face of the bearing prior to a fast start contributes to cumulative wear. (LAS)

c. Results of Analyses

It has been determined that the cause of the excessive wear is lack of adequate prelubrication of the turbocharger thrust bearing during fast starts without prior lubrication. The bearings can withstand a limited number of dry starts. However, wear becomes excessive as the number of dry starts accumulates. Wear also accumulates, but at a significantly slower rate, with the drip prelubrication system that has been in use at Catawba since installation of the emergency diesel engines. The Catawba turbocharger bearings were worn but continued to function for hundreds of hours and numerous starts, up to 174 starts. (LAS, SKC)

d. <u>Corrective Action Taken</u>

Duke Power is implementing a design change in the turbocharger bearing prelubrication system to provide for a pressurized lubrication of the bearing for at least two minutes prior to nearly all scheduled test and demonstration starts. This technique has been demonstrated to prevent accumulated wear at other nuclear sites and is recommended in the Owners' Group report (FaAA 84-5-7). The drip prelube will be retained to provide some protection during the infrequent dry starts of the diesels.

The NRC is in the process of revising periodic test requirements to permit the enhanced prelubrication system described in the preceding paragraph to be used for all test starts except one test start every 6 months. In other words, the NRC is amending its test procedures to reduce significantly the number of dry starts to which the turbocharger bearings will be subjected. This in itself will significantly reduce the potential wear to the turbocharger thrust bearings. In addition, Duke has established an inspection program which will periodically check the condition of the bearings. (RPM, LAS)

e.&f. <u>Assurance that the Problem has been Corrected and Effect of Replacement</u>

The significant reduction in the number of dry starts from ambient conditions to which the turbocharger bearings will be subjected will, in itself, reduce bearing wear to the extent that bearings would only need to be examined every 5 years. The new lubrication system is expected to essentially eliminate any wear associated with non-dry engine starts. Periodic maintenance and surveillance inspection conducted every 5 years as well as routine oil pressure monitoring will assure that turbocharger bearings do not become worn enough to affect either fast start capability or the ability to carry load. (LAS, SKC, RPM, JAG, SRW)

4. Electrical Cable Insulation

a. Problem and Effect on Operability

Some electrical cables used at Catawba have been identified as not meeting insulation flame test requirements or not having sufficiently high temperature ratings. Meeting flame test requirements provides increased assurance that insulation will not continue to burn when an external flame has been removed. Meeting high temperature ratings protects against degradation of insulation due to high temperatures, which is a long term effect which does not have any immediate effect on engine operability. Successful performance during the extended operation tests demonstrated that this condition did not adversely affect startability or operability. In any event, these cables are being replaced with qualified cables.

This is a category 4 item. (SRW, RPM)

b. Analyses Performed

Catawba diesel cable has been reviewed to determine if it meets applicable requirements (ref. 3.1.10). (SRW, RPM)

c. Results of Analyses

The review indicated that three cables on each engine did not meet insulation requirements. The investigation also indicated that certification was not available for State type NT sliding link terminal blocks used in the starting air solenoid controls to show that these blocks were not manufactured between 1974 and 1976.

It should be noted that this item did not adversely impact startability and operability. (SRW, RPM)

d. Corrective Action Taken

Replacement with qualified cable is planned for completion by September 1984. Duke Power has a program in place for inspecting States sliding link terminal blocks to ensure that they are satisfactory. (RPM, SRW) e.&f. Assurance that the Problem has been Corrected and Effect of Replacement

Replacement of the cables will result in all diesel wiring meeting required temperature and flame requirements for long-term operation. The terminal block inspection program provides assurance the terminals will be satisfactory.

5. Connecting Rod Bearings

a. Problem and Effect on Operability

The base of the connecting rod where it attaches to the crankshaft rides on a babbitted aluminum bearing shell. The shell is in two parts, upper and lower.

Some cracking of bearing shells has been reported elsewhere; therefore inspection of the bearing shells at Catawba was warranted.

All Catawba connecting rod bearing shells were X-rayed following the extended operation test to determine if they met the latest Owners' Group criteria. This X-ray inspection together with liquid penetration, dimensional and visual inspections confirmed there were no serviced-induced problems, but did indicate that 8 shells out of 32 did not meet the latest X-ray criteria. This matter does not affect startability and operability.

This is a category 4 item. (LAS, SKC)

b. Analyses Performed

Metallurgical and stress analyses have been performed to determine the acceptance criteria for use with X-ray inspection. (FaAA 84-3-1.) (LAS, JAG)

c. Results of Analyses

The FaAA analysis showed that discontinuities less than 0.05 inches in highly stressed areas are acceptable.

X-ray inspection techniques were utilized to implement the evaluation of each bearing shell with respect to the acceptance criteria. Those bearings that pass the X-ray inspection have been shown by analysis to have fatigue lives well in excess of the anticipated 2000 hours of engine operation over the life of the Catawba plant. (LAS, JAG)

d. Corrective Action Taken

The results of the X-ray inspections of all 32 connecting rod bearing shells from diesel 1A and 1B indicated that five bearing shells from 1A and three bearing shells from 1B did not meet acceptance standards. Even though no cracking was observed, and even though these bearing shells had operated satisfactorily during the extended operation test, the bearing shells that did not meet the X-ray acceptance standards were replaced, to increase the confidence in the bearings' ability to perform as required. (LAS, CHW, JAG, RPM)

e. Assurance that the Problem is Corrected

The Catawba diesels' bearing shells were inspected after the extended operational tests and showed no service induced degradation. The bearing shells were X-rayed and conservative acceptance standards applied to assure that deleterious material defects which could reduce fatigue life were not present. Several bearing shells that operated satisfactorily but had RT indications were replaced. Periodic inspections by visual, dimensional, and liquid penetrant techniques as well as periodic lube oil analysis for wear metals will be used to monitor normal wear of the bearings. (LAS, CHW, RPM, JAG)

f. <u>Effect of Replacement</u>

As noted above, stringent liquid penetrant and X-ray standards have been imposed. New bearing shells are inspected to these standards to ensure that they are free of significant material defects and will perform satisfactorily. (RPM, JAG)

6. Push Rods

a. Problem and Effect on Operability

In engine operation precise timing for opening and closing of intake and exhaust valves is required. This timing is provided by the camshaft. The mechanical links between the camshaft and the valves are the pushrods.

Some of the originally supplied pushrods, with manually welded ball bearing ends, experienced cracking of the welds joining the rod shaft to the ball bearing ends. These cracks were found after about 400 hours of operation in Catawba diesel 1A. The originally supplied push rods had not, and would not have, affected Catawba diesel startability and operability. While some of the welds had cracked, the ball and socket joint at the rod end was constrained by the rocker arm socket which prevented the rod end from becoming loose. As long as the ball remained constrained the push rod remained functional.

All the originally-supplied pushrods on engines 1A and 1B have been replaced with new design friction welded pushrods.

This is a category 3 item. (CHW, LAS, SKC, RPM)

b. <u>Analyses Performed</u>

The friction welded push rod design has been evaluated (FaAA Report 84-3-17) through detailed analysis, destructive metallographic examination and accelerated fatigue testing to verify the adequacy of the friction welded design. (ret. 3.1.14) (CHW, LAS)

c. <u>Results of Analyses</u>

The analyses concluded that the cracking was associated with the non-weldability of the steel ball ends used in the original pushrod. The analyses and tests showed that the friction weld joint used on the new push rod design is inherently defect free and thus is not expected to fail. (CHW, LAS, JAG)

d. Corrective Action Taken

The push rods in the Catawba diesels have been replaced with new design friction welded push rods. (RPM)

e. Assurance that the Problem has been Corrected

Inspections of the new type friction welded push rods, which operated first in the 1A diesel and then were transferred to the 1B diesel, showed no degradation. The new type push rods were visually examined and liquid penetrant examined at the friction weld after over 400 hours in the 1A engine with no signs of cracks. The same push rods were then installed in 1B engine and used for over 500 hours. Inspections of the new push rods after the 1B tests showed no evidence of cracking or other signs of distress. Hence, the new pushrod design has over 900 hours of operation in Catawba diesels with no signs of distress. (RPM, JAG)

f. Effect of Replacement

All push rods to be used in Catawba diesels, or stocked at Catawba as spares, are inspected. This inspection includes a visual inspection to assure that the push rods are of the new friction welded design and a liquid penetrant examination to assure that there are no cracks in the friction welds. (RPM)

7. Fuel Injection Pump Delivery Valve Holder

a. Problem and Effect on Operability

The fuel injection pump delivery valve holder provides the pressure closure for the fuel injection pump. In addition the fuel line from the pump to the injector attaches to the valve holder.

During the extended operation test run one fuel injection pump valve holder cracked during operation of the 1A engine which resulted in a fuel seepage. Since this occurred during a test run, the engine was shut down to investigate the seepage. The engine had the capability for continued safe operation. In an actual emergency condition the leak from the valve holder would not have affected startability and operability. The affected fuel pump can be quickly taken out of service, if necessary. Thereafter, the fuel input to the affected cylinder would be reduced to zero and the remaining 15 operating cylinders would assume the necessary engine load. Therefore, it is concluded that this problem would have no effect on diesel startability and operability under emergency conditions.

This is a category 3 item. (RPM, SRW, JAG, SKC)

b. Analyses Performed

A metallurgical failure analysis was performed on the fuel injection pump delivery valve holder and analytical crack growth calculations were performed. (ref. 3.2.1) (JAG)

c. Results of Analyses

The results of the metallurgical analysis indicate that the valve holder cracked as a result of a large material defect. An axially oriented linear indication in the high pressure fuel oil passage of the valve holder led to the failure. The crack growth analysis indicates that any axial linear indications large enough to initiate and propagate would have caused failure of the valve holder within ten million cycles of operation. This indicates that the valve holder failure was an isolated material defect. (JAG)

d. <u>Corrective Action Taken</u>

The failed valve holder was replaced as part of a complete fuel pump assembly. In addition, a boroscope evaluation of the high pressure fuel oil passage was made of all valve holders on diesel 1A. Results of this evaluation indicated that four valve holders appeared to have small surface irregularities. These four valve holders were removed from the engine, cleaned, reamed to .170 inches, rechecked by boroscope, found to be free of problems, and reinstalled. Similar inspections and corrective action will be taken for diesel 1B. (RPM, SRW, JAG)

e. <u>Assurance that the Problem has been Corrected</u>

Surface cracks sufficiently large to initiate fatigue failure can be easily detected by a boroscope. The fuel valve holders now in service have been boroscope inspected and have no such irregularities. (RPM)

f. <u>Effect of Replacement</u>

New valve holders are being inspected to verify the absence of material defects and are therefore expected to perform satisfactorily. (RPM)

8. Fuel Line Fittings

a. Problem and Effect on Operability

High pressure fuel lines and fittings connect the fuel pump to the fuel injector. Low pressure fittings are used on the low pressure fuel lines mounted on the engine.

During the extended test run one high pressure fuel line was replaced on the Catawba 1A diesel due to leakage around a fitting. During the extended test run on Diesel 1B one high and one low pressure fuel line fitting leaked.

Because these leaks occurred during a test run, the diesels were shut down to correct the leaks. However, had a need existed, the diesels would have been capable of continued safe operation.

These leaks would not affect the ability of the engine to start or to carry the load.

This is a category 3 item. (JAG, RPM, SKC)

b. <u>Analyses Performed</u>

On site engineering evaluations were performed. (JAG, RPM)

c. <u>Results of Analyses</u>

Evaluation of the 1A high pressure fuel line indicated that a flat spot in the cone portion of the tube resulted in the leakage. On Diesel 1B, the high pressure fitting was retorqued eliminating the leak. The low pressure fitting had teflon tape added to eliminate the leakage. (JAG, RPM)

d. <u>Corrective Action Taken</u>

The affected line was replaced on diesel 1A. Special fitting installation instructions which require controlled torques are being followed to guard against improper installation on both 1A and 1B engines. (JAG, RPM)

e.&f. <u>Assurance that the Problem has been Corrected and Effect of Replacement</u>

The use of the special fitting installation instructions provides assurance that this type of problem will not recur. (RPM)

9. Fuel Injection Pump Delivery Valve Block

a. Problem and Effect on Operability

The delivery valve block is an internal part of the fuel injection pump. It provides high pressure fuel to the fuel lines.

During the 1B extended operational test two fuel injection pump delivery valve blocks leaked because of axial cracks. This type of crack allows some fuel to bypass the delivery valve which results in less fuel being delivered to the affected cylinder. This was evidenced by a declining cylinder exhaust temperature in the affected cylinder. A third such assembly was found to have similar cracking during disassembly and inspection of the 1B engine; however that crack had not caused any decrease in the amount of fuel supplied to the cylinder and therefore there was no decrease in cylinder temperature.

Such cracking in these components would not, in an emergency situation, affect diesel startability or operability. The remaining cylinders will assume the load from the affected cylinder.

This is a category 3 item. (JAG, RPM)

b. Analyses Performed

A metallurgical evaluation of all parts was conducted. This included a metallographic examination of the fractured pieces using optical and scanning electron microscopes, microhardness surveys and chemical analysis. (JAG, RPM)

c. Results of Analyses

Metallurgical analysis indicates that the failures were due to fatigue initiating from small cracks produced by improper grinding of the delivery valve seats inside the delivery valve blocks. (JAG, RPM)

d. Corrective Action Taken

The cracked delivery valve blocks are being replaced as part of complete fuel pump assemblies. All other delivery valve blocks will be inspected. (JAG, RPM) e.&f. <u>Assurance that the Problem has been Corrected and Effect on Replacement</u>

As noted, the cracked delivery valve blocks have been replaced; all other delivery valve blocks will be inspected. All replacement parts will also be inspected. (JAG, RPM)

10. Turbocharger to Intercooler Adapter

a. Problem and Effect on Operability

The turbocharger adapter takes intake air that has been compressed by the turbocharger and directs it to the intercooler where the compressed intake air is cooled prior to admission to the cylinders.

During the extended operation test run, the right bank turbocharger to intercooler adapter partially cracked at a flange weld on both 1A and 1B engines. The cracks had no effect on the startability or operability of the diesels. The diesels were run at full power for hundreds of hours even with the cracks at the flange weld.

This is a category 4 item. (JAG, RPM, SKC)

b. Analyses

An on-site engineering evaluation was performed of the fit up between the adapter and the turbocharger. (RPM, JAG)

c. <u>Results of Analyses</u>

The engineering evaluation indicates that the cracks are caused by excessive displacements at a location with limited flexibility. In neither case were cracks discovered in the left bank turbocharger. (JAG, RPM)

d. <u>Corrective Action Taken</u>

The cracked welds were repaired and visually and magnetic particle inspected. Though the 1A engine has operated satisfactorily with the repaired weld, and the repair has proven to be effective, a redesign is being accomplished that will install a flexible joint between the adapter and turbocharger to absorb the displacements. (JAG, RPM)

e. <u>Assurance that the Problem has been Corrected</u>

The cracks do not affect diesel operability (diesel 1B operated for hundreds of hours with the crack present without any effect). In addition, the flexible joint will prevent cracking in the future. The flexible joint will be fabricated from a high-temperature fabric which is commonly used in expansion joints. Use of this flexible joint will mechanically uncouple the turbocharger discharge from the intercooler adapter. This will isolate the adapter from mechanical displacement experienced by the turbochargers. (JAG, RPM)

f. Effect of Replacement

The replacement will assure that the weld joints on the right bank intercooler adapter will not crack. This is also in accordance with the recommendations made by the NRC Staff. (JAG, RPM)

11. Intercooler Jacket Water Line

a. Problem and Effect on Operability

Water is supplied through a line to the intercooler to cool compressed air coming from turbocharger.

During the extended operation test run on diesel 1B a minor leak was found on the right bank intercooler inlet jacket water line due to a crack between the casing and the pipe. This leak was minor, and did not result in a reduction of engine output. The engine was run another two days after its discovery. Hence, it is concluded that this problem did not effect startability and operability.

This is a category 3 item. (SRW, RPM, SKC)

b. Analyses Performed

The jacket water piping was subjected to an on-site engineering evaluation, including vibration measurement. (SRW, RPM)

c. Results of Analyses

The piping was found to be vibrating at a frequency close to the rotational frequency of the diesel engine. It was concluded that the crack in the flange was the result of fatigue induced by this vibration. (SRW, RPM)

d. Corrective Action Taken

The flange crack was weld repaired and returned to service. It was determined that the natural frequency of the line could be changed by the addition of a permanent solid pipe hanger to the line. This modification was made on diesel 1B and it resulted in a significant reduction in the amplitude of the pipe vibrations. (SRW, RPM)

e. Assurance that the Problem has been Corrected

Observations of the amplitude of the vibrations at the line before and after the modification indicate that the amplitude and therefore the stress caused by the vibration has been reduced to a level that will not result in cracking of the piping. Visual examination of diesel 1A indicated no cracks at this location: a vibration test will be conducted to determine the adequacy of the installation. Hence adequate corrective action has been taken to assure that the problem will not recur. (SRW, RPM)

f. <u>Effect of Replacement</u>

The corrective modification assures that the vibration-induced failure will not recur. (SRW, RPM)

12. Turbocharger Lube Oil Drain Line

a. Problem and Effect on Operability

The turbocharger lube oil drain line returns lube oil from the turbocharger to the lube oil sump. Due to deficiencies with the originally supplied piping, a temporary drain line was installed on diesel 1A.

During the extended operation test run this temporary drain line leaked. This leaking had no effect on diesel engine startability or operability. The temporary line has been replaced with permanent piping and fittings. The 1B turbocharger lube oil drain line was replaced prior to its extended operational test. No leaking was observed from this line on 1B during the test run. Consequently, the problem has been corrected.

This is a category 3 item. (SRW, RPM, SKC)

b.&c. Analyses and Results of Analyses

The temporary drain line was replaced

with a permanent installation when suitable parts became available. (SRW, RPM)

d.,e.&f. Corrective Action Taken, Assurance that the Problem has been Corrected and Effect of Replacement

This problem has been resolved by the installation of a permanent drain line. The fact that this permanent drain line design did not leak during the 1B extended operational test provides assurance that the problem has been eliminated. (SRW, RPM)

13. <u>Turbocharger Prelube Oil Lines</u>

a. <u>Problem and Effect on Operability</u>

The turbocharger drip prelube oil line supplies oil during standby to assure that some lubrication will be present in the turbocharger bearings at start up until the main lube oil supply takes over as the engine comes up to speed. Thus the prelube oil lines perform no function during operation.

Two leaks in the 1/4 inch prelube oil lines occurred during the 1A extended operation test. Each leak emanated from a 1/4 inch fitting in the line. In each instance the engine was shut down to investigate the leaks. This condition would not affect diesel startability or operability in an emergency and the engine would not be shut down in this condition.

This is a category 3 item. (LAS, RPM, SKC)

b. Analyses

Metallurgical failure analyses were performed (ref. 3.2.2). (JAG, RPM)

c. Results of Analyses

This leakage was determined to be due to fatigue cracks emanating from compression fitting locations. (JAG, RPM)

d. Corrective Action Taken

The lines have been replaced using an improved fitting torquing procedure, additional support clamps, vibration dampening devices, improved compression fittings and heavier wall stainless steel tubing. Diesel 1B had this design change made prior to its extended operational test. No leakage was noted from these lines on 1B during its operational tests. (JAG, RPM)

e.&f. Assurance that the Problem has been Corrected and Effect of Replacement

The use of improved compression fittings, improved procedures for tightening compression fittings, design features to prevent vibration, and heavier wall tubing provides a high confidence level that this problem will not recur. The fact that diesel 1B had this design change made prior to its extended test and that the prelube system did not leak during that test gives assurance that this problem has been adequately addressed. In addition, vibration levels of the subject tubing have been monitored during operation to verify that the vibration levels have been reduced to acceptable values. (JAG, RPM)

14. Rocker Box (Subcover) Subassembly

a. Problem and Effect on Operability

This component is located on top of the cylinder head. Its function is to enclose the rocker arms and support the rocker arm shafts.

Two problems have been experienced with this component. The first was fracturing off of a piece of a boss (also called a pedestal) in the 1A engine. The second problem--found in both the 1A (two instances) and 1B (two instances) engines during the post extended operation test inspections--involved tight cracks running down the boss in the web of the pedestal between the bolt hole and the boss surface.

With respect to the first problem, support was still provided for the rocker arm shaft. The cracks found in the other subcovers also do not affect the ability of the subcovers to carry the loads imposed. Therefore neither of these problems affected, nor would they affect, diesel engine operability or startability. Moreover, it should be noted that these matters were discovered during the inspection which followed the extended operation tests. This provides further assurance they would not affect operability.

This is a category 3 item. (LAS, SKC, RPM)

b. Analyses Performed

On-site engineering evaluations including visual inspections, were performed on both problems. In addition, a metallurgical analysis was performed by FaAA on the second problem, cracking in the web of the pedestal. This included fractography with a scanning electron microscope. (RPM, LAS, JAG)

c. Results of Analyses

On-site engineering evaluations indicate that the first problem was due to a misaligned dowel, not to fatigue. The second problem was due to overload from an oversized bushing, not to fatigue. Examination of fracture surfaces by FaAA showed that the nature of the fractures was due to over-load; no evidence of fatigue was observed. Neither problem would, or did, affect diesel operability or power output. In neither case was there a secondary effect. (RPM, LAS, JAG)

d. <u>Corrective Action Taken</u>

All subcovers from both the 1A and 1B diesel engines were liquid penetrant inspected to determine the extent of the problem. The cracked subcover castings were replaced, and installation practices have been changed to ensure that misaligned dowels or oversized bushings are not used. (RPM)

e. <u>Assurance that the Problem has been Corrected</u>

This problem is not service induced and therefore the corrective measures listed above will prevent recurrence. (RPM)

f. <u>Effect of Replacement</u>

All replacement subcovers will be liquid penetrant inspected to assure that there are no cracks. (RPM)

15. Exhaust Valve Tappet Rocker Arm Adjusting Screw Swivel Pad

a. Problem and Effect on Operability

The purpose of the rocker arm swivel pad is to accommodate changing angular relationsips between the rocker arms and the intake and exhaust valves as the rocker arms rotate on the rocker shafts.

One of the swivel pads on diesel 1B cracked during operation. Another swivel pad on 1B was cracked during the inspection following the extended operation test on diesel 1B. The first swivel pad separated from the adjusting screw during diesel operation; when this occurred, valve clearance was increased. However, this did not prevent the engine from providing full load. Therefore the problem did not, nor would it, affect engine startability or operability. The second swivel pad was cracked during disassembly for inspection and thus had no functional effect on the engine.

This is a category 3 item. (RPM, RSW, JAG, SKC)

b. Analyses Performed

A metallurgical failure analysis was performed (ref. 3.2.9) on the first failure. The second failure occurred when a rocker assembly was inadvertently dropped on the swivel pad during engine disassembly. (JAG, RPM)

c. Results of Analyses

The failure analysis indicates that the first swivel pad cracked because of overload, attributable to improper swaging during manufacture. The second cracking was caused by poor handling of a rocker arm assembly during engine disassembly. (JAG)

d. Corrective Action Taken

All 1A and 1B swivel pads have been inspected by liquid penetrant test to detect cracks. All 1A swivel pads were found to be free of defects and to be correctly swaged. The first defective 1B swivel pad was replaced prior to the extended run and was subjected to several hundred hours of run time. The second 1B swivel pad (cracked during maintenance) is in the process of being replaced. (RPM, JAG)

e. Assurance that the Problem has been Corrected

The satisfactory performance of the 1A swivel pads and all but one 1B swivel pad during the operational tests demonstrates that the design is satisfactory. The inspections being performed are such that any improperly manufactured swivel pads will be identified and eliminated. (RPM, JAG)

f. Effect of Replacement

Inspections of replacement parts will include a visual examination to insure proper swaging and liquid penetrant test to check for cracks. (RPM)

16. Intermediate Rocker Arm Sockets

a. Problem and Effect on Operability

The intermediate rocker arm sockets are hemispherical sockets in the rocker arm in which the spherical head of the pushrod seats. The sockets are shrunk into the rocker arm castings.

Two sockets with chipped and/or cracked lips were found on diesel 1A during the inspection following the extended operational test. These lips protruded beyond the adjacent rocker arm casting surface. These cracks or chips do not affect rocker arm operability since the push rod seats further down in the sockets. Hence, this chipping or cracking does not have any effect on diesel engine startability or operability.

This is a category 4 item. (RPM, SKC, JAG)

b. Analyses Performed

An engineering evaluation was performed of these conditions. It consisted primarily of visual examination of the affected parts and an evaluation of installation practices. (RPM, JAG)

c. Results of Analyses

It was concluded that the chips and cracks did not effect functioning of the sockets since the push rods seat further in the socket, well inside the area with chips or cracks. The chips and cracks show no evidence of propagating into the functioning part of the socket. It is believed that the chipping and cracking was caused by improper installation of the rocker arm prior to valve adjustment, such that excessive clearance existed allowing the pushrods to contact the lips. (RPM, JAG)

d. Corrective Action Taken

All rocker arm sockets on diesels 1A and 1B have been visually inspected. The two chipped and cracked sockets on diesel 1A have been ground smooth. In addition, assembly practices have been changed to ensure that excessive clearance does not exist in the rocker arm at assembly; this is expected to preclude recurrence of the chipping and cracking. (RPM, JAG)

e. <u>Assurance that the Problem has been Corrected</u>

The chipped and cracked sockets are considered to be a minor matter which has not affected, and will not affect, diesel operability. In addition, the assembly practice changes mentioned above will preclude recurrence. (RPM, JAG)

f. <u>Effect of Replacement</u>

Not applicable. (RPM)

17. Exhaust Valve Stems

a. Problem and Effect on Operability

Nine exhaust valve stems on the 1A diesel had small areas, less than 4% of the contact surface of the valve stem, with flaked off chromium plating. Eight valves on the 1B diesel had similar areas of flaked off chromium plating and 20 had non-relevant scratching of the chromium plating. The chromium flaking occurred at about 6 to 8 inches above the valve seat, at the location where the stem enters the valve guide. The chrom. flaking had no effect on diesel startability or operability, and caused no measurable wear to the valve guides.

This is category 4 item. (JAG, RPM, LAS, SKC)

b.&c. Analyses Performed and Results of Analyses

Analyses of this condition were not required since it did not affect diesel startability or operability and the valves are to be replaced. (RPM, SKC)

d. Corrective Action Taken

Valve stems with flaked chromium plating are being replaced simply as a matter of conservatism. (RPM, SKC)

e.&f. Assurance that the Problem has been Resolved and Effect of Replacement

The valve stem chromium flaking did not affect 1A or 1B diesel startability or operability during the extended tests. To provide additional assurance that no long-term wear could develop, the affected valve stems are being replaced and this condition will be monitored in the future during scheduled maintenance inspections. The replacement valves will be visually inspected before installation. (RPM)

18. Lube Oil and Jacket Water Thermocouples

a. Problem and Effect on Operability

Thermocouples are used to monitor diesel engine temperatures. Several failures have occurred with lube oil and jacket water thermocouples as a result of intermittent shorts. These failures do not affect engine startability or operability since they are supervisory indications, do not automatically shut the engine down, and, in the event of an emergency situation, would not cause the operator to shut the engine down. Alternate indications of system conditions are available to provide the operator with information to assure safe operation.

This is a category 4 item. (RPM, SKC)

b.&c. Analyses and Results of Analyses

Analyses were not required since occasional thermocouple failures are a normal occurrence and do not affect diesel operability under emergency run conditions. (RPM, SKC)

d. <u>Corrective Action Taken</u>

The failed thermocouples were replaced. (RPM)

e.&f. <u>Assurance that the Problem has been Corrected and Effect of Replacement</u>

Occasional thermocouple failures are a normal occurrence and do not affect diesel operability under emergency run conditions. Failed thermocouples are replaced at the first opportunity. All failed thermocouples have been replaced on the Catawba engines. (RPM)

19. Crankcase and Camshaft Cover Capscrews

a. Problem and Effect on Operability

These fasteners hold crankcase and camshaft covers in place. They perform no other structural function.

Occasional failures of these capscrews have occurred on both diesels 1A and 1B. Since a multitude of capscrews are used on engine covers occasional failure of some capscrews has not affected, and will not affect, engine startability or operability.

This is a category 4 item. (RPM, SKC)

b. Analyses Performed

Metallurgical failure analyses have been performed on these capscrews. (ref. 3.2.5) (JAG)

c. Results of Analyses

The failures are due to fatigue associated with under or over torquing of the bolts during installation or removal. (JAG)

d. Corrective Action Taken

All of these bolts are being replaced by higher strength bolts with improved fatigue resistance. In addition, controlled torquing procedures have been instituted. (RPM, JAG)

e. Assurance that the Problem has been Corrected

Use of higher strength bolts greatly decreases the likelihood of this problem. In addition, use of controlled torque procedures will prevent the over or under torquing that is believed to be the root cause of the fatigue failures. (RPM, JAG)

f. Effect of Replacement

All cover capscrews used in the Catawba diesel generators will meet specifications to assure increased fatigue resistance. (RPM)

20. Turbocharger Exhaust Gas Inlet Bolts

a. Problem and Effect of Operability

Forty bolts connect the exhaust gas manifold to the turbocharger adapter on each turbocharger. These bolts are 1/2" diameter and are used in three lengths, 1-1/2" (16), 4-1/2" (12) and 5" (12). They are made from stainless steel.

Four 4-1/2" bolts were found broken on the diesel 1A right bank after 267 hours of operation. One stainless steel bolt was also found broken on diesel 1B. This was discovered during engine disassembly. These bolts do not carry a structural load; rather, their function is to hold a gasket in compression to maintain a seal at the connection.

The failure of four out of forty bolts did not cause the loss of the seal. Moreover, if the seal were lost, the engine would be capable of carrying the required load. In any event, any such failure would be easily detectable and could be corrected. Therefore, the cracked or broken turbocharger exhaust gas inlet bolts did not affect, nor would they have affected, diesel engine startability or operability.

This is a category 4 item. (JAG, RPM, SKC)

b. Analyses Performed

A metallurgical failure analysis was performed. (3.2.8) (JAG)

c. Results of Analyses

The analyses indicate that one bolt on the 1A and one bolt on the 1B diesels failed from creep rupture while the others failed from overtorquing during removal. The creep rupture failures are believed to be caused by over torquing during installation. (JAG)

d. Corrective Action Taken

All bolts on the 1A diesel were temporarily replaced with new stock bolts of the same material and will be replaced with ASME SA 453 Grade 660 material which has improved high temperature performance at the first refueling outage. The same improved grade bolt material is now being installed on the 1B diesel. Bolt installation practices have been revised to insure that proper preloads are applied during installation. In addition improved thread lubricant will be used on reassembly to ease removal in the future. (RPM, JAG)

e.&f. Assurance that the Problem has been Corrected and Effect of Replacement

The first group of failed bolts was found and replaced after 267 hours of operation. When being replaced, all bolts were installed using proper torquing practices. After another 540 hours of operation of the 1A diesel all bolts, including those replaced, were inspected by visual methods at a magnification of 5x. This inspection showed that no new cracks had initiated. Thus, the original bolt material, when torqued properly, performs satisfactorily. A similar visual inspection will also be done on the 1B engine. The replacement SA 453 Grade 660 bolts will provide an increased level of assurance of satisfactory performance. In addition the revised installation practices will assure that all bolts will be properly torqued when installed. (RPM, JAG)

21. Clamp Bolts

a. Problem and Effect on Operability

Several bolts on clamps which hold fuel oil and lube oil lines to the sides of the engine were found to be cracked or broken. Failure of these clamps could lead to vibration of the lines which could cause fatigue-induced failures. No such failures occurred during the extended operation test run. Any increased vibration due to loosened clamps will be observed by the engine operator prior to failure and corrective action will be taken. Therefore, the cracked or broken bolts on the clamps did not affect, nor would they have affected, diesel engine operability or startability.

This is a category 3 item. (RPM, SKC)

b. Analyses Performed

A metallurgical failure analysis was performed (ref. 3.3.5). (JAG)

c. <u>Results of Analyses</u>

Failure analysis of these bolts indicates that they failed due to fatigue as a result of under or over torquing. (JAG)

d. <u>Corrective Action Taken</u>

All of these bolts are being replaced by higher strength bolts with improved fatigue resistance. In addition, controlled torquing procedures have been instituted. (RPM, JAG)

e.&f. <u>Assurance that the Problem has been Corrected and Effect of Replacement</u>

Use of higher strength bolts greatly decreases the likelihood of this problem. In addition, use of controlled torquing procedures will prevent the over or under torquing that is believed to be the root cause of the fatigue. In addition during engine operation a plant operator will supervise the engine operation. Any increased vibration of fuel and lube oil lines because of loosened clamps will be observed by the engine operator and corrective action will be taken. (RPM, JAG)

22. Turbocharger Bolting

a. Problem and Effect on Operability

One turbocharger to bracket capscrew, 5/8" x 11 NC x 2" long, failed on diesel 1B. Since the turbocharger is held to the bracket by 4 capscrews this did not affect turbocharger functioning.

This is a category 3 item. (RPM, SKC)

b. Analyses Performed

A metallurgical failure analysis was performed. (ref. 3.3.7) (JAG)

c. Results of Analyses

The analysis of the capscrew failure indicates that it failed due to fatigue. (JAG)

d. Corrective Action Taken

All of these bolts are being replaced by higher strength bolts with improved fatigue resistance. In addition, controlled torquing procedures have been instituted. All bolts used in the future will be of the improved fatigue resistant type. (RPM, JAG)

e. Assurance that the Problem has been Corrected

Use of higher strength bolts greatly decreases the likelihood of this problem. In addition, use of controlled torquing procedures will prevent the over or under torquing that are believed to be root causes of the fatigue. (RPM, JAG)

f. Effect of Replacement

Replacement bracket capscrews used at Catawba are purchased to higher strength specifications than the originally supplied bolts. (RPM, JAG)

23. Fuel Injector Nozzle Holder Studs

a. Problem and Effect on Operability

Fuel injector nozzle holder studs are used to attach the cylinder head pulling fixture to the head during maintenance cylinder head removal.

While removing a cylinder head with the pulling fixture, the nozzle holder studs failed. This problem was associated with disassembly of the engine and therefore does not affect startability or operability.

This is a category 3 item. (RPM, JAG, SKC)

b. Analyses Performed

A failure analysis including metallurgical examination was performed (ref. 3.3.6). (JAG)

c. Results of Analyses

The failure analysis indicated that the studs failed because of improper bending overload applied during cylinder head stud torquing/untorquing and not during diesel operation. During disassembly, the studs are used to hold a pulling fixture to the head. The pulling fixture is used both for reacting cylinder head stud torquing/untorquing loads and to lift the head. The investigation indicated that these capscrews were bent during untorquing of the head studs leading to failure due to overload when the head weight was put on them during head removal. The studs were bent due to improper cleaning of the fixture landing area on the head prior to seating the pulling fixture. This allowed the pulling fixture to rock on the head during head stud untorquing and resulted in high bending loads being applied to the studs. (JAG)

d. Corrective Action Taken

All studs were inspected. Damaged studs were replaced. Procedures for installing the head pulling fixture are being revised to assure that improper loads are not applied. (RPM, JAG)

e. <u>Assurance that the Problem has been Corrected</u>

This problem was an isolated maintenance error and procedural changes have been instituted to prevent recurrence. (RPM, JAG)

f. <u>Effect of Replacement</u>

Replacement studs were inspected before installation. (RPM)

24. Starting Air Distributor Cover Capscrew

a. Problem and Effect on Operability

These capscrews hold the starting air distributor cover in place.

The head of one out of six 1/2" capscrews on the right bank starting air distributor cover failed on diesel 1B. The problem was found during a visual check of the engine while it was shut down. This failure did not affect engine startability or operability.

This is a category 4 item. (SRW, RPM, SKC)

b. Analyses Performed

An on-site engineering evaluation of the probable failure cause was performed. (RPM)

c. Results of Analyses

It is believed that the likely cause of the failure is fatigue due to under or over torquing of the bolt. This is similar to other cover bolt failures analyzed. (RPM)

d. Corrective Action Taken

All distributor capscrews will be replaced using a material which has improved fatigue strength. Improved torquing procedures will be used during engine reassembly. (RPM)

e.&f. Assurance that the Problem has been Corrected and Effect on Replacement

Use of higher strength bolts will greatly decrease the likelihood of this problem. In addition, use of improved torquing procedures will prevent the over or under torquing that are believed to be the root causes of the fatigue. (RPM)

25. Spring Retaining Nut and Roll Pin on Air Start Valves

a. Problem and Effect on Operability

Upon disassembly of two air start valves on the 1A diesel it was determined that the spring retaining nut was jammed on one valve and a retaining nut roll pin was missing on the other. The situation had existed since installation and had not effected the ability of the air start valves to function through more than 120 starts and 810 hours of operation. Therefore, our conclusion is that the jammed nut and missing roll pin had not affected diesel operability or startability.

This is a category 4 item. (RPM, JAG, SKC)

b.&c. Analyses and Results of Analyses

On examination it was found that the spring retaining nut on the air start valve was jammed because of galled threads. The spring retaining nut roll pin was probably missing on receipt. Detailed analyses of this condition were not performed because these matters were not service-induced. (RPM, JAG)

d. Corrective Action Taken

The jammed nut was replaced and the galled threads were chased. The missing roll pin was replaced. All air start valves have been disassembled for inspection. No additional valves other than the two noted showed any problems. All air start valves were reassembled using the proper site assembly procedures. (RPM, JAG)

e.&f. Assurance that the Problem has been Corrected and Effect of Replacement

Site assembly procedures provide controls that assure that this type of problem will not occur in the future. (RPM)

28. Q. IN ADDITION TO THE CATAWBA SPECIFIC PROBLEMS DISCUSSED ABOVE, WERE ANY OTHER ACTIONS TAKEN WITH REGARD TO OTHER CATAWBA DIESEL ENGINE COMPONENTS AS A RESULT OF THE TEST AND INSPECTION PROGRAM?

A. After over eight hundred hours of operation, some normal wear is to be expected to be found on parts of the diesel engine. Several parts were found on the Catawba 1A diesel engine that had indications resulting from this normal wear. Most of these parts were returned to service without much more than routine cleaning and lubrication. Other parts were, as a result of this normal wear, repaired or replaced for extra conservatism. These parts are as follows:

Part	As Found Condition	Action
Air Start Valve	Nicks in valve seat Galled retaining nuts	Reground Replaced
Crankshaft	Minor surface indications found with eddy-current.	Polished out
	Minor pores or surface indications found in oil hole with fluorescent PT.	Polished out
Link Rod Bushing	Marking found in bushing due to debris.	Replaced
Lube Oil Line Support	Found Loose	Retorqued
Overspeed Trip Drive Coupling	Small indentations in elastomer piece.	Replaced
Overspeed Trip Drive Bearings	Damaged during disassembly.	Replaced

Part	As Found Condition	Action
Turbocharger Bracket Bolting	Some bolts found with low torques.	Retorqued with locking compound.

Similar approach to that of diesel 1A will be followed on diesel 1B. (RPM, JAG, SRW)

29. Q. DID THE DETAILED INSPECTIONS DISCUSSED ABOVE ADDRESS ALL DIESEL ENGINE COMPONENTS?

A. No. (RPM)

30. Q. HOW DID YOU VERIFY THE ACCEPTABILITY OF THOSE COMPONENTS WHICH WERE NOT INSPECTED?

A. Through the use of an engineering validation process. The engineering validation process is a confirmatory type of review wherein components were selected only where there was no reason for concern about their condition, i.e., the parts were expected to be satisfactory based on an absence of problems in the industry. (RPM, JAG, SRW)

31. Q. DESCRIBE THE COMPONENTS WHICH WERE SUBJECT TO THE ENGINEERING VALIDATION PROCESS. DESCRIBE THE PURPOSE OF THE ENGINEERING VALIDATION PROCESS AS IT RELATES TO THOSE COMPONENTS.

A. Components were selected for inclusion in the engineering validation report in cases where they had been categorized as important to diesel operability (i.e., were categorized as Class A or Class B) and their operating history and manufacturing source warranted not performing a detailed inspection to verify their satisfactory condition. Typical examples of components subject to this approach were the lube oil pressure regulating valve and fuel oil strainers. A complete listing is in Table B-1 of the June 29 report (Attachment 12). The purpose of the engineering validation was to review all available information regarding the part to assure that its operating and maintenance history indicated that it was performing satisfactorily. (RPM, JAG, SRW)

32. Q. DESCRIBE HOW A COMPONENT WAS EXAMINED UNDER THE ENGINEERING VALIDATION APPROACH.

A. The engineering validation consisted of:

- visual observation of the components, where this was appropriate and meaningful.
- review of test results, especially from the extended operation tests.
- review of maintenance records.
- review of operating records.
- an engineering evaluation of the information obtained to assess the condition and quality of the component. (RPM, JAG, SRW)

33. Q. WHO CARRIED OUT THE "VISUAL OBSERVATION" AND "ENGINEERING EVALUATION" OF THE COMPONENTS SELECTED FOR THE ENGINEERING VALIDATION APPROACH?

A. The "visual observation" and "engineering scan" of components was performed by engineers working under the supervision of Duke General Office engineering staff. These engineers had worked extensively on the diesel project and had extensive experience in the application and evaluation of mechanical components. Thus they were in a position to perform the engineering validation in a knowledgeable manner. (RPM, JAG, SRW)

34. Q. DESCRIBE THE INSPECTION WHICH HAS BEEN CONDUCTED FOR THE 1B DIESEL GENERATOR.

A. The inspection of the 1B diesel was developed based on the results of the 1A diesel inspections. The 1B inspection is described in the letters of July 16, 1984 and August 1, 1984 from Hal B. Tucker to H. R. Denton, which are Attachments 14 and 15 to this testimony. The 1B inspection included:

- Disassembly of all 16 cylinders, including removal and replacement of piston skirts.
- Inspection of 100% of many selected critical parts such as connecting rod bearing shells, connecting rods and bushings, piston pins, cylinder heads, intake and exhaust valves, cylinder liners, subcover assemblies, fuel pumps, rocker arm bolting, turbochargers, etc. These parts were selected for inspection considering (1) TDI generic problems, (2) Catawba specific problems, (3) results of inspections of the Catawba 1A diesel and other

TDI diesels, and (4) accessibility provided by disassembly for piston skirt replacement.

- Inspection (as was also the case with 1A) of the most highly stressed oil holes on the crankshaft.
- Inspection of 25% of the cylinder blocks and cylinder head studs. These inspections were limited to 25% since the 1A inspections showed no significant problems in these components.
- The inspections rely on visual and nondestructive examination methods to verify that defects have not developed in the parts. The inspections were performed of the areas on the parts where experience or engineering evaluation indicates defects are the most likely to occur. (RPM, SRW, JAG)

35. Q. DESCRIBE THE DIFFERENCES IN THE INSPECTION BETWEEN THE 1A DIESEL GENERATOR AND 1B DIESEL GENERATOR. EXPLAIN WHY THESE DIFFERENCES ARE PERMISSIBLE.

A. The significant differences between the 1A and 1B inspections, and the justification for these differences, are as follows:

- Material and hardness checks were deleted for the 1B diesel since these checks on the 1A diesel revealed no problems.
- Dimensional inspections of many parts which were

taken mainly for information purposes on the 1A diesel were deleted.

- The cylinder block NDE inspections were reduced from 100% to 25% based on the results of the 1A diesel which showed no defects.
- Disassembly and inspection of some accessories were deleted based on the absence of problems detected in the 1A inspections.
- The scope of the engineering validation was amended to concentrate on specific parts based on their operating history.

Both the NRC and its consultant, PNL, have reviewed the 1B inspection plan and reported on it in the SER and TER. The NRC Staff has concluded that Duke's inspection plan is adequate with one modification. Duke has reviewed the Staff's suggested modification and commits to abide by it. (RPM, JAG, SRW)

36. Q. DEFINE WHAT IS MEANT BY THE TERM "REPLACEMENT PARTS."

A. In the context of the diesel engine qualification program, replacement parts are those new parts, or classes of parts used to replace those parts in which indications were found during the detailed inspections following the extended operation test runs of the engines. It should be noted that some of the replaced parts such as the piston skirts, showed no indications but were replaced as a matter of conservation. (GWH, RPM, JAG, SRW)

37. Q. WITH RESPECT TO THE REPLACEMENT PARTS FOR THE CATAWBA DIESEL GENERATORS, PLEASE EXPLAIN THE ROLE OF THE QUALITY ASSURANCE DEPARTMENT.

A. The role of the QA Department is to assure that any replacement parts used in the engines of the Catawba diesel generators meet acceptance criteria. (JOB, JMC)

38. Q. FOR THE CASE OF THE DIESEL GENERATOR REPLACEMENT PARTS, HOW IS THE ROLE OF THE QA DEPARTMENT DIVIDED AMONG THE DIVISIONS?

A. The divisions with primary responsibility for the diesel replacement parts are the QA Vendors Division and the QA Operations Division. The QA Vendors Division is responsible for Duke's oversight of activities at TDI. The QA Operations Division is responsible for activities which assure quality once a replacement part arrives on-site at Catawba. (JOB, JMC)

39. Q. PLEASE DESCRIBE THE ACTIVITIES OF THE QA VENDORS DIVISION IN ASSURING THAT REPLACEMENT PARTS WILL PERFORM THEIR INTENDED FUNCTIONS.

A. The QA Vendors Division performs audits and surveillances of vendors. The purpose of these activities is to provide assurance by Duke Power that the replacement parts have been manufactured to the required specifications in the purchase order. (JMC)

40. Q. WERE ADDITIONAL QA ACTIVITIES PERFORMED FOR REPLACEMENT PARTS?

A. Yes. (JOB, JMC)

41. Q. WHAT GROUP WITHIN DUKE POWER COMPANY REQUESTED THE PERFORMANCE OF THESE ACTIVITIES FOR REPLACEMENT PARTS?

A. The Nuclear Maintenance Group within the Nuclear Production Department requested additional QA oversight. (JOB)

42. Q. WHY WERE THESE ADDITIONAL QA ACTIVITIES REQUESTED?

A. Because questions have been raised concerning the TDI QA Program, Duke Power Co. decided to perform augmented inspections on selected replacement components. Subsequently, the Duke Power QA Department was requested to perform additional specific inspections on-site at Catawba when these parts were received. (GWH)

43. Q. PLEASE INDICATE WHAT ADDITIONAL ACTIVITIES THE QA VENDORS DIVISION PERFORMED FOR THE TDI REPLACEMENT PARTS.

A. The QA Vendors Division has engaged in increased surveillances at TDI to verify that replacement parts were manufactured to required specifications. In addition, in conjunction with the qualification program headed by the Nuclear Production Department Maintenance Engineering group, QA Vendors Division personnel have witnessed the conduct of NDE at TDI. (JMC)

44. Q. PLEASE DESCRIBE THE NORMAL ACTIVITIES OF THE QA OPERATIONS DIVISION IN ASSURING THAT REPLACEMENT PARTS WILL PERFORM THEIR INTENDED FUNCTIONS.

A. QA Operations Division personnel perform receipt inspections to determine that the ordered items and documentation have been received and that no shipping damage or deterioration has occurred. (JOB)

45. Q. WHAT ADDITIONAL ACTIVITIES ARE CONDUCTED ON-SITE AT CATAWBA BY QA OPERATIONS DIVISION FOR THE TDI REPLACEMENT PARTS?

A. In accordance with procedures established by the Nuclear Production Department described in the testimony of other witnesses for the disassembly and inspection program, personnel in the QA Operations Division conduct NDE of replacement parts when they are received. This testing includes radiography, magnetic particle testing (MT), dye penetrant testing (PT), ultrasonic testing (UT), visual inspection, and hardness testing. The NDE is performed by certified QC inspectors under my supervision and control. In addition, radiographic inspections are conducted by outside contractors or Duke QA personnel. The radiographs are interpreted by Duke QA personnel. (JOB)

46. Q. FOR REPLACEMENT PARTS EXPLAIN HOW THE QUALITY ASSURANCE DEPARTMENT HAS ASSURED THEIR ADEQUACY.

A. Below are listed the major parts which were replaced on the diesel engines as a result of the test and inspection program. The actions that were taken by the

QA Department to assure its quality are beside each part.

- Connecting Rod Bearing Shells (replaced on 1A and 1B) - QA performed surveillance at TDI which involved review of subvendor documentation, verification of the TDI-approved supplier, and review of processing through TDI receipt inspection. After determining that documentation required by the purchase order existed, a vendor release was issued. QA performed radiographic examination after receipt at Catawba, in addition to normal receipt inspection to assure that these items contained no unacceptable indications.

- Piston Skirts (replaced on 1A and 1B) - Piston skirts were received in two shipments. QA performed two surveillances at the TDI facility which involved review of the identification and heat treating process. QA also witnessed 100% MT examinations on the second shipment at TDI's facility. After determining that documentation required by the purchase order existed, QA issued a vendor release. QA performed MT and PT examinations and hardness tests after receipt at Catawba, in addition to normal receipt inspection on the first shipment to assure that there were no surface indications and that the skirts had been hardened as required by the specification.

- Push Rods (replaced on 1A and 1B) - QA performed two surveillances at TDI which involved review of TDI QA activity on the subvendor and review of subvendor documentation. After determining that documentation required by the purchase order existed, QA issued a vendor release. QA performed PT examination of friction weld area after receipt at Catawba, in addition to normal receipt inspection to assure that no surface indications were present.

- Subcover (replaced on 1A and 1B) - QA issued a vendor release after determining that TDI had generated documentation required by the purchase order. QA performed PT examination after receipt, in addition to normal receipt inspection to assure that no surface indications were present.

- Cylinder Head Assembly (replaced on 1A and 1B) - QA performed surveillance in TDI facility during which documentation was reviewed. After determining that documentation required by the purchase order existed, QA issued a vendor release. Cylinder heads were installed during qualification runs. QA performed UT and MT examinations after disassembly to assure that no surface indications were present and that casting thickness met specifications in critical areas.

- Exhaust Valves (replaced on 1A and 1B) - QA issued a vendor release. Thereafter QA performed detailed visual inspection of chrome plating in addition to normal receipt inspections to assure that no flaking of the plating had occurred.

- Turbochargers (replaced on 1A and 1B) - QA performed three surveillances at United Technologies/Elliott Corporation facility. After determining that documentation required by the purchase order existed, QA issued a vendor release. QA performed normal receipt inspections.

- Fuel Injection Pump Valve Holder - Due to unacceptable delivery time, an entire fuel injection pump assembly was removed from one of the Unit 2 engines and installed in the 1A engine during the extended run. This pump was disassembled, visually inspected, and reassembled by Nuclear Production prior to installation in the 1A engine with QC inspectors verifying compliance with the written maintenance procedures.

- Miscellaneous fasteners - After determining that documentation required by the purchase order existed, QA issued vendor releases. QA performed normal receipt inspections.

- Fuel Injection Pump - Due to unacceptable delivery time, two fuel pumps were removed from the Unit 2 engines for installation on Engine 1B. QA performed normal receipt inspection.

(JOB, JMC)

47. Q. DESCRIBE ANY PROBLEMS DETECTED WITH TDI REPLACEMENT PARTS DURING THE QUALITY ASSURANCE INSPECTIONS AND VERIFICATIONS OF THOSE PARTS. EXPLAIN HOW THOSE PROBLEMS WERE DETECTED, AND EXPLAIN THE CORRECTIVE ACTIONS TAKEN BY QUALITY ASSURANCE TO ASSURE THAT THOSE PROBLEMS WERE PROPERLY IDENTIFIED, DOCUMENTED, AND RESOLVED.

A. The following discrepancies were identified with the replacement parts:

- Two connecting rod bearing shells were rejected by radiographic examination at Catawba. This examination was performed as an augmented receipt inspection. Other acceptable bearing shells were used in the reassembly.

- One AE piston skirt in the first shipment was rejected by MT examination at Catawba. This examination was performed as an augmented receipt inspection. Another acceptable piston skirt was used in the reassembly. Vendor surveillance of MT examination of the second shipment at TDI facility was scheduled (see below).

- Two piston skirts had indications detected by MT at the TDI facility during a Vendors Division surveillance visit in which 100% witnessing of MT was performed by Duke Power QA personnel. Indications were removed by light buffing and skirts re-examined by MT and accepted. This was documented in a QA Vendors Division surveillance report. The TDI procedure was revised to expand the surface area of each skirt to be tested to include the area where the original indications were found.

(JOB, JMC, GWH)

48\. Q. STATE THE CONCLUSIONS OF QA VENDORS DIVISION WITH RESPECT TO THE ADEQUACY OF THE REPLACEMENT PARTS FOR THE CATAWBA DIESEL GENERATORS.

A. As a result of the argumented surveillances and witnessing of shop tests undertaken by QA Vendors Division personnel under my supervision and control to assure the quality of the replacement parts for the Catawba 1A and 1B diesel engines, I conclude that these parts were manufactured according to specifications and from that standpoint are adequate to perform their intended service. (JMC)

49\. Q. STATE THE CONCLUSIONS OF QA OPERATIONS DIVISION WITH RESPECT TO THE ADEQUACY OF THE REPLACEMENT PARTS FOR THE CATAWBA DIESEL GENERATORS.

A. As a result of the argumented on-site inspection of the replacement parts conducted by personnel under my supervision and control, I conclude that the components were manufactured according to specifications and are free of defects. The replacement parts are, therefore, adequate to perform their intended service. (JOB)

50\. Q. THE NRC STAFF HAS CONCLUDED THAT THE CATAWBA UNIT 1 DIESEL ENGINES WILL PROVIDE A RELIABLE STANDBY SOURCE OF

ON-SITE POWER IN ACCORDANCE WITH GDC 17 THROUGH THE FIRST REACTOR REFUELING OUTAGE. THAT CONCLUSION IS BASED UPON, AMONG OTHER THINGS, A CONDITION THAT THROUGH CHANGES TO THE TECHNICAL SPECIFICATIONS, FUTURE TESTING OF THE ENGINES BE LIMITED TO 185 BMEP. PLEASE EXPLAIN WHAT THIS MEANS WITH RESPECT TO OPERATION OF THE DIESEL ENGINES.

A. BMEP is an engineering term to denote the specific power of an engine. This index relates to the combustion pressure level of the engine. It indicates the horsepower per cylinder per cycle. For the TDI DSRV-16 engine 185 BMEP means 5750 KW at 450 RPM. The effect of the NRC/PNL recommendation is to limit, on a temporary basis, the output of each of the diesel generators for Catawba Unit 1 to 5750 KW, or 82% of the 7000 KW nameplate rating. (SKC, GWH)

51. Q. DOES DUKE INTEND TO LIMIT OPERATION OF THE CATAWBA 1A AND 1B DIESELS AS RECOMMENDED BY THE NRC STAFF?

A. Yes. We believe that the limitation, though only temporary, is overly conservative. It is our view that the engines are fully capable of satisfactory operation at their design BMEP of 225 psi. Nevertheless, we will limit operation as recommended by the NRC Staff. Thus, we will limit engine operation and testing (including surveillance testing required by the Technical Specifications) to within ±5% of the nominal engine load where the upper limit of this engine load range corresponds to a BMEP of 185 psi.

To this end, Duke will submit an amendment to its Technical Specifications prior to operation above 5% power. The amendment will provide that the monthly and 18-month surveillance tests be performed at a load greater than or equal to the maximum emergency service load, but not to exceed 5750 KW (82% of rated load; 185 psi BMEP).

In addition, in keeping with the NRC Staff's SER, prior to full power licensing Duke will amend its plant procedures, including the Catawba Abnormal Procedure for Loss of Normal Power and any other applicable procedures, to assure that in the event of an emergency loads will not be added unnecessarily to the engines in excess of 185 BMEP (5750 KW). (GWH, SKC, CHW, LAS)

52. Q. WILL THIS AFFECT DUKE'S ABILITY TO PROVIDE A RELIABLE STANDBY SOURCE OF ON-SITE POWER IN ACCORDANCE WITH GENERAL DESIGN CRITERION 17?

A. No. As has been previously mentioned, the emergency load requirement is 5256 KW during a loss of coolant event or 5714 KW under loss of offsite power conditions. Operation of either 1A or 1B diesel at 185 BMEP corresponds to an output of 5750 KW, which is greater than the requirement for emergency power under either condition. (GWH, RCG)

53. Q. WHAT WOULD BE THE CONSEQUENCES IF ONE OF THE PROBLEMS ADDRESSED ABOVE CAUSED AN ENGINE TO SUFFER A REDUCTION IN POWER OUTPUT?

A. As stated above, it is our conclusion that none of the problems addressed in the diesel engine qualification program will affect the ability of the Catawba diesels to start or carry the required loads in an emergency situation. A review of those problems leads to the conclusion that failure of a component which would lead to reduction in output would most likely affect only one cylinder. Even if we assume that we lose all power from one cylinder, the engine would be fully capable of carrying the required load. (GWH, RPM, SKC)

54. Q. WHAT EFFECT WOULD THIS HAVE ON THE ENGINES' ABILITY TO SUPPLY EMERGENCY LOAD?

A. If one cylinder stops producing power, the remaining 15 would increase output to produce sufficient power to compensate for the loss. In such an instance the BMEP of those 15 working cylinders would rise above 185 psig, probably to about 196 psig, if and when the full 5750 KW output is needed for the loss of offsite power. We do not believe that such emergency operation at a BMEP of 196 psig would have any adverse effect on engine operability. As we have already stated, we believe that the engines are fully capable of performing satisfactorily at their design BMEP of 225 psi.

Moreover, though the SER states that the 185 psi BMEP limitations apply to operation and testing in other than emergency situations, it recognizes that in emergency situations the engine BMEP might have to be increased. The Staff has, therefore, recommended that Duke amend its procedures to provide that, in the event of an emergency, load above 185 psi BMEP will not unnecessarily be added to an engine. (SER, p. 6) Clearly, in an emergency situation emergency requirements take precedence, and if it is necessary for an engine to run above 185 psi BMEP it will be done.

In any event, it should be pointed out that there is a fully redundant diesel generator set for Unit 1 which is capable of carrying the full emergency load.

Finally, in the extremely unlikely event both engines were required, and both experienced a reduction in power, the loss of offsite power load (which is listed as 5714 KW) could be reduced significantly without exceeding the fuel design limits and design conditions of the reactor coolant system boundary, or affecting the ability to maintain core cooling and containment integrity and other vital functions in the event of postulated accidents as required by GDC-17. (GWH, RPM, SKC, RCG)

55. Q. HOW WOULD THAT BE ASSURED?

A. An examination of the loads required for the loss of offsite power scenario has revealed that a part of the loads in the 5714 KW figure are not required to meet the requirements of GDC-17.

The maximum load placed on a diesel during a loss of offsite power event has been calculated by adding the electrical loads of the individual components connected to it during this event. For purposes of calculation, the load of each piece of equipment is assumed to be either the maximum power required by that piece of equipment during a loss of offsite power event or the nameplate rating of the equipment. The nameplate rating is greater than the maximum power required by the equipment during the event. Thus it is assumed that all of the loaded equipment operates continuously during the event (when in fact much of the equipment will operate intermittently) and that each requires full rated power (when in fact many will draw significantly less than rated power). With these extremely conservative assumptions, the maximum potential load on a diesel generator during a loss of offsite power event is calculated to be 5714 KW. (GWH, RCG)

56. Q. WHAT EQUIPMENT IS SUPPLIED FROM THE DIESELS DURING A LOSS OF OFFSITE POWER EVENT?

A. The 5714 KW LOOP figure includes loads from a substantial amount of equipment not necessary for safe shutdown. During a loss of offsite power event, some or all of the following loads included in the 5714 Loop load calculation could be disconnected from the diesel generators:

EQUIPMENT	LOAD
Equipment that maintains non-safety equipment in operational condition (example - main turbine turning gear)	"A" diesel - 70 KW "B" diesel - 84 KW
Motor Driven Auxiliary Feedwater Pump - operator starts and uses Turbine Driven Auxiliary Feedwater Pump	497 KW
Fire Protection Pumps - when not required to fight fire	272 KW
Shutoff Spent Fuel Pool Cooling Pumps	194 KW
Terminate fuel handling area Ventilation	242 KW
Terminate portions of Containment Ventilation (can be done in stages)	up to 532 KW
Shutoff Instrument Air Compressor & Dryer	127 KW

Therefore, it is clear that under LOOP conditions it would be practicable to reduce diesel loads well below 5714 KW without affecting safe shutdown capability. Thus there is clearly more than a 36 KW margin to protect safety with the diesels operating at 185 psi BMEP. (GWH, RCG)

57. Q. WILL ADDITIONAL TESTING OF THE CATAWBA DIESELS BE CONDUCTED?

A. Yes. Return to service testing will be performed. (RPM, SRW, JAG)

58. Q. WHAT PURPOSE WILL THIS ADDITIONAL TESTING SERVE?

A. This additional testing will assure that, following inspection, replacement of parts and reassembly, the engine is properly reassembled and is operable. (RPM, SRW, JAG)

59. Q. PLEASE EXPLAIN WHAT RETURN TO SERVICE TESTS WILL BE CONDUCTED ON CATAWBA DIESELS 1A AND 1B FOLLOWING REASSEMBLY OF THE ENGINES AFTER THE REVALIDATION INSPECTIONS.

A. Duke Power Company, in a letter to Mr. H. R. Denton of the NRC on July 6, 1984 (Attachment 13), outlined the return-to service testing of the Catawba diesel 1A and 1B engines following their reassembly after the revalidation inspections. Pertinent points of the program are as follows:

- The engines will be run-in in accordance with the manufacturer's recommendation.
- Ten modified 3500 KW load tests will be performed. During each test the engine will be run a minimum of one hour.
- A 24 hour load test will be performed at 5750 KW (185 psi BMEP load).

- Two fast start tests will be accomplished. During each test the engine will be started and come up to speed within 11 seconds. The diesel engine will then be loaded in the period from 11 to 30 seconds. Peak load will be 4100 KW. After achieving this load, the engine will be run for an hour.

In a letter to Mr. H. B. Tucker of Duke Power Company of August 14, 1984, the NRC presented its staff safety evaluation report (SER) of the Catawba Unit 1 diesels.

The SER indicated that the return to service testing proposed by Duke Power Company was acceptable provided that peak power levels during the testing do not go above approximately 5750 KW. As noted above, Duke's return to service testing program is now in accordance with the peak power limits stipulated in the SER. (RPM, SRW)

60. Q. HAS A PERIODIC MAINTENANCE, INSPECTION AND SURVEILLANCE PROGRAM BEEN DEVELOPED?

A. Yes. (RPM)

61. Q. PLEASE DESCRIBE YOUR PERIODIC MAINTENANCE, INSPECTION AND SURVEILLANCE PROGRAM FOR THE CATAWBA 1A AND 1B DIESEL ENGINES AFTER THESE ENGINES ARE RETURNED TO SERVICE FOLLOWING THE REVALIDATION PROGRAM?

A. Duke Power Company in a letter to Mr. H. R. Denton of the NRC on July 16, 1984, outlined the periodic maintenance, inspection and surveillance program to be performed on the Catawba 1A and 1B diesel engines. Pertinent points in the program included the following:

- Periodic operational testing of the diesels in accordance with the Catawba technical specifications. The technical specifications require that a start test be conducted monthly on each engine. Also a series of tests to demonstrate that the engines are capable of operating under emergency conditions is conducted at each refueling.
- Periodic maintenance of the diesels such as filter replacements, etc. in accordance with TDI recommendations.
- Routine surveillance of the engine while it is operating. The routine surveillance procedures include checking instrumentation, checking level in lube oil pump, etc.
- Inspection of the engine on weekly, monthly, semi-annual, each refueling, alternate refuelings, five year and ten year intervals. The inspections cover such diverse areas as calibration of instrumentation to major disassembly of the engine for detailed non-destructive examinations.

In a letter to Mr. H. B. Tucker of Duke Power Company from the NRC, dated August 14, 1984, the NRC forwarded the Staff Safety Evaluation Report, (SER), pertaining to the Catawba diesel engines. Pertinent points made in the SER pertaining to Duke's proposed maintenance program are:

- Change lube oil samples to once a month for the first three months.
- Modify barring-over procedures to 4 hours after operation and then again 24 hours after operation, and prior to subsequent operation.
- Visual inspection of block daily during operation.
- Check of connecting rod bolt elongation at refueling or after 200 hours of operation whichever comes first.
- Check 100% of air start valve capscrews at each refueling.
- Take web deflection measurements at each refueling outage as soon as possible after engine shut down.
- Inspect at first refueling four connecting rod bearing shells, two main bearing caps and shells, four pistons, four heads and four liners.

Duke has reviewed the NRC staff's SER and agrees to accept the NRC staff's recommendations on the maintenance program. Duke is in the process of modifying the Catawba diesel periodic maintenance, inspection and surveillance program to incorporate all comments made in the SER on this program. (GWH, RPM, SRW, JAG)

62. Q. HAVE YOU REVIEWED THE CONDITIONS THAT THE NRC STAFF HAS PLACED UPON DUKE WITH RESPECT TO THE CATAWBA DIESEL ENGINES?

A. Yes. The Staff, in Section 4.0 of the SER, concluded "that the TDI diesel engines at Catawba Unit 1 will provide a reliable standby source of onsite power in accordance with General Design Criterion 17."

The Staff listed seven items required of Duke to support the Staff's conclusion prior to operation above 5% power. These items are:

- Installation of a flexible joint arrangement at the turbocharger right bank of both engines.

- A commitment to inspect the turbocharger bearings of one engine if an improved prelubrication system is not installed.

- Replacement of the #6L cylinder head on the 1A engine.

- A commitment to inspect the 1B engine's jacket water pump impeller nut at the first refueling.

- A commitment to incorporate the modified maintenance and surveillance program as discussed in the SER and TER, including identification of the rocker box subassembly inspection frequency and cause of failure.

- Revised Technical Specifications limiting operation and testing to 185 psig BMEP (5750KW).

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

Duke has reviewed each of the items carefully and commits to comply with each prior to operation above 5% power.

The NRC Staff also stated in its SER that it would condition the license to require Duke to implement TDI Owners' Group recommendations applicable to Catawba Unit 1, as reviewed and accepted by the Staff, by the plant's first refueling outage. Such a condition is acceptable to Duke. (GWH)

63. Q. AS A RESULT OF THE EXTENDED OPERATION TEST AND THE TEST AND INSPECTION PROGRAM, ARE YOU SATISFIED THAT THE CATAWBA DIESEL ENGINES WILL PERFORM THEIR INTENDED FUNCTION?

A. Yes. Duke Power Company approached the TDI diesel engine issue with the intention of conclusively determining the suitability of these machines to serve their intended function. It was not expected that the Catawba diesels would initially be fault free but it was expected that any latent deficiency would be detected through appropriate tests and inspections and mitigated through analyses, design changes, modifications, procedural changes, and enhanced preventive maintenance and periodic inspections.

Duke therefore ran both the 1A and 1B engines for millions of stress cycles to assure that any latent fatigue and/or wear related problems would be manifested. The 1A engine was then fully disassembled and examined in detail to reveal any distress. Any components that did not meet stringent criteria were fully analyzed and modifications or replacements were made as necessary. The 1B engine was also disassembled and inspected in detail. Following reassembly of each engine, extensive return to service testing will be performed and an enhanced preventive maintenance and periodic inspections program will be implemented.

The extended runs and inspections on both engines have been completed. The inspection results have been generally favorable. The problems identified are described in the body of this testimony. Each problem has received extensive analysis and has been resolved appropriately.

In view of the extensive scope of this program and the conservative approach under which it is being conducted, we firmly believe that the Transamerica Delaval Incorporated diesel engines at the Catawba Nuclear Station are fully qualified to perform their intended function.

Further, we believe that the Catawba diesels will be able to perform their intended function in conformance with the conditions imposed in the NRC SER. (GWH, RPM, SKC, CHW, LAS, JAG, SRW)

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
DUKE POWER COMPANY, et al.	)	Docket No. 50-413
	)	50-414
(Catawba Nuclear Station	)	
Units 1 and 2)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "Testimony of G. Wayne Hallman, Russell P. Muschick, S. Robert Ward, Jeffery A. Gorman, Clifford A. Wells, Lee A. Swanger, Simon K. Chen, Jesse O. Barbour, J. Malcolm Curtis, and Robert C. Gambert Relating To Problems Encountered in the Catawba Diesel Generator Qualification Program" in the above captioned matter have been served upon the following this 21st day of August, 1984.

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

**Dr. Paul W. Purdom
236 Columbia Drive
Decatur, Georgia 30030

**Dr. Richard F. Foster
P. O. Box 4263
Sunriver, Oregon 97702

***Chairman
Atomic Safety and Licensing Board Panel
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

***Richard P. Wilson, Esq.
Assistant Attorney General
State of South Carolina
P. O. Box 11549
Columbia, South Carolina 29211

**Robert Guild, Esq.
Attorney-At-Law
P. O. Box 12097
Charleston, South Carolina 29412

*Palmetto Alliance
2135 1/2 Devine Street
Columbia, South Carolina 29205

*Jesse L. Riley
854 Henley Place
Charlotte, North Carolina 28207

***Chairman
Atomic Safety and Licensing
Appeal Board
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

*George E. Johnson, Esq.
Office of the Executive Legal
Director
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

***Karen E. Long
Assistant Attorney General
N. C. Department of Justice
P. O. Box 629
Raleigh, N. C. 27602

***Don R. Willard
Mecklenburg County Department
Of Environmental Health
1200 Blythe Boulevard
Charlotte, North Carolina 28203

***John Clewett, Esq.
236 Tenth Street, S.E.
Washington, D. C. 20003

*J. Michael McGarry, III, Esq.
Anne W. Cottingham, Esq.
Bishop, Liberman, Cook, Purcell
and Reynolds
1200 Seventeenth Street, N.W.
Washington, D. C. 20036

***William L. Clements
Docketing and Service Section
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Albert V. Carr, Jr.

*   Hand Delivery
** Express Mail
*** U. S. Mail

ATTACHMENTS

Number	Title
1	Resume - G. Wayne Hallman
2	Resume - Russell P. Muschick
3	Resume - S. Robert Ward
4	Resume - Jeffrey A. Gorman
5	Resume - Clifford H. Wells
6	Resume - Lee A. Swanger
7	Resume - Simon K. Chen
8	Resume - Jesse O. Barbour
9	Resume - J. Malcolm Curtis
10	Resume - Robert C. Gamberg
11	April 5, 1984 Report to H. R. Denton describing extended operation test and inspection program plan
12	June 29, 1984 Report to NRC describing results of the Catawba 1A engine inspection
13	July 6, 1984 Report to H. R. Denton describing scope of Catawba 1B engine inspection and return to service test program for the 1A engine
14	July 16, 1984 Report to H. R. Denton describing periodic maintenance, inspection and surveillance program
15	August 1, 1984 Report to H. R. Denton in response to questions raised by NRC and Battelle personnel during a visit to Catawba on July 26, 1984
16	August 3, 1984 Letter to NRC addressing loads on engine 1B during its extended operation test run

Number	Title
17 -	August 8, 1984 Letter to NRC addressing questions raised by NRC and Battelle personnel during a visit to Catawba on July 26, 1984
18	August 20, 1984 Table showing loads on engine 1A during its extended operation test run

Resume

G. W. Hallman

Education: BSME - 1960 N.C. State University
Graduate work (MSME - 30 hrs.) - 1966 University of Akron
Nuclear Physics Course (NE-419) - 1972 N.C. State University

Additional Training: Duke Power Advanced Management Training - 1980
Catawba Nuclear Station Systems Training - 1981

Work Experience:

From	To	Title	Company
8/82	present	Nuclear Maintenance Manager General Office	Duke Power

Manage group of 60 people responsible for the Duke Power nuclear station maintenance program. This is a staff position that provides overall technical direction, failure analysis expertise, advanced maintenance techniques and other expertise, advanced maintenance techniques and other expertise such as welding technology, vibration analysis and metallurgy. This group is also responsible for coordination of nuclear modifications, computerized equipment history, the preventive maintenance program and the materials management program.

From	To	Title	Company
1/78	8/82	Superintendent of Maintenance Catawba Nuclear Station	Duke Power

Manage group of 130 people responsible for the implementation of the maintenance and materials program at Catawba. This group consisted of engineers, craft supervisors and craftsmen responsible for the maintenance of mechanical, electrical and instrumentation equipment as well as warehousing and tool control.

From	To	Title	Company
9/75	12/77	System Engineer Mechanical Maintenance General Office	Duke Power

Supervision of five engineers responsible for analysing mechanical equipment problems in nuclear and fossil stations.

From	To	Title	Company
7/72	8/75	Maintenance Engineer Mechanical General Office	Duke Power

Engineer responsible for analysing mechanical equipment problems in nuclear and fossil stations.

10/69	12/71	Maintenance Supervisor Utility Department Celriver Plant	Celanese Fibers Company

Supervision of 30 people responsible for the maintenance of a 20 MW electric generating plant, a pumping station, a water filter plant, a waste treatment plant and numerous pieces of refrigeration and HVAC equipment.

7/66	9/69	Project Engineer Celriver Plant	Celanese Fibers Company

Engineer responsible for design, procurement and installation on numerous plant improvement and expansion projects.

10/64	6/66	Results Engineer Barberton, Ohio Office	Babcock and Wilcox Company

Engineer responsible for resolution of various operating problems in industrial and utility boilers.

8/60	9/64	Performance Engineer Barberton, Ohio Office	Babcock and Wilcox Company

Engineer responsible for the final design of industrial and utility boilers.

Russell P. Muschick

Business Address:

Duke Power Company
422 S. Church Street
Charlotte, N.C. 28242

Mechanical Maintenance Engineer

Education:

B.S. degree, Mechanical Engineering
Clemson University - 1970

Professional Experience:

Joined Duke Power Company - 1970

1970-1974 Site Engineer - Buzzard Roost Gas Turbine Site. Responsible for all aspects of operation and maintenance of ten combustion turbines with combined out put of 300 MW.

1974-1977 Operations Engineer - Belews Creek Steam Station. Assigned to coordinate startup activities for Unit #2. Lead responsibility for coordinating station activities on following equipment:

- Main and Feedwater Turbines
- Pulverizers
- Voltage Regulators
- Fans/Ducts
- Electrical Distributors

1977-1980 Maintenance Engineer - Oconee Nuclear Station. Assigned to Mechanical Maintenance Engineering Support Group. Had lead responsibility for coordinating maintenance activities on following equipment:

- Main and Auxiliary Turbines
- Moisture Separator Reheaters
- Reactor Coolant Pumps
- Reactor Vessel Internals

Major Projects Completed:

- Replacement of MSR Tube Bundles
- Repair/Replacement of Reactor Internal Vents
- Tooling for Remachining of BWC RCP's
- Upgrade of Bingham RCP Seals

1980-1981 Assigned as ONS Unit 2 Mechanical Maintenance Coordinator. In this position - controlled maintenance activities associated with ONS #2. This period included a planned refueling, several forced outages, and normal operating activities.

1981-Present Assigned to General Office Mechanical Maintenance Group. Worked to coordinate resources external to nuclear stations needed to support mechanical engineering concerns.

S. ROBERT WARD

EDUCATION

- B.S. Electrical Engineering, University of Michigan, 1959
- Bettis Reactor Engineering School, Naval Reactors, USAEC, 1960
- Graduate Work, University of Maryland, 1963
- Registered Professional Engineer

EMPLOYMENT

- 1959 to 1963 Naval Reactors Headquarters, USAEC
- 1963 to 1965 Central Engineering, Chrysler Motor Corporation
- 1965 to 1980 MPR Associates, Inc.
- 1980 to present Dominion Engineering, Inc.

EXPERIENCE

- Analysis of specialized problems associated with both dc and ac machinery

- Design, specification and troubleshooting of instrumentation, control and process systems for central station power plants, marine equipment, and offshore structures

- Design, specification and review of power distribution systems for nuclear power plants, ships and offshore structures

- Design, specification and review of components and hardware such as pumps, propulsion system components, bearings, seals, underwater mechanisms, mooring systems and tow cables

- Structural review of pressure vessels and piping systems

- Design reviews of offshore structures from the standpoint of structural, material and fabrication adequacy

- Preparation of operating manuals, maintenance instructions, and troubleshooting procedures

- Quality assurance audits of nuclear power plant design, construction and start-up activities

JEFFREY A. GORMAN

EDUCATION

- B.S. Civil Engineering, Cornell University, 1958
- Bettis Reactor Engineering School, Naval Reactors, USAEC, 1961
- M.S. Engineering Science, California Institute of Technology, 1966
- PhD Engineering Science, California Institute of Technology, 1968
- Registered Professional Engineer

EMPLOYMENT

- 1958 to 1959 American Overseas Petroleum, Ltd.
- 1959 to 1965 Naval Reactors Headquarters, USAEC
- 1968 to 1980 MPR Associates, Inc.
- 1980 to present Dominion Engineering, Inc.

EXPERIENCE

- Troubleshooting equipment problems especially related to fracture, fatigue, corrosion and erosion of mechanical components

- Evaluation of nuclear fuel mechanical design and performance

- Development of steam generator support system design and operation guidelines to minimize corrosion damage

- Engineering evaluation of steam generator eddy current inspection results and other NDE problems

- Development of inservice inspection programs and evaluation of inspection results for nuclear and fossil power plants

- Structural design and analysis to ASME Code requirements

- Design and analysis of piping system components such as piping, valves, pumps, etc.

- Evaluation of metallurgical problems, performance of fracture mechanics analyses, and development of specification requirements for power plants and for offshore structures

- Design of specialized reactor servicing equipment such as TV inspection systems, underwater lighting, and shielding

- Development of repair procedures for major reactor plant problems such as pipe cracking

- Quality Assurance audits of nuclear power plant design, construction, and fabrication activities

- Member of EPRI Corrosion Advisory Committee/Materials and Corrosion Committee, and assisted in review of ARPA's stress corrosion cracking handbook

Failure
Analysis
Associates

Attachment 5

CLIFFORD H. WELLS

Specialized Professional Competence

Structural lifetime prediction and reliability analysis, nondestructive evaluation, mechanics of deformation and fracture, elevated temperature design methods and analysis, mechanical test methods and fracture analysis, microstructural mechanisms of fatigue and material modeling, and integrated inspection and analysis systems for structural lifetime assurance.

Past research includes mechanical behavior of materials at high temperature and in aggressive environments, development of a turbine rotor fatigue lifetime prediction system, modeling of material deformation and fracture under complex stress states, development of mechanical testing methods.

Background and Professional Honors

B.S. (Mechanical Engineering), Yale University
M.S. (Civil Engineering), Yale University
Ph.D. (Applied Mechanics), Yale University
Oak Ridge School of Reactor Technology
Vice-President, Research and Development,
Failure Analysis Associates
Assistant to President and Director of Engineering Mechanics,
Southwest Research Institute
Assistant Manager, Materials Engineering and Research,
Pratt & Whitney Aircraft
Structural Engineer,
Oak Ridge National Laboratory
Research Assistant,
Yale University
Fellow, ASME
President-elect, Federation of Materials Societies
Chairman, Air Force Studies Board Panel on NDE, National Research Council
Chairman, National Materials Advisory Board Committee on Fatigue at Elevated Temperature
Member, National Materials Advisory Board Committee on Fretting Initiated Fatigue
Chairman, Executive Committee, Materials Division of ASME
EPRI Materials and Corrosion Committee
Metal Properties Council Subcommittee on Materials for Coal Conversion
Editor, Fatigue of Engineering Materials and Structures
Editor, Journal of Nondestructive Evaluation

Selected Publications

"Mechanical Test Methods for Coal Gasification Environments," Proceedings of Conference on Properties of Materials in Coal Gasification Environment, American Society for Metals (1981) (with L. A. Zeiss and R. D. Brown).

"Mechanical Properties of Alloys in Coal Gasification Atmosphere," Proceedings of Conference on the Properties of Materials in Coal Gasification Environment, American Society for Metals (1981) (with L. A. Zeiss and R. D. Page).

"Reliability of Steam Turbine Rotors," Proceedings of Conference on Residual Life, Copenhagen, Denmark (1980).

"Analysis of Life Prediction Methods for Time-Dependent Fatigue Crack Initiation in Nickel-Base Superalloys," National Materials Advisory Board Publication NMAB-347, National Academy of Sciences (1980).

"High-Temperature Fatigue," Fatigue and Microstructure, 1978 ASM-TMS Seminar, American Society for Metals, pp. 307-333 (1979).

"Development of an Automated Life Prediction System for Steam Turbine Rotors," ASME Paper 78-WA/DE-15, The American Society of Mechanical Engineers, New York (1978) (with T. S. Cook and H. G. Pennick).

Failure Analysis Associates

LEE A. SWANGER

Specialized Professional Competence

Failure analysis of materials; metallurgical engineering, physical and mechanical metallurgy, and thermodynamics; foundry process development including ferrous and non-ferrous castings; powder metallurgy and powder rolling; electrochemistry, including electroplating and corrosion; materials testing, fatigue, and fracture; metal matrix and polymer matrix composites; tribology, friction, wear, and lubrication; internal combustion engine and compressor component design and testing; sleeve bearing design, manufacture, and failure analysis.

Background and Professional Honors

Ph.D. (Materials Science and Engineering), Stanford University, with Distinction
M.B.A. (Marketing/Finance), Cleveland State University
M.S. (Materials Science and Engineering), Stanford University
B.S. (Metallurgy), Case Institute of Technology, with Highest Honors

Managing Engineer,
Failure Analysis Associates
Director, Research and Development,
Imperial Clevite Inc.
Associate Director, Product Development,
Gould Inc., Engine Parts Division
Manager, Tribology and Bearing Research,
Gould Laboratories, Materials Research
Associate Senior Research Metallurgist,
General Motors Research Laboratories
Lecturer, Metallurgical Engineering,
Cleveland State University
Visiting Research Associate, Metallurgical Engineering,
Ohio State University

Registered Professional Engineer, State of Ohio, #44024
Member, Tau Beta Pi, Engineering Honorary Fraternity
Member, Sigma Xi, Scientific Research Honorary Fraternity
Member, Beta Gamma Sigma, Graduate Business Honorary Fraternity
National Merit Foundation Scholarship
Xerox Corporation Fellowship
IBM Corporation Fellowship
Hertz Foundation Fellowship
Member, American Society for Metals
Member, Society of Automotive Engineers
Interviewer, Hertz Foundation Fellowship Project

Selected Publications

U.S. Patent No. 4,333,215: "Bearing Material and Method of Making," issued June 8, 1982.
"Compacted Graphic Cast Iron Components for Improved Thermal Fatigue Resistance," Imperial Clevite Inc., Internal Report (January 1982).
"Marketing Strategies to Achieve Cash Flow Objectives," M.B.A. thesis, Cleveland State University (June 1982).
"Squeeze-Cast Pistons for Heavy-Duty Applications," Gould Inc., Internal Report (February 1981).
"Evaluation of Graphite Epoxy and Graphite-Babbitt Composite Sleeve Bearings," Gould Laboratories, Phase Report (October 1977).
"Environmentally Induced Blistering of Aluminum P/M Components," Gould Laboratories, Project Completion Report (December 1976).

Attachment 7

PEI CONSULTANTS	Biographical Data On Dr. Simon K. Chen, PE	March 16, 1983

<u>Position</u> President

<u>Home</u> 325 Racine Street, Delavan, WI 53115
Home Phone: 414-728-6994

<u>Education</u>

B.S., M.E.	1947	National Chiao-Tung University
M.S., M.E.	1959	University of Michigan
Ph.D., M.E.	1952	University of Wisconsin
M.B.A.	1964	University of Chicago, Executive Program

<u>Work Experience</u>

President, Power and Energy International, Inc. — 1979 - present
Technical consulting and product development

President, Beloit Power Systems, Inc. — 1973 - 1979
Manufacturers of engine and turbine driven alternators, up to 15,000KW, rotary positive screw gas compressor, power plant controls, and gen-sets.

V.P., Engineering and Application, Fairbanks-Morse Power Systems Colt Industries — 1969 - 1973
Developer of O.P. Blower series line with increased rating, O.P. sparked gas engine, manufacturer of SEMT-PC-2 for marines, stationary and nuclear standby applications, developer of 38A-20 engine, producer of large irrigation pump, rotary compressor, alternators and motors.

Divisional Chief Engineer, Diesel Engine R&D, International Harvester Company — 1965 - 1969
Developer and manufacturers of vehicular diesels and spark-gas engines for construction equipment, farm equipment, medium-duty truck, and industrial applications.

Chief Project Research Engineer, Engineering Research, IH — 1956 - 1965
Corporate research on alternate power plant, engine combustion, advanced power train concept, advanced vehicle analysis, and corporate product planning.

Project Engineer, IH, Melrose Park — 1952 - 1956
In charge of combustion research on diesel and stratified charge engine.

<u>Technical Society Membership List and Honors</u>

SAE, ASME, SNAME, EGSMA, CIE, Who's Who in the World, Who's Who in Finance and Industry, Engineers of Distinction by Engineers Joint Council in 1973, SAE Arch T. Colwell Merit Award in 1966, University of Wisconsin Alumni Distinguished Service Award, 1973, Chinese Institute of Engineer's Achievement Award in 1976, Director and Technical Chairman of Diesel Engine Manufacturing Association, 1971-73, Member Compressed Air and Gas Institute, 1973-79, SAE Fellow-1983, Registered Professional Engineer - State of Wisconsin.

PEI CONSULTANTS

Publications

Dr. Simon K. Chen

January 16, 1984

- "Compression and End Gas Temperatures from Iodine Absorption Spectra," Co-author, SAE, 1954.
- "Development of a Single Cylinder Compression Ignition Research Engine," Co-author, SAE 650733, 1965.
- "Development and Evaluation of the Simulation of the Compression-Ignition Engine," Co-author, SAE 650451, 1965.
- "Engine Development Criteria and Techniques," Modern Engineering and Technology Seminar, Taiwan, Republic of China, July 1974.
- "Engine Cycle Analysis and Combustion Problems," Modern Engineering and Technology Seminar, Taiwan, Republic of China, July 1974.
- "Diesel Application," Modern Engineering and Technology Seminar, Taiwan, Republic of China, July 1974.
- "Highlights of the Energy Sêssion," Energy Quarterly, Republic of China, January 1975.
- "A Collection of Abridged Management Papers," Modern Engineering and Technology Seminar, Taiwan, Republic of China, July 1976.
- "Marketing in a Competitive Market," Modern Engineering and Technology Seminar, Taiwan, Republic of China, July 1976.
- "Management Philosophy and High Technology Development," Energy Quarterly, Taiwan, Republic of China, January 1978.
- "Vibration Analysis for a Sound Generator-Set Design," Electrical Generating Systems Marketing Association, Chicago, IL, September 26-27, 1978.
- "Waste Heat Recovery Cycle Analysis and Systems for Diesel and Gas Turbine Engines," 13th CIMAC Conference, Vienna, Austria, May 7-10, 1979.
- "Small Industrial Diesel Planning," September 16, 1980.
- "An International Perspective of Taiwan's Automotive Industry," Society of Automotive Engineers, SAE-ROC Technical Meeting, Tawian, Republic of China, November 23-25, 1981.
- "The Development of ROC Machine Tool Industry and the Impact of Automation," Industrial Technology Research Institute, Taiwan, Republic of China, September 1981.
- "Japan's Robot and Robotics Development," March 11, 1982.
- "Techno-Economic Recommendations to Fight Recession Accelerated by Energy Shock," May 5, 1982.
- "US Robots and Robotics," August 1983.
- "A Review of Engine Advanced Cycle and Rankine Bottoming Cycle and Their Loss Evaluations," Co-authored, SAE 830124, 1983.
- "Flexible Manufacturing Systems Applications," Modern Engineering and Technology Seminar, Singapore, November 1983.
- "The Impact of Automation on Newly Industrialized Countries," Modern Engineering and Technology Seminar, Singapore, November 1983.

Attachment 8

RESUME

JESSE O. BARBOUR

PERSONAL: Business Address: Duke Power Company
Quality Assurance Department
P.O. Box 33189
Charlotte, NC 28242

Telephone: (704) 373-4795

Age: 45 Height: 6'5" Weight: 205 lbs.

FORMAL EDUCATION:

NC State University: BSME (with honors) 1961
NC State University: Special Continuing Education Course in Nuclear Physics - 1972

ADDITIONAL TRAINING:

Management Training Course at Duke Power Management School - 1977

Advanced Management Training Course at Duke Power Management School - 1981

Numerous (30+) In-House Seminars and Classes on all Aspects of Quality Inspections and Assurance at Duke Power Company

PROFESSIONAL INVOLVEMENT:

Registered Professional Engineer - NC 3821

Member ASME (21 Years)

WORK EXPERIENCE:

FROM	TO	TITLE	COMPANY
5/74	Present	Quality Assurance Manager, Operations	Duke Power

Manage group of 134 people responsible for implementation of the Duke Power Operational Quality Assurance Program and the Inservice Inspection program at Oconee, McGuire and Catawba Nuclear Stations. This consists of:

1) Surveillance of day-to-day station activities to assure compliance with established procedures
2) Review of work packages for maintenance and modification work to establish Quality Control Inspection hold points
3) Quality Control Inspections of maintenance and modification work activities to assure compliance with established procedures
4) Review of finished work packages for completeness and accuracy

FROM	TO	TITLE	COMPANY

5) Development of Inservice Inspection plans to meet Section XI of the ASME Boiler and Pressure Vessel Code
6) Bid specification preparation for Inservice Inspection contracts
7) Bid proposal review and contract award for Inservice Inspection work
8) Contract Management and field implementation of Inservice Inspection work by both Duke and contractor personnel
9) Issue of reports of Inservice Inspection work to regulatory authorities
10) Development of procedures and revisions necessary to carry out these activities
11) Procurement and maintenance of equipment necessary to carry out these activities
12) Interface with regulatory authorities as necessary involving these activities.

Current budget for this operation is $9.1 million annually.

9/72	5/74	Staff Quality Assurance Engineer	Duke Power

Same responsibilities as above except on a smaller scale as only Occonee Nuclar Station was involved at that time.

9/71	9/72	Staff Maintenance Engineer	Duke Power

Responsible for coordinating maintenance work on company steam generating equipment (both fossil and nuclear) by contract and Duke personnel.

8/68	9/71	Maintenance Supervisor, Shops and Field	Celeanse Fibers Co. Rock Hill, SC

Supervised crew of 8 foremen and 90 craftsmen in operation of a large industrial maintenace shop involving machinists, welders, sheet metal workers, riggers, pipe fitters, painters, carpenters and laborers. This shop supported a textile plant which manufactured acetate and triacetate yarn and other textile products.

6/65	8/68	Project Engineer	Celeanse Fibers Co. Rock Hill, SC

Supervised designers and technicians in the design, procurement and installation of chemical processing and textile equipment.

6/61	6/65	Design Engineer	RJ Reynolds Tobacco Co. Winston-Salem, NC

Designed Pressure Vessles to Section VIII of the ASME Boiler and Pressure Vessel Code as well as atmospheric tanks and mechanical machine components and monitored manufacture of these items in company shops.

Attachment 9

J M CURTIS

Personal: 1116 Réverdy Lane
Matthews, NC 28105
Home Telephone: 704-847-4708

Education: Georgia Institute of Technology toward E.E. not complete.
I.C.S. Stationary Engineering completed
Technical level - completed Electrical, Electronics, Non-destructive Testing, Radiography, Ultrasonic and Magnetic Particle NDE Schools date back to 1959. Management schools dated back to 1965

Professional Involvement: American Society of Mechanical Engineers
American Society of Non-destructive Testing
American Society of Quality Control

Accomplishments: Apprenticeship as electrician
National Board of Boiler & Pressure Vessel Inspectors Commission #5393
North Carolina Boiler & Pressure Vessel Inspections - 1960
Registered Professional Quality Engineer State of California #5442

Work Experience:

From	To	Title	Assignment	Organization
1969	Present	QA Manager, Vendors QA Supervisor Senior Designer	QA Depart. Engineering Dept.	Duke Power

Four of the years in Mechanical Engineering Section, ten years in Quality Assurance Department. Activity mostly directed to the monitoring and control of vendor's Quality Assurance Programs.

From	To	Title	Assignment	Organization
1954	1969	District Manager Test Engineer Inspection Engineer	Loss Prevention & Loss Control	Factory Mutual Engrg.

Inspection and testing mechanical and electrical equipment. Supervision during last ten years of engineering activity involving loss prevention. Ten years also involved field test engineering in all phases of non-destructive testing.

From	To	Title	Assignment	Organization
1949	1954	Inspection	Mechanical & Electrical Dept.	U S Steel

Inspection and repair of mechanical and electrical equipment with leading steel manufacturing company.

Attachment 10

RESUME OF
ROBERT C. GAMBERG

PERSONAL: Home Address: 1720 Wensley Dr.
Charlotte, N. C. 28210

Telephone: (704) 373-8575 (Office)
(704) 553-2290 (Home)

Age: 31 Height: 6' 0" Weight: 180

FORMAL EDUCATION: University of Virginia: BSNE 1975

ADDITIONAL TRAINING:
Fisher Control Valve Seminar - Charlotte, N.C.
Consolidated Safety & Relief Valve Seminar - Charlotte, N.C.
Pump Seminar - Duke Power Co.
Heat Exchanger Seminar - Duke Power Co.
Professional Development Program - Duke Power Co.
Supervisory Development Program - Duke Power Co.
Fluid Mechanics Seminar - Duke Power Co.
Instrumentation & Controls Seminar - Duke Power Co.
Engineering Economics II - Duke Power Co.

WORK EXPERIENCE:

FROM	TO	TITLE	PROJECT	COMPANY
10/81	Present	Design Engineer I	Catawba Nuclear Station	Duke Power Company

Work group leader of 4-6 engineers responsible for the mechanical fluid system design of 25 fluid systems on Catawba Nuclear Station. Responsibilities include formulation of design criteria, determination of equipment design parameters, preparation of system design calculations, flow diagrams, system descriptions, review of vendor drawings, & plant licensing, trouble shooting and start up support. Currently supervise 4 engineers.

FROM	TO	TITLE	PROJECT	COMPANY
6/75	10/81	Design Engineer I Assistant Design Engineer Engineer Associate Engineer Assistant	Catawba Nuclear Station	Duke Power Company

Design responsibility for various fluid systems on Catawba Nuclear Station. Duties are similar to those listed above.

G. W. Hallman

ATTACHMENT 11

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

HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

TELEPHONE
(704) 373-4531

NUCLEAR MAINTENANCE MANAGER

APR 11 1984

NAME	CODE	INITIAL
DHG		
CAL		
SHS		
RLW		
LVW		
FWM		

TICKLE DATE
I - Info R - Retain
C - Copy A - Action

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 /GAC

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

Mr. Robert Guild, Esq.
Attorney-at-Law
P. O. Box 12097
Charleston, South Carolina 29412

cc: Palmetto Alliance
2135½ Devine Street
Columbia, South Carolina 29205

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

bcc: D/G Task Force
C. L. Hartzell
M. S. Tully
N. A. Rutherford
R. C. Futrell
L. T. Parker
SREC
NC MPA-1
NCEMC
Group File: CN-801.01

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:

- Participation in a TDI Owners Group Program that was formed to investigate the concerns and formulate corrective action plans to address these concerns.
- Successful completion of regulatory requirements relating to the diesels.
- 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 ary 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 lifetime 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:

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

The parameters recorded hourly are:

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

- 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.

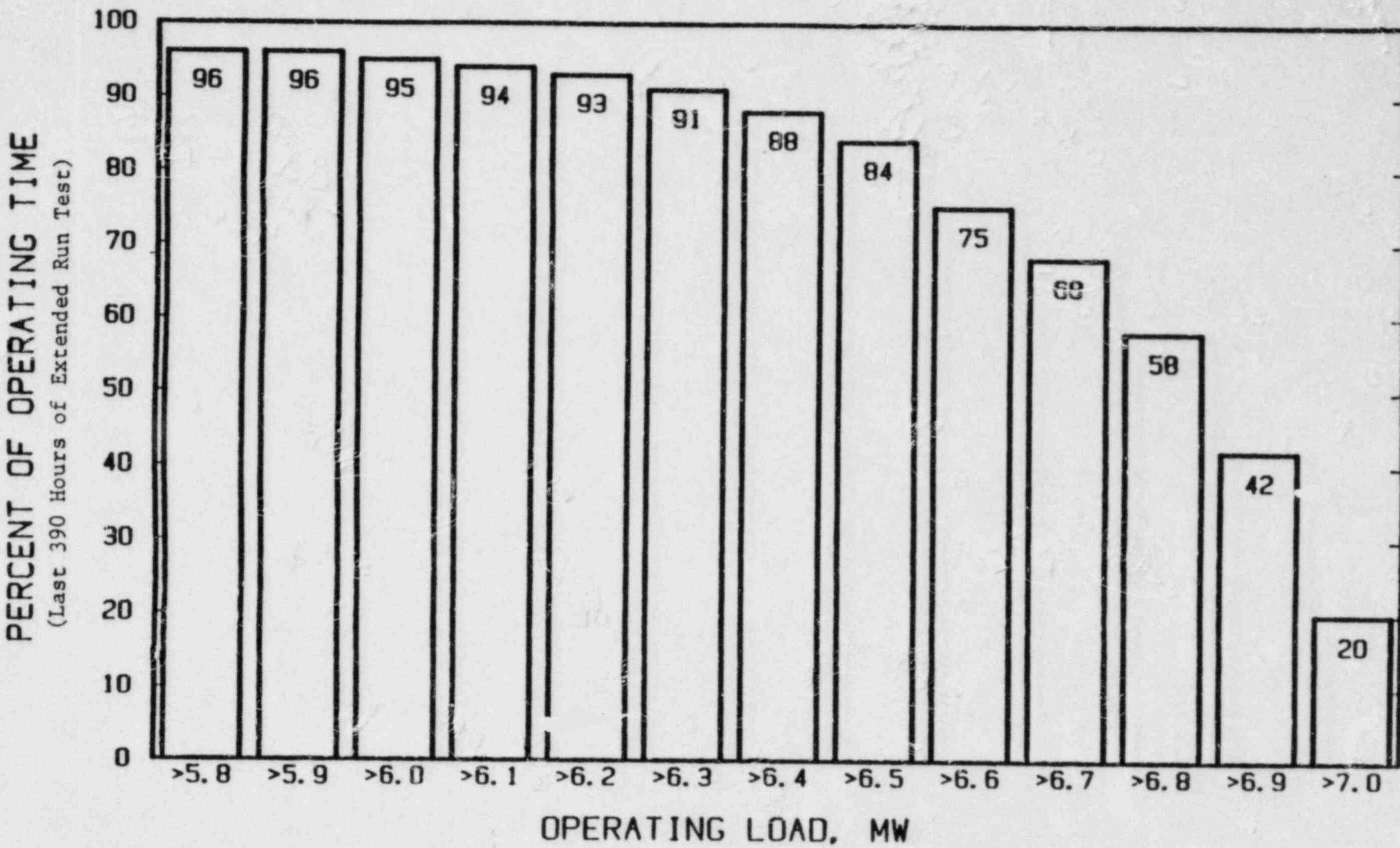
4.6 <u>Problem Reports</u>

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:

- o The parts are free from deleterious conditions, such as cracks, excessive wear, pitting, distortion, etc.
- o The parts have critical dimensions in agreement with the original design (taking into account normal wear).
- o 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:

- o 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.
- o 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 Insp ction 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:

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

The specific inspection methods to be employed include the following:

Visual - Examine for:

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

Dimensional Measurements - Examine for:

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

Nondestructive Examinations

- o 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.	Dimen.	Visual	Surface NDE	Vol. NDE	Material	Hardness	Notes
			Sample Size, Percent of Engine Parts Inspected						
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.	Sample Size, Percent of Engine Parts Inspected: Dimen.	Visual	Surface NDE	Vol. NDE	Material	Hardness	Notes
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:

- Liquid penetrant examination of cylinder block top surface around the cylinder and between the head studs and cylinder liner.
- Ultrasonic wall thickness measurements of cylinder head.

The following inspections were performed on all 16 cylinders:

- Visual inspection of subcover assembly.
- Visual inspection of all intake, exhaust and connector pushrods.
- Visual inspection of all rocker arm assemblies.
- 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
VICE PRESIDENT
NUCLEAR PRODUCTION

TELEPHONE
(704) 373-4531

June 29, 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 met with the NRC Staff to discuss Duke's proposed program for resolution of the TDI diesel generator issue for Catawba. This meeting, and a follow-up letter dated April 5, 1984, provided a detailed description of the Extended Operation Test of the Catawba 1A diesel generator and the proposed inspection plan.

The inspection program involved extensive disassembly of the diesel and 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 where there was no history of problems. A preliminary report detailing the status of the component revalidation inspection program was prepared by Duke and submitted to the NRC on June 1, 1984. This report covered the results of over 76% of total inspections to be performed. Representatives from Duke met with the NRC Staff on June 21, 1984 to discuss these inspection results.

Inspection of the 1A diesel is now complete, except for a few inspections that must be performed during or following engine reassembly. The attached report describes the results of the inspections and evaluations performed. This report addresses over 99% of the inspection plan which includes about 4,800 separate inspections. Results of remaining inspections during engine reassembly will be documented in the Owners Group Phase II program.

As a result of the Extended Operation Test of the Catawba 1A diesel generator and the extensive inspections conducted, it is concluded that TDI diesel generators installed at Catawba will provide a reliable source of backup power.

Very truly yours,

Hal B. Tucker

Hal B. Tucker

ROS/php

cc: Mr. James P. O'Reilly, Regional Administrator
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

NRC Resident Inspector
Catawba Nuclear Station

Robert Guild, Esq.
Attorney-at-Law
P. O. Box 12097
Charleston, South Carolina 29412

Palmetto Alliance
2135½ Devine Street
Columbia, South Carolina 29205

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

CATAWBA NUCLEAR STATION
DIESEL ENGINE 1A COMPONENT REVALIDATION INSPECTION

FINAL REPORT

PREPARED BY
DUKE POWER COMPANY

June 29, 1984

Table of Contents

Figures

Table

1.0 Introduction

This report describes the results of inspections and evaluations performed on the Catawba 1A diesel engine. These inspections were performed as part of an overall program to verify the reliability of Transamerica Delaval, Incorporated (TDI) diesel engines used for safety-grade power supplies at Catawba. The overall program is described in an April 5, 1984 letter to the NRC, reference 1. The scope of the inspections meets or exceeds the TDI Owners Group inspection program.

The inspections of the 1A diesel engine discussed herein were performed in April through June, 1984. The inspections involved extensive disassembly of the diesel and 100% inspection of parts for which there was a history of problems or other reasons for special concern. Substantial (e.g. 25%) sampling inspections were performed of other important parts where there was no history of problems. The scope of the inspections is essentially as described in reference 1, with the exception that pistons, connecting rods, and related parts were inspected on a 100% basis rather than on a sample basis. Also, one additional main bearing and three additional cylinder liners were added to the inspection plan.

The diesel disassembly, reassembly, and inspections were performed in accordance with the Duke Power Quality Assurance Program. The assembly, disassembly and inspection work was largely performed by Duke Power personnel, with selected inspections performed by Failure Analysis Associates (FaAA) and Stone and Webster (S&W) personnel in conjunction with the TDI Owners Group program.

Detailed results of the inspections are contained in Section 5.0, Appendix A and are discussed in Section 3.0. Some parts which are important to diesel operability were not inspected since inspection is not called for by the TDI Owners Group program and there has been no history of problems. For such items an engineering evaluation of the operating and maintenance history of each of these parts was performed and is documented in Appendix B of Section 5.0.

This report on the Catawba 1A diesel inspections covers over 99% of the inspection plan which includes over 4780 separate inspections. Inspection results not covered in this report are as follows:

- Material comparitor tests on valves. These tests are awaiting a material sample from FaAA.

- Eddy-current (ECT) test of fuel line tubing. These tests are awaiting FaAA scheduling.

This report is the final report on the Catawba 1A inspections. A supplemental letter type report will be submitted covering results of the material comparitor and eddy current inspections mentioned above.

Upon reassembly of the Catawba 1A engine, walkdown inspections of the various piping, tubing, and electrical conduit runs on the engine will be accomplished. Results of these inspections will be factored into the Owners Group Phase II program.

2.0 Summary and Conclusions

2.1 Overview of Inspection Results

In March 1984, the Catawba 1A diesel engine successfully completed (reference 1) its extended operation test which resulted in more than 800 total accumulated hours on the engine. This test confirmed the ability of the diesel to operate reliably for long periods of time at high power. Subsequent to the extended operation test, extensive disassembly and inspection of this diesel engine has been performed to confirm the satisfactory condition of various parts and to identify any parts requiring repair, replacement, and/or redesign to ensure highly reliable standby electric generator service.

The post extended operation test inspections are now nearly completed, with the only exceptions being as outlined in Section 1.0. The results of the inspections are summarized in Table 2-1. Engineering and quality assurance evaluations of the inspection results have been performed. This work is considered to have identified all significant conditions. These conditions are discussed below.

The most significant results of the Catawba 1A diesel engine post extended operation 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. These problems include failed crankshafts, cracked connecting rod-crankpin bearing shells, connecting rod box cracks,and cracked cylinder blocks.

- 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 (Figure 2-1). This problem is discussed further in Section 2.2.

- The turbocharger thrust bearings were found to be severely worn, even though they had continued to function satisfactorily during the test. This condition was anticipated since similar problems have been experienced at other stations. As a result of this history, a redesigned lube oil system is being developed which is expected to prevent recurrence of the problem. It will be installed by September 1, 1984. In the meantime, the bearings are being replaced as necessary to ensure operability.

- Several other problems of potential significance to diesel operability were detected and are being further investigated as part of the TDI Owners Group program. These are:

- Two subcover castings were found to have cracks in an intake rocker arm pedestal (Figure 2-2). These cracks are discussed in Section 2.3.

- Two Catawba cylinder heads (one on diesel 1A and one on 1B) experienced small jacket water leaks into the fuel injector cavity. Metallographic examinations of the head removed from the 1A diesel indicates that the leak was due to a fatigue crack (Figure 2-3). This problem is discussed in Section 2.4.

• A small eddy-current test (ECT) indication was detected in crankpin to web fillet #7 (generator end) on the crankshaft. Metallurgical examination using replicas indicates that the indication was due to a .027 and a .021 inch long linear defects located about .105 inches apart. The .021 defect was polished out at a depth of less than .005 inch. The .027 inch indication was polished out in about .020 inches of depth. Another indication was detected by fluorescent dye penetrate in the #8 main journal oil hole. This indication was approximately a quarter inch long and made up of a series of extremely small pores. This indication was polished out in less than .005 inches. Evaluation of these indications shows that they are due to initia' fabrication. This problem is discussed Section 3.1.1.

• A variety of routine minor conditions were noted, and are discussed in Section 3.0 and 5.0. None of these conditions impact the operability or structural integrity of the diesel. Typical conditions of this type include:

  - Chipped and cracked edges of rocker arm sockets. (Section 3.3.1)

  - Chipped and removed valve stem chrome plate. (Section 3.3.2)

  - Jammed air start valve adjusting nut. (Section 3.3.3)

  - Heads of small bolts broken off, due to under or over torquing. (Section 3.3.5)

2.2 Piston Skirt Cracking

Four type AN skirts were found to have cracks adjacent to piston pin bosses. (Figure 2-1) These cracks run approximately vertically, and appear to initiate on the inside of the skirt where a circumferential reinforcing rib intersects the piston pin boss. The largest crack, on skirt 3L, was through wall and was about 3 to 4 inches long on the outside.

It is understood from TDI that this type of crack has never before been reported to TDI for stress relieved piston skirts. However, similar cracks have occurred on non-stress relieved type AN skirts and, as a result, TDI recalled non-stress relieved skirts for stress relief. Those Catawba 1A skirts which had not been originally stress relieved were returned to TDI and stress relieved in 1983, prior to the extended operation test and other tests. Thus, the cracking of the Catawba 1A skirts indicates that this type of cracking is possible even with stress relieved type AN piston skirts.

An extensive failure analysis of the cracked Catawba type AN piston skirts is now being performed by Failure Analysis Associates (FaAA) as part of the TDI Owners Group program. This program includes determination of residual and applied stresses, fractography, and metallurgical evaluations. Preliminary results indicate that tensile residual stresses on the order of 20 ksi were found to exist in the area where the type AN pistons had cracked.

The cracked AN type piston skirts in the Catawba 1A diesel did not cause any operational problems, and 12 of the 16 skirts were free of cracks. Nevertheless, all the piston skirts will be replaced with improved design AE skirts. The AE skirts have been stress relieved and include improved design features such as a thicker reinforcing rib and better rib-piston boss intersection details. These improvements are expected to adequately reduce the stresses and propensity for cracking in the area which experienced cracking at Catawba. The FaAA/Owners Group program will quantify the benefits achieved by use of AE piston skirts. It is anticipated that this will show that no cracking is expected during the life of the Catawba diesels. The AE piston skirts also incorporate the latest improvements in the stud boss region, which has been a problem area in earlier piston designs at the skirt to head transition.

2.3 Subcovers

Two cast iron subcovers were found to have cracks in a pedestal where the intake rocker arm shaft is bolted to the subcover (Figure 2-2B). Prior to the extended operation test, another subcover was found to have a piece of this pedestal missing (Figure 2-2C). None of these cracks have affected diesel operability. However, since similar problems have been reported with other diesels, FaAA has initiated a failure analysis of a Catawba subcover as part of the Owners Group program. Preliminary studies indicate that the cracks are due to installation tolerances between dowels, bushings and the pedestal leading to excessive interference and possibly fatigue cracking.

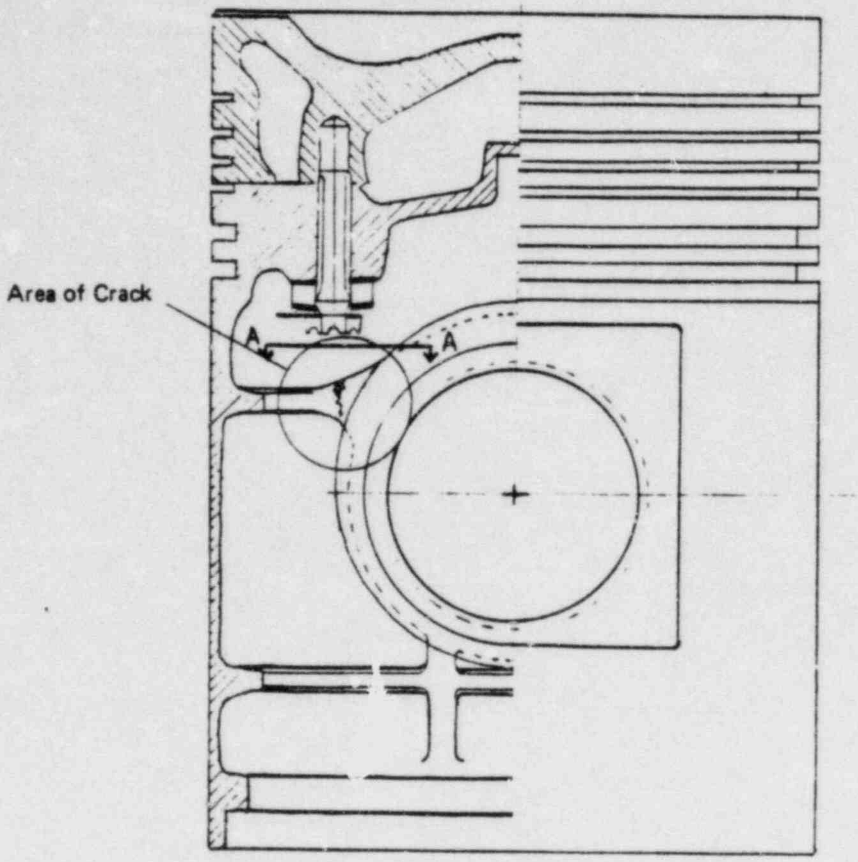
2.4 Cylinder Head Leaks

Two cylinder heads at Catawba, one on engine 1A and one on engine 1B, developed small jacket water leaks into the fuel injection cavity. The 1A leak developed during the extended operation test and the engine was shut down due to other problems three days after detection of the leak. The 1A leak did not affect engine operability. The leak on the 1B engine was of similar magnitude to that of 1A. The 1A cylinder head has recently been examined by FaAA. This investigation (reference 20)revealed that the leak was caused by a crack initiating from the corner of a welded-in plug where it was seated in the cylinder head (Figure 2-3). This welded-in plug is reported by TDI to have been used to repair the casting around the fuel injector hole. Evaluation of all heads installed on Engine 1A (reference 22) indicates that one other head (6 left) has been repair welded with a plug.

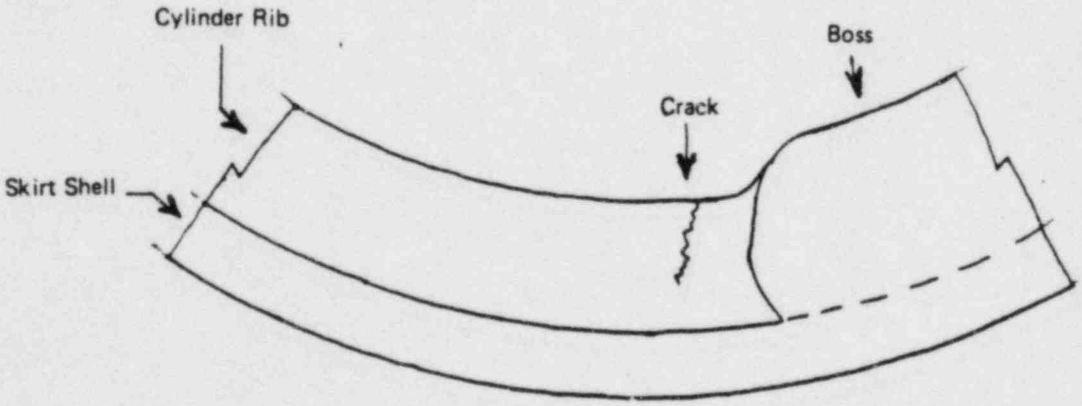
The leaks caused by the cracks have not affected diesel operability since they result in small amounts of water leaking into the fuel injector cavity and then off of the diesel. As all of the heads now on diesel 1A have experienced no cracking and were not leaking after the extended operation test, the heads are considered acceptable for continued operation. However, the repaired head (6 left) will be replaced as a matter of conservative judgement.

2.5 Conclusions

This is the final report on the post extended operation test inspections of the critical areas of the Catawba 1A diesel. The extended operation test and the post test inspections have demonstrated that the Catawba 1A diesel will reliably provide standby electric generation. The extended operation test was for the most part accomplished at loads significantly greater than required for standby electric generation. As such, parts inspected have been subjected to considerably higher fatigue loads and temperatures than will be actually seen in service. The inspections have indicated that the piston skirts must be replaced with improved type AE piston skirts and that a few minor damaged parts such as subcover castings with cracked pedestals should be replaced. In addition, the diesel engine preventative maintenance program will be re-evaluated based on the results of these inspections to determine whether additional periodic inspections are required. Future correspondence on the Catawba diesels will include: return to service operational test plan once diesel 1A is reassembled; preventive maintenance and periodic surveys of the diesel; and periodic tests of the diesel.

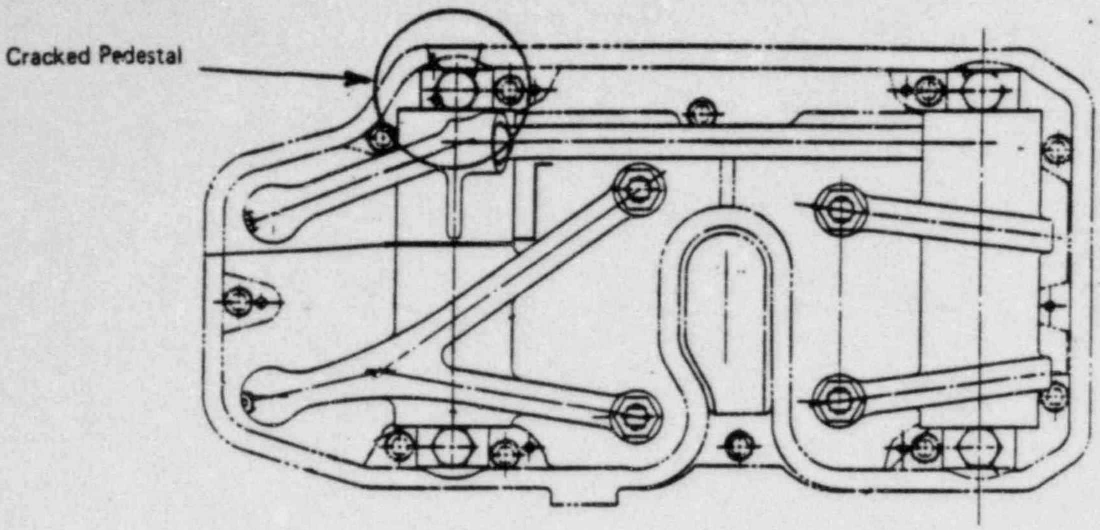


Elevation view of skirt

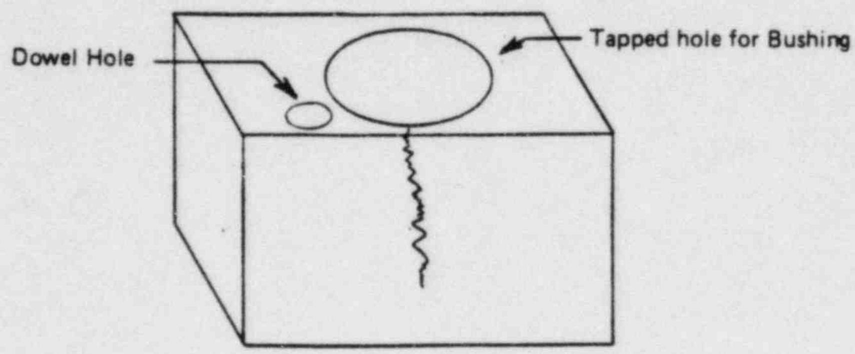


View A—A
Detail of crack initiation

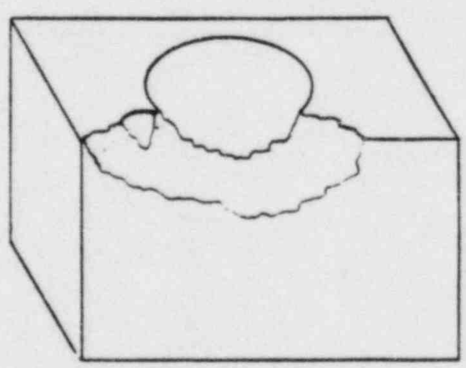
FIGURE 2-1
CRACKED TYPE AN PISTON SKIRT



A. Plan view of subcover



B. Crack in web between bolt hole and surface



C. Cracked off Edge of Pedestal

FIGURE 2-2
CRACKED SUBCOVER CASTINGS

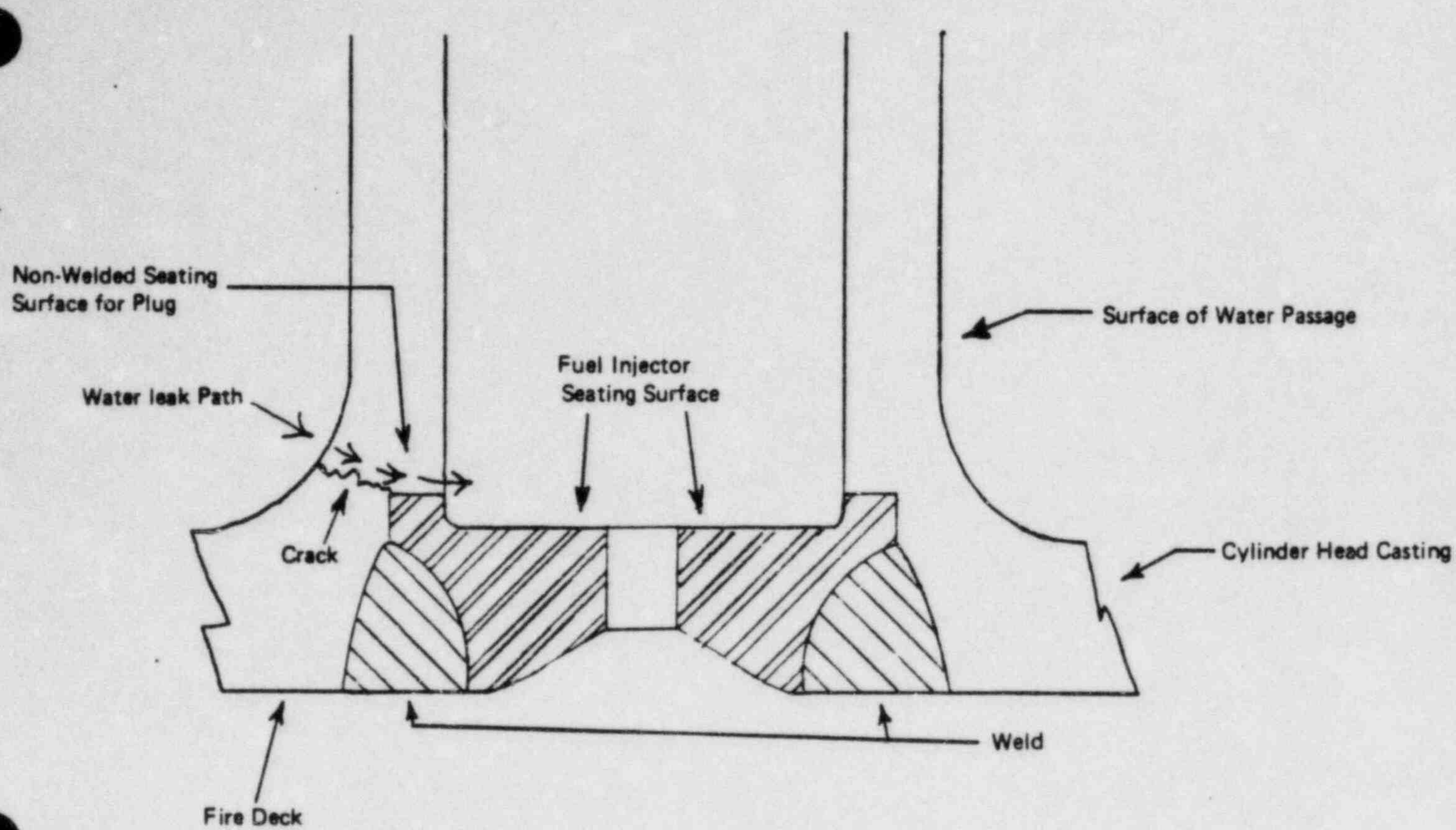


FIGURE 2-3
CRACK IN CYLINDER HEAD

TABLE 2-1
SUMMARY OF CATAWBA DIESEL 1A POST EXTENDED OPERATION TEST RESULTS

Part Name	Part No.	Class	Dimen.	Visual	S. NDE	V. NDE	Material	Hardness	Eng Ev	Notes	ults (Ref. paragraph)
			Sample Size, Percent								
Lube Oil Pressure Regulating Valve	00-420	A	–	–	–	–	–	–	X	9	Satisfactory
Jacket Water Standpipe, Ftngs, Gasket	00-700A	B	–	100	–	–	–	–	–	–	Pending – Owners Group Phase II Evaluation
Jacket Water Standpipe Valves	00-700B	B	–	–	–	–	–	–	X	9	Satisfactory
Jacket Water Standpipe Supports	00-700C	B	–	100	–	–	–	–	–	–	Pending – Owners Group Phase II Evaluation
Jacket Water Standpipe Switches	00-700E	B	–	–	–	–	–	–	X	9	Satisfactory
Jacket Water Standpipe Bolting Materials	00-700F	B	–	100	–	–	–	–	–	–	Pending – Owners Group Phase II Evaluation
Main Bearing Cap Base Assembly	02-305A	A	–	50	50	–	–	–	–	–	Satisfactory (3.1.6)
Main Bearing Studs and Nuts	02-305C	A	10	30	–	–	–	–	–	–	Satisfactory
Main Bearing Caps	02-305D	A	–	50	50	–	–	–	–	–	Satisfactory
Lube Oil Internal Headers	02-307A	A	–	100	–	–	–	–	–	–	Pending – Owners Group Phase II Evaluation
Lube Oil Tubing and Fittings-Internal	02-307B	A	–	100	–	–	–	–	–	–	Satisfactory (3.2.2)
Lube Oil Line Supports-Internal	02-307D	B	–	100	–	–	–	–	–	–	Satisfactory except for some loose supports.
Crankshaft	02-310A	A	100	100	38	–	–	–	–	3,4	Satisfactory, minor ECT indication polished out. (3.1.1)
Crankshaft Bearing Shell	02-310B	A	50	50	–	–	–	–	–	–	Satisfactory, some bolts had low torque.
Crankshaft Thrust Bearing Ring	02-310C	A	100	–	–	–	–	–	–	4	Satisfactory, cold clearances pending.
Crankcase Assembly	02-311A	A	–	100	–	–	–	–	–	–	Satisfactory
Cam Bearing Caps and Dowels	02-311B	B	–	–	–	–	–	–	X	9	Satisfactory
Crankcase Mounting Hardware	02-311D	B	–	–	–	–	–	–	X	9	Satisfactory
Cylinder Block	02-315A	A	40	–	100	–	–	–	–	–	Satisfactory (3.1.5)
Cylinder Liner	02-315C	A	100	100	–	–	20	20	–	–	Satisfactory (3.1.4)
Cylinder Block Jacket Water Manifold	02-315D	B	–	100	–	–	–	–	–	–	Satisfactory
Cylinder Head Studs	02-315E	B	–	25	–	–	3	–	–	–	Satisfactory (3.1.7)
Cyl. Block Jacket Wtr. Manifold Nuts	02-315F	B	–	100	–	–	–	–	–	–	Satisfactory
Cylinder Block Seals and Gaskets	02-315G	B	–	–	–	–	–	–	X	9	Satisfactory
Jacket Water Inlet Manifold Assembly	02-316A	B	–	100	–	–	–	–	–	–	Pending – Owners Group Phase II Evaluation
Jacket Water Inlet Manifold Coupling	02-316B	B	–	100	–	–	–	–	–	–	Pending – Owners Group Phase II Evaluation
Jacket Water Discharge Manifold	02-317A	B	–	100	–	–	–	–	–	–	Satisfactory
Jacket Water Disch. Manifold Coupling	02-317B	B	–	100	–	–	–	–	–	–	Pending – Owners Group Phase II Evaluation
Jacket Water Disch. Manifold Supports	02-317C	B	–	100	–	–	–	–	–	–	Pending – Owners Group Phase II Evaluation
Flywheel	02-330A	A	–	–	–	–	–	–	X	9	Satisfactory
Flywheel Bolting	02-330B	A	–	100	–	–	–	–	–	–	Satisfactory
Front Gear Case Bolting	02-335B	C	–	100	–	–	–	–	–	–	Satisfactory
Connecting Rods and Bushings	02-340A	A	100	100	100	–	25	25	–	–	Satisfactory except for one gouged bushing (3.3.4)
Connecting Rod Bearing Shells	02-340B	A	100	100	100	100	–	–	–	–	Satisfactory, 5 halves did not meet acceptance stds.(3.1.2)
Piston	02-341A	A	100	100	100	–	–	–	–	5	Four cracked skirts (2.2, 3.1.3), all skirts replaced.
Piston Rings	02-341B	A	25	100	–	–	25	–	–	–	Satisfactory
Piston Pin Assembly	02-341C	A	25	100	–	–	25	25	–	–	Satisfactory
Intake Tappets	02-345A	A	–	25	–	–	–	–	–	–	Satisfactory
Fuel Tappets	02-345B	A	–	25	–	–	–	–	–	–	Satisfactory except for some minor scratches.
Fuel Pump Base Assembly	02-345C	B	–	–	–	–	–	–	X	9	Satisfactory
Camshaft Assembly	02-350A	A	–	100	–	–	–	–	–	–	Satisfactory
Camshaft Bearing	02-350B	B	–	100	–	–	–	–	–	7	Satisfactory
Camshaft Supports, Bolting and Gear	02-350C	A	–	100	–	–	100	100	–	–	Satisfactory
Crankshaft Gear	02-355A	A	–	100	–	–	–	–	–	–	Satisfactory
Idler Gear Assembly	02-355B	A	–	100	–	–	–	100	–	–	Satisfactory
Air Start Valve	02-359	A	100	100	–	–	–	–	–	–	Sat. except for one jammed nut & missing pin (3.3.3, 3.1.13)
Cylinder Head	02-360A	B	100	100	100	100	–	–	X	2,9	Satisfactory except for one leak (2.4, 3.1.16)
Intake and Exhaust Valves	02-360B	B	25	100	–	–	25	–	–	–	Satisfactory, some valves have chipped chrome plating(3.3.2)
Cylinder Head Bolting and Gaskets	02-360C	B	–	–	–	–	–	–	X	–	Satisfactory
Valve Springs	02-360D	B	–	100	–	–	–	–	–	1	Satisfactory
Subcover Assembly	02-362A	B	–	100	100	–	–	–	–	–	Satisfactory except for two cracked pedestals (2.3, 3.2.6)
Fuel Injection Pump	02-365A	B	–	100	–	100	–	100	X	9	Valve holders to be refurbished (3.2.1)
Fuel Injection Tips	02-365B	B	–	–	–	–	–	–	X	9	Satisfactory

TABLE 2-1 (Continued)

Part Name	Part No.	Class	Sample Size, Percent: Dimen.	Visual	S. NDE	V. NDE	Material	Hardness	Eng Ev	Notes	Results (Ref. paragraph)
Fuel Injection Tubing	02-365C	B	-	100	100	-	-	-	-	8	Pending - Owners Group Phase II Evaluation (3.1.11)
Fuel Injection Tubing Supports	02-365D	B	-	100	-	-	-	-	-	-	Pending - Owners Group Phase II Evaluation
Fuel Pump Linkage and Control Shaft	02-371A	A	-	-	-	-	100	100	-	-	Satisfactory
Fuel Pump, Linkage, Bearings and Shaft	02-371B	A	-	100	-	-	-	-	-	-	Satisfactory
Intake Manifolds	02-375	B	-	100	-	-	-	-	-	-	Satisfactory
Exhaust Manifold	02-380A	B	-	100	-	-	-	-	-	-	Satisfactory
Exhaust Manifold Bolting	02-380B	B	9	9	-	-	-	-	-	-	Satisfactory, manifold to turbo bolts to be replaced.(3.2.8)
Cylinder Block Cover, Gaskets and Bolts	02-385B	C	-	-	-	-	-	-	X	9	Satisfactory visual inspection of gaskets.
Crankcase Cover Gaskets and Bolting	02-386B	C	-	100	-	-	-	-	-	-	Several bolt head failures (3.2.5)
Intake & Intermediate Rocker Arm Assmbly.	02-390A	B	-	100	100	-	100	100	-	-	Satisfactory except two sockets had chipped lips. (3.3.1)
Exhaust Rocker Arm Assembly	02-390B	B	-	100	100	-	100	100	-	-	Satisfactory (3.2.9)
Intake and Exhaust Pushrods	02-390C	B	-	100	100	-	-	-	-	-	Satisfactory (3.1.14)
Connector Pushrod	02-390D	B	-	100	100	-	-	-	-	-	Satisfactory
Rocker Arm Bushings	02-390E	B	-	100	-	-	-	-	-	-	Satisfactory
Rocker Arm Bolting	02-390G	B	-	100	100	-	100	100	-	-	Satisfactory (3.1.8)
Overspeed Trip Governor	02-410A	A	-	-	-	-	-	-	X	9	Satisfactory
Overspeed Trip & Accessory Drive	02-410B	A	-	100	100	-	100	100	-	-	Satisfactory
Overspeed Trip Couplings	02-410C	A	-	100	-	-	-	-	-	-	Satisfactory
Overspeed Trip Vent Valves	02-410D	A	-	-	-	-	-	-	X	9	Satisfactory
Speed Regulating Governor Drive	02-411A	A	-	100	100	-	100	100	-	-	Satisfactory
Governor Drive Couplings	02-411B	A	-	100	-	-	100	-	-	-	Satisfactory
Governor Linkage	02-413	A	-	100	-	-	-	-	-	-	Satisfactory
Fuel Pump Linkage-Auto Shutdown Cylinder	02-413B	B	-	100	-	-	-	-	-	-	Satisfactory
Speed Regulating Governor	02-415A	A	-	-	-	-	-	-	X	9	Satisfactory
Governor Booster Servomotor	02-415B	B	-	-	-	-	-	-	X	9	Satisfactory
Governor Heat Exchanger Assembly	02-415C	A	-	-	-	-	-	-	X	9	Satisfactory
Lube Oil Pump	02-420	A	-	-	-	-	-	-	X	9	Satisfactory
Jacket Water Pump	02-425A	A	-	100	-	-	100	100	-	-	Satisfactory
Intercooler Piping-Coupling, Bolt, Gskt.	02-436B	A	-	100	-	-	-	-	-	-	Satisfactory
Turbo Cooling Water Pipe and Fittings	02-437A	B	-	100	-	-	-	-	-	-	Pending - Owners Group Phase II Evaluation
Turbo Cooling Water Pipe Supports	02-437B	A	-	100	-	-	-	-	-	-	Pending - Owners Group Phase II Evaluation
Start Air Manifold Pipe, Tubing & Fttng.	02-441A	A	-	100	-	-	-	-	-	-	Pending - Owners Group Phase II Evaluation
Start Air Manifold Vlvs, Strners, Fltrs.	02-441B	A	-	-	-	-	-	-	X	9	Satisfactory
Start Air Manifold Pipe Supports	02-441C	A	-	100	-	-	-	-	-	-	Pending - Owners Group Phase II Evaluation
Starting Air Distributor Assembly	02-442A	A	100	100	-	-	-	100	-	6	Satisfactory
Start Air Distributor Tbg., Ftg., Gskts.	02-442B	A	-	100	-	-	-	-	-	-	Pending - Owners Group Phase II Evaluation
Fuel Oil Booster Pump	02-445	A	-	-	-	-	-	-	X	9	Satisfactory
Fuel Oil Piping and Tubing	02-450B	A	-	100	-	-	-	-	-	-	Pending - Owners Group Phase II Evaluation (3.2.10)
Fuel Oil Piping Supports	02-450D	A	-	100	-	-	-	-	-	-	Pending - Owners Group Phase II Evaluation (3.3.5)
Fuel Oil Filters	02-455A	B	-	-	-	-	-	-	X	9	Satisfactory
Fuel Oil Strainers	02-455B	B	-	-	-	-	-	-	X	9	Satisfactory
Fuel Oil Filter Mounting Hardware	02-455C	A	-	100	-	-	-	-	-	-	Satisfactory
External Lube Oil Lines	02-465A	A	-	100	-	-	-	-	-	-	Pending - Owners Group Phase II Evaluation
External Lube Oil Line Supports	02-465B	A	-	100	-	-	-	-	-	-	Triple header clamp bolt broken, otherwise satisfactory.
External Lube Oil Valves	02-465C	A	-	-	-	-	-	-	X	9	Satisfactory
Turbocharger Lube Oil Piping	02-467A	B	-	100	-	-	-	-	-	-	Pending - Owners Group Phase II Evaluation (3.2.7)
Turbocharger Lube Oil Piping Supports	02-467B	B	-	100	-	-	-	-	-	-	Pending - Owners Group Phase II Evaluation
Turbocharger Bracket	02-475A	B	-	100	-	-	-	-	-	-	Satisfactory
Turbocharger Air Butterfly Valve	02-475B	A	-	100	-	-	100	100	-	-	Satisfactory
Turbocharger Bracket Bolting	02-475D	B	-	8	-	-	8	-	-	-	Satisfactory
Control Panel Cabinet	02-500A	A	-	-	-	-	-	-	X	9	Satisfactory
Control Air Accumulator	02-500F	A	-	-	-	-	-	-	X	9	Satisfactory
Control Air System Valves	02-500G	A	-	-	-	-	-	-	X	9	Satisfactory

TABLE 2-1 (Cont'd)

Part Name	Part No.	Class	Dimen.	Visual	S. NDE	V. NDE	Material	Hardness	Eng Ev	Notes	Results (Ref. paragraph)
			Sample Size, Percent								
Control Air System Pressure Switches	02-500H	B	-	-	-	-	-	-	X	9	Satisfactory
Control System Relays	02-500J	A	-	-	-	-	-	-	X	9	Satisfactory
Control System Solenoid Valves	02-500K	A	-	-	-	-	-	-	X	9	Satisfactory
Control Air System Piping, Tubing, Ftngs	02-500M	B	-	100	-	-	-	-	-	-	Pending - Owners Group Phase II Evaluation
Control Panel Wiring	02-500N	A	-	-	-	-	-	-	X	9	Satisfactory
Lube Oil Sump Tank	02-540A	B	-	100	-	-	-	-	-	-	Satisfactory
Lube Oil Sump Tank Bolting	02-540B	B	-	100	-	-	-	-	-	-	Satisfactory
Lube Oil Sump Tank Mounting Hardware	02-540C	B	-	100	-	-	-	-	-	-	Satisfactory
Foundation Bolts and Anchors	02-550	B	-		-	-	-	-	X	9	Satisfactory
Instrumentation Thermocouples	02-630D	B	-	-	-	-	-	-	X	9	Satisfactory (3.2.4)
Engine & Auxiliary Module Wiring Conduit	02-688A	A	-	100	-	-	-	-	-	-	Satisfactory
Engine and Auxiliary Module Wiring	02-688B	A	-	-	-	-	-	-	X	9	Satisfactory (3.1.10)
Engine and Auxiliary Module Wiring Boxes	02-688C	A	-	-	-	-	-	-	X	9	Satisfactory
Engine Alarm Sensors	02-690	A	-	-	-	-	-	-	X	9	Satisfactory
Off Engine Safety Alarm Sensors-Switches	02-691A	B	-	-	-	-	-	-	X	9	Satisfactory
Engine Shutdown Tubing and Fittings	02-695A	B	-	100	-	-	-	-	-	-	Pending - Owners Group Phase II Evaluation
Engine Shutdown Valves, Regs. & Orifice	02-695B	A	-	-	-	-	-	-	X	9	Satisfactory; air system cleanliness needs to be maintained.
Engine Shutdown Trip Switches	02-695C	A	-	-	-	-	-	-	X	9	Satisfactory
Fuel Oil Duplex Strainer	02-825D	A	-	-	-	-	-	-	X	9	Satisfactory
Turbocharger Thrust Bearing Lube System	02-CPR	C	-	100	-	-	-	-	-	-	Pending (3.1.15)
Thermostatic Valve	CM136-40	B	-	-	-	-	-	-	X	9	Satisfactory
Intake Air Filter	CM-106	B	-	-	-	-	-	-	X	9	Satisfactory
Intake Air Silencer	CM-107	B	-	-	-	-	-	-	X	9	Satisfactory
Before and After Lube Oil Pump	CM-109	A	-	-	-	-	-	-	X	9	Satisfactory
Full Flow Lube Oil Filter	CM-110	A	-	-	-	-	-	-	X	9	Satisfactory
Lube Oil Heat Exchanger	CM-111	B	-	-	-	-	-	-	X	9	Satisfactory
Generator Shaft and Bearings	CM-119A	A	-	-	-	-	-	-	X	9	Satisfactory
Jacket Water Heat Exchanger	CM-120	B	-	-	-	-	-	-	X	9	Satisfactory
Oil Prelube Filter	CM-122	A	-	-	-	-	-	-	X	9	Satisfactory
Lube Oil Keepwarm Strainer	CM-131	A	-	-	-	-	-	-	X	9	Satisfactory
Intercooler	F-068	A	-	100	100	-	-	-	-	-	Satisfactory
Turbocharger	MP-022/3	A	100	100	-	-	-	-	-	-	Satisfactory except thrust bearings damaged (3.1.15)
Lube Oil Full Pressure Strainer	SE-025	A	-	-	-	-	-	-	X	9	Satisfactory

Notes To Table

1. Intake and exaust valve springs have proper color code.
2. Ultrasonic wall thickness measurement of fire deck area and fuel nozzle area. Eng Ev to determine if head has been repaired.
3. A torsiograph was developed of the crankshaft.
4. Crankshaft web deflections and thrust clearance was measured with the diesel hot and will be measured cold.
5. Measure torque on belleville spring loaded bolts.
6. Hardness of the spools was not measured since excessive wear had not occurred.
7. Inspections of the camshaft bearings was not performed since an inspection of the camshaft lobes showed no abnormal wear.
8. ECT inspections were limited to both ends of all high pressure injection lines.
9. Engineering validation of part is to determine that the part is per bill of materials and a review of unscheduled maintenance reports associated with part.

3.0 Discussion of Inspection Results

This discussion of inspection results is contained in three parts. The first part (Section 3.1) covers inspections related to the 16 generic problems being addressed by the TDI Owners Group. The second part (Section 3.2) covers inspections performed to address concerns raised by specific problems which have been experienced with Catawba diesels. The third part (Section 3.3) covers significant inspection results arising from a general inspection of the engine. All of these inspection results are documented in the Appendices, Section 5.0.

3.1 Inspections Related to TDI Generic Problems

The inspections related to TDI generic problems which were performed, and the results of these inspections, are described below.

3.1.1 Crankshaft (Part No. 02-310A)

PROBLEM:

A crankshaft failure occurred at Shoreham. The cause of the failure being high cycle fatique cracks initiating from fillets in the crankshaft at the junction of a crankpin and web (reference 2). Similar cracks were found to exist on other crank-web fillets in all three diesels at Shoreham.

The Catawba crankshaft design differs from that originally used at Shoreham. The Catawba crankshaft has substantially lower stresses, which meet industry standards and are not expected to cause problems (references 3 and 12). Nevertheless, it was considered prudent to inspect a sample of crankpin-web and main bearing journal-web fillets.

SCOPE OF INSPECTIONS:

The crankshaft inspections consisted of:

- Web deflection measurements.
- Visual inspections of the crankpin journals and the fillets at either end of all eight crankpins.
- Eddy-current inspection of crankpin-web fillets for all crankpins except #2.
- Visual inspection of main bearing journals and journal to web fillets for main bearings #4, #5, #6, and #8.
- Flourescent dye penetrant inspection of oil holes in main bearing journals #4, #6, and #8.
- Torsiograph tests.

No unusual or reportable conditions were noted, with two exceptions. A small indication was detected by ECT on the generator end of the crankpin-web fillet for crankpin #7. Detailed examination by polishing and taking of replicas indicates that the ECT indication was caused by a .027 and a .021 inch defect linear defects. The .021 inch defect was polished out at a depth of .005 inches. The .027 inch indication was polished out at a depth of about .020 inches.

A small indication was detected on the #8 main journal oil hole by fluorescent dye penetrate. This indication was approximately a quarter inch long made up of a line of small pores. The indication was polished out at a depth of about .005 inches.

Torsiographic tests were conducted by FaAA. Results, reference 16, indicate that torsional vibration frequencies and stresses were almost identical to the Grand Gulf tests and also that calculated by TDI. These stresses meet industry standards.

SUMMARY:

In summary, the inspections of the crankshaft indicate that it is free of significant defects and is not experiencing the type of problem experienced with the Shoreham crankshaft. One small indication was detected by ECT in a crankpin fillet. Results of a FaAA analysis (reference 24) indicate that the indication was non-service induced. The small indication on main journal oil hole #8 was porosity or a machining mark and therefore not service induced.

3.1.2 Connecting Rod Bearings (Part No. 02-340B)

PROBLEM:

Several connecting rod bearing shells in the Shoreham diesel engine cracked. Analysis performed by Failure Analysis Associates (reference 4) indicates that stresses in the Catawba diesel engine bearing shells are about one half or less of those that were present in the original Shoreham engines. Thus, cracking of Catawba bearing shells was considered unlikely. Nevertheless, thorough inspections of the shells were performed to confirm freedom from problems.

SCOPE OF INSPECTIONS:

The bearing shell inspections consisted of:

- Visual inspection of bearing and back surfaces of all bearing shells.

- Measurement of the thickness of all bearing shells.

- PT examination of the bearing shells.

- X-ray examination of all bearing shells.

RESULTS OF INSPECTIONS:

No cracks were detected by visual, or liquid penetrant inspection. Visual and liquid penetrant inspections indicated babbit fatigue in the area of link rod maximum bearing pressures. This has been evaluated and found to exist on all TDI vee block engines and not to affect bearing operation (reference 17). X-ray inspections indicate that five of the sixteen bearing halves inspected do not meet acceptance standards.

SUMMARY:

Surface inspection results indicate that connecting rod bearing shells are acceptable for continued operation. X-ray inspections results indicate that five bearing halves do not meet acceptance standards. They will not be installed in the engine. These bearing halves will be retained for further investigation. Spare bearing halves which meet all inspection standards will be installed in their place.

3.1.3 Pistons (Part No. 02-341A)

PROBLEM:

Cracks were experienced at stud attachment bosses in "Modified AF" piston skirts at Shoreham (references 5 and 6). 23 out of 23 "Modified AF" skirts experienced such cracks, while one AN skirt did not (reference 6). TDI indicated that type AN skirts have been widely used and, if properly heat treated, would perform satisfactorily.

During the extended operation test, Catawba diesel 1A had type AN skirts which had been heat treated at the factory. Because of the freedom from reported problems with AN skirts, no problems were expected with the Catawba piston skirts, and inspections were originally planned on a sample basis.

SCOPE OF INSPECTIONS

The inspections of piston skirts listed below were directed at assessing their structural integrity. Some of these inspections were planned on a sample basis. However, as a result of cracks found near the piston pin bosses, 100% inspections were performed.

- Visual inspection of 100% of the pistons skirts.

- PT examination of stud bosses of 100% of the piston skirts.

- PT examination of piston pin bosses of 100% of the piston skirts.

- PT or MT examination of areas adjacent to piston pin bosses (these are the areas where several cracks were noted).

- Ultrasonic (UT) and radiography (RT) examinations were performed if PT or MT indications were observed.

RESULTS OF INSPECTIONS:

The most significant condition noted was the presence of cracks in four piston skirts adjacent to piston pin bosses. The largest crack was 3 or 4 inches long and was through the wall. The cracks appear 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 unknown at this time but is believed to be due to cyclic fatigue. Skirts have been sent to FaAA for failure analysis.

One small (1/2" long) linear indication was also noted in the bore of a piston pin boss. No indications were found at stud bosses.

SUMMARY:

Cracks were found to be present in piston skirts near piston pin bosses. As a result, all of the piston skirts will be replaced with type AE pistons. In addition, a detailed failure analysis has been initiated, as part of the TDI Owners Group program.

3.1.4 Cylinder Liners (Part No. 02-315C)

PROBLEM:

Severe grooving has been noted in at least one TDI nuclear diesel engine (reference 7). This grooving was attributed to debris that entered the diesel during assembly or initial startup.

SCOPE OF INSPECTIONS:

All of the cylinder liners were 100% inspected to check for the presence of grooves or other damage.

RESULTS OF INSPECTIONS:

No significant grooves approaching the 1/16" deep grooves seen in the Grand Gulf diesel were observed in the Catawba cylinder liners. Minor pitting and scratching were observed which is normal for a diesel which has seen substantial service. These pits and scratches are considered to have no effect on diesel operability.

SUMMARY:

The inspections indicate that the cylinder liners are in satisfactory condition.

3.1.5 Cylinder Block (Part No. 02-315A)

PROBLEM:

Cracks have been reported on cylinder blocks in the area of the cylinder liner landing and at cylinder head stud holes (reference 7).

SCOPE OF INSPECTIONS:

The cylinder block inspections included the following:

- The area between the cylinder studs and the liner and the area around the studs were PT examined for all cylinders.
- The cylinder liners were removed from seven cylinders (3, 4, 5 and 6 left; 3, 4 and 5 right) and the cylinder liner landing area within the block was PT examined.
- The stud holes were examined by ECT for the seven cylinders identified above.

RESULTS OF INSPECTIONS:

No significant indications were noted.

SUMMARY:

Cylinder block cracks were not detected on diesel engine 1A.

3.1.6 Engine Base (Part No. 02-305A)

PROBLEM:

Linear indications have been reported as emanating from main bearing stud holes in the engine base. These problems have been attributed to inadequate bearing cap stud preload (references 7 and 13).

SCOPE OF INSPECTIONS:

The main bearing saddle area around and between the stud holes was PT examined for bearings 4, 5, 6, and 8. In addition, the stud tension required to permit removal of the nuts was measured.

RESULTS OF INSPECTIONS:

No linear indications have been found, and stud tensions were in the normal range.

SUMMARY:

Inspections indicate that this problem has not occurred in the Catawba 1A diesel.

3.1.7 Cylinder Head Studs (Part No. 02-315E)

PROBLEM:

Isolated failures of cylinder head studs have been reported as occurring in non-nuclear TDI diesels (reference 8). Also, improper torquing of these studs has been reported as contributing to the cylinder block cracking problem discussed in paragraph 3.1.5.

SCOPE OF INSPECTIONS:

Inspections of the cylinder head studs included the following:

- The breakaway torque was measured for the head studs of three cylinders (4L, 5L, and 6L).
- The removed studs from the three cylinders identified above were visually inspected.
- One stud from each of four cylinders was checked by material comparitor and hardness measurement.

RESULTS OF INSPECTIONS:

Measured breakaway torques all were above 1100 ft-lbs. These torques indicate that required torque (1500 ft-lbs) was originally applied and that the torque has remained at acceptable values after extended operation.
No significant visual indications were noted.

Material comparitor and hardness test results indicated that studs are made of acceptable material.

SUMMARY:

A sampling inspection of cylinder head studs indicates that they are acceptable and that they had been correctly torqued.

3.1.8 Rocker Arm Capscrews (Part No. 02-390G)

PROBLEM:

A fatigue failure is reported to have occurred with a rocker arm capscrew at Shoreham (reference 7). This failure was attributed to undertorquing. Reference 8 indicates that properly torqued capscrews have satisfactory fatigue resistance.

SCOPE OF INSPECTIONS:

Inspections of the rocker arm capscrews included the following:

- The breakaway torque of all the capscrews was measured.
- All capscrews were visually and MT examined.
- All the capscrews were checked by superficial hardness test methods and material comparitor tests.

RESULTS OF INSPECTIONS:

The breakaway torques of the intake/intermediate capscrews varied between 276 and 336 ft.-lbs., and the torques of the exhaust capscrews ranged between 324 and 498 ft.-lbs. These values indicate that the required torque of 365 ft.-lbs. had been originally applied and that acceptable torque values were still present after extended service.

No indications were noted in the visual or MT examination.

The material comparitor and hardness tests indicate that the capscrews material is satisfactory.

SUMMARY:

The diesel engine 1A capscrews were found to be satisfactory and to have been properly torqued.

3.1.9 Connecting Rods (Part No. 02-340A)

PROBLEM:

Cracking of connecting rods is reported to have occurred, apparently due to relative motion between the two halves of the connecting rod at the "rack-teeth" joint (reference 7).

SCOPE OF INSPECTIONS:

The inspections of the connecting rods included the following:

- Breakaway torque was measured on the connecting rod bolts for all eight master/link rod/rod box assemblies.
- Magnetic particle inspection of all connecting rod bolts was accomplished.
- The threaded holes on the rod boxes of all connecting rod assemblies were ECT inspected.
- The areas of the rod box which have been reported as being subject to cracking were LP examined.
- Material comparitor and hardness tests were performed on master rod, rod box, and link rod for four connecting rod assemblies.
- Areas of the connecting rod which would be subject to fretting or wear if looseness developed were visually inspected (rack-teeth, washers, seating surfaces) on all connecting rod assemblies.
- Connecting rod rack-teeth (serrations) degree of contact with mating part was measured by blueing the part on all connecting rods.

RESULTS OF INSPECTIONS:

Normal torque values were found, and no significant indications were detected. Material properties were acceptable, and no signs of joint looseness or fretting were seen. Degree of contact between serrations varied from 80 to 100%.

SUMMARY:

The connecting rods on diesel 1A have seen over 800 hours of operation. Reports of fretting wear, cracks in the connecting rods, loose capscrews and cracks in tapped threads were not seen on the Catawba 1A diesel. The fact that these reported incidents were not seen on the Catawba 1A diesel as well as the fact that the connecting rod bearing shells did not show any type of wear associated with connecting rod looseness indicates that the reported incidents did not take place on the Catawba 1A diesel during it extended run operation.

During reassembly of the engine, elongation of the connecting rod bolts will be measured and compared with TDI recommended values. This will be done in addition to torquing the bolts to TDI recommended values.

3.1.10 Electrical Cables (Part No. 02-688B)

PROBLEM:

A number of electrical cables used by TDI have been identified as either failing insulation flame test requirements or not having sufficiently high temperature ratings (references 7 and 14).

SCOPE OF INSPECTION:

Stone and Webster, as part of TDI Owners Group activities, reviewed the Catawba electrical cable installation.

RESULTS OF INSPECTION:

The Stone & Webster inspections (reference 18) have been completed with the following results.

- TDI SIM 361 has not been implemented on the Catawba diesels. This involves replacement of: shielded cable from a terminal block to the tachometer relay in the engine control panel; shielded cable from Airpax magnetic pickup to the junction box on the side of the engine; and multiconductor cable from an engine mounted junction box to the Woodward governor actuator.

- Certification that States type NT sliding link terminal blocks used in the starting air solenoid controls were not manufactured between 1974 and 1976.

SUMMARY:

Replacement of wiring to implement TDI SIM 361 will be done by September 1984. With this replacement, all wiring will be of acceptable temperature rating and adequately sized for circuit ampacities. Duke Power Co. (reference 19) has a program for inspecting States sliding link terminal blocks during installation and each time the link is operated. Performance problems and defective links are reported to Design Engineering. Hence, Duke Power Co. already has a program for uncovering defective terminal blocks and therefore find it unneccesary to verify the manufacturing date of the TDI terminal blocks.

3.1.11 Fuel Injection Lines (Part No. 02-365C)

PROBLEM:

Several cases of failure of high pressure fuel injection lines have occurred. These failures have been attributed to a fatigue crack initiating at pre-existing .006" draw seam at the tubing ID. (reference 10).

SCOPE OF INSPECTIONS:

All of the high pressure fuel injection lines will be inspected in an area six inches from each end or from the end to the first turn using ECT methods in early July.

RESULTS OF INSPECTIONS:

The inspections have not yet been performed.

SUMMARY:

The fuel lines have operated for over 10 million cycles without problem and are thus considered to be satisfactory. In addition, ECT inspections will be performed to confirm their satisfactory condition.

3.1.12 Jacket Water Pumps (Part No. 02-425A)

PROBLEM:

Several jacket water pump shaft failures occurred at Shoreham (reference 11). The Catawba jacket water pumps are of a different design than the Shoreham pumps. However, even though the problems experienced at Shoreham are not expected to apply to the Catawba diesels, detailed inspections were performed of the Catawba jacket water pumps.

SCOPE OF INSPECTIONS:

The engine driven jacket water pump inspections included the following:

- Visual and PT examination of coupling.
- Visual inspection of clearance ring.
- Verification of shaft material by material comparitor and hardness checks.
- PT and RT of pump impeller.

RESULTS OF INSPECTIONS:

All planned testing has been completed. The only significant condition noted was some porosity in the impeller casting. Based on RT examination, the porosity was evaluated as acceptable.

SUMMARY:

The jacket water pump was inspected and found to be satisfactory.

3.1.13 Air Start Valve Capscrews (Part No. 02-359)

PROBLEM:

Capscrew bottoming out due to insufficient hole depth for the capscrew length can lead to insufficient clamping force (reference 7). TDI recommended reducing capscrew length to prevent this problem. Catawba diesel capscrews were modified prior to the extended operation test.

SCOPE OF INSPECTION:

The inspections for the capscrews included the following:

- Measure breakaway torque on all capscrews.
- Measure length of capscrews for 4 valves.

RESULTS OF INSPECTIONS:

Breakaway torques and capscrew lengths were acceptable, and the valves showed no signs of insufficient clamping force.

SUMMARY:

There appeared to be no problems with airstart valve capscrew bottoming out in the Catawba 1A diesel.

3.1.14 Push Rods (Part No. 02-390C)

PROBLEM:

Originally supplied pushrods experienced cracking of the welds joining the rod to their rod ends. New design push rods with friction welds were installed in the Catawba diesels during the extended operation test and accumulated about 400 hours of operation.

SCOPE OF INSPECTIONS:

The inspections of the new design push rods included the following:

- Visual inspection of the shaft end welds to verify that the desired new type of friction welds were used.
- PT examination of all the welds.

RESULTS OF INSPECTIONS:

All the push rods were confirmed as having the correct type of weld and were found to be free of defects.

SUMMARY:

The Catawba diesel engine push rods are considered to be satisfactory.

3.1.15 Turbocharger Bearings (Part No. MP-022/23; 02-CFR)

PROBLEM:

Severe wear of the bearings has been reported, apparently due to inadequate lubrication during diesel starts (reference 7). An improved lube oil supply system is being developed for Catawba, with installation by September 1, 1984.

SCOPE OF INSPECTION:

- The bearings were visually and dimensionally inspected.

RESULTS OF INSPECTIONS:

The thrust faces of the turbocharger bearings were found to be severely worn. It should be noted that this wear had not affected turbocharger operation during the extended operation test.

SUMMARY:

The turbocharger bearings are being replaced with new parts, and are expected to operate as well as the original bearings, which caused no operational problems for several hundred hours. Until the new lube oil system is installed, the bearings will be inspected as necessary to ensure that they remain in operable condition.

3.1.16 Cylinder Heads (Part No. 02-360A)

PROBLEM:

Two small jacket water leaks have been experienced at Catawba resulting in water leaking into the fuel injector nozzle cavity. Failure analysis of one of the leaking heads has been completed (reference 20). The leak was due to cracks propagating from a corner where a welded plug was installed in the fuel injector nozzle seating area. This welded plug was used to repair the injector bore during manufacture. (Figure 2-3)

SCOPE OF INSPECTION:

The inspections performed of the cylinder head included:

- PT examination of valve seats in cylinder heads.

- UT examination of fire deck thickness at selected locations.

RESULTS OF INSPECTIONS:

No cracks were detected and all thicknesses were acceptable.

ENGINEERING EVALUATION:

An engineering evaluation (reference 22) was done to determine if any of the heads now installed on the 1A diesel were repaired. This evaluation consisted of using a boroscope to see if there was a parting line at the bottom of the fuel injector cavity indicating the presence of a plug. In addition, the fire deck area of the head was visually inspected for the presence of weld metal indicating a plug was installed. The results of this engineering evaluation indicated that the head installed on cylinder 6 left was repaired with a welded plug. This head was factory installed on the engine and has seen over 800 hours.

SUMMARY:

The currently installed heads in the 1A diesel engine are considered to be satisfactory since they were not leaking when last used and exhibit no cracks in inspectable areas. Further, the type of leaks caused by cracks due to plug welding do not affect diesel operation and are not significant. However, the repaired head (6 left) will be replaced.

3.2 Catawba Specific Problems

3.2.1 Fuel Injection Pump (Part No. 02-365A)

PROBLEM:

A fuel injection pump nozzle valve holder at Catawba cracked as a result of a material defect (reference 1).

SCOPE OF INSPECTIONS:

The inspections performed to date related to the problem included:

- Measuring the hardness of each valve holder.
- Performing a UT examination of each fuel pump valve holder.

RESULTS OF INSPECTIONS:

All the fuel pump valve holders were found to be acceptable based on the inspections conducted.

ENGINEERING EVALUATION:

A failure analysis was performed on the fuel injection pump nozzle valve holder (reference 21). The results of this analysis indicate that an axially oriented linear indication in the high pressure fuel oil passage of the failed part led to the reported failure. Further analysis indicates that axial linear indications that would lead to cracking of the valve holder would cause cracking to occur within 10 million cycles of fuel pump operation. As the remaining valve holders on diesel 1A have withstood 10 million cycles of operation, the valve holder failure experience is considered an isolated material defect. In addition to this analysis, a boroscope evaluation (reference 23) of the high pressure fuel oil passage was made. Results of this evaluation indicate that several of the valve holder bores were rough machined with protrusions, counter bore 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.

SUMMARY:

It is concluded that the valve holder failure is due to a material defect. Failure analysis indicates that due to extended operation of the diesel, no defects that would cause cracking are present in the remaining valve holders. One valve holder, based on boroscope inspection, appears to have a linear indication. Three other valve holders appear to have recesses. These four valve holders will be removed from the engine, cleaned, rechecked by boroscope and reamed to a diameter of 0.170 inches if indications are still present after cleaning. Valve holders that have indications after reaming will be replaced.

3.2.2 Turbocharger Prelube Oil Lines (Part No. 02-307B)

PROBLEM:

Two failures of the prelube oil lines occurred during the 1A extended operation test, due to fatigue cracking at compression fittings (reference 21). The lines have been replaced using an improved procedure, using additional clamps, vibration dampening devices, improved compression fittings and heavier wall stainless steel tubing. A further improved prelube system will be installed to correct turbocharger bearing lubrication problems.

SCOPE OF INSPECTIONS:

The piping will be visually inspected to verify that it has been installed in accordance with the latest approved drawings, and to verify that there is no evidence of vibration induced damage (fretting, etc.).

RESULTS OF INSPECTIONS:

Inspection of this piping has not yet been performed.

SUMMARY:

After the diesel is reassembled, the system will be inspected to verify that it is properly installed so as to prevent vibration problems.

3.2.3 Turbocharger Adaptor (Part No. 00-495A)

PROBLEM:

A turbocharger to intercooler adaptor cracked at a flange weld. This is assumed to have been caused by poor flange alignment with mismatched bolt holes. Catawba now uses improved alignment practices when torquing turbocharger flange bolts (reference 1).

SCOPE OF INSPECTIONS:

The adaptor weld joints were visually and MT examined.

RESULTS OF INSPECTIONS:

No defects were noted.

SUMMARY:

These welds are considered to be satisfactory.

3.2.4 Lube Oil and Jacket Water Thermocouples (Part No. 02-630D)

PROBLEM:

Several failures have occurred with these thermocouples as a result of intermittent shorts (reference 1).

SCOPE OF INSPECTIONS:

Inspections of thermocouples are not considered useful.

RESULTS OF INSPECTIONS:

Not applicable.

SUMMARY:

Occassional thermocouple failures are a normal occurrence and do not affect diesel operability under emergency run conditions. Failed thermocouples are repaired or replaced at the first opportunity.

3.2.5 Crankcase and Camshaft Cover Capscrews (Part No. 02-386B)

PROBLEM:

Occasional failures of these capscrews has occurred due to fatigue (reference 21) because of over or under torque.

SCOPE OF INSPECTIONS:

All of these capscrews are being replaced with capscrews with improved fatigue strength and of known chemical and physical properties. Accordingly, inspection is not applicable.

SUMMARY:

This problem has been resolved by replacement of the capscrews using capscrews of appropriate quality and by revising installation procedures to control torques to appropriate values.

3.2.6 Rocker Box (Subcover) Subassembly (Part No. 02-362A)

PROBLEM:

Two types of problems have been experienced with these components. The first type was reported in reference 1 and involves fracturing off of a piece of the boss (also called a pedestal), apparently due to installation with a misaligned dowel pin. The second type of problem was detected in the post extended operation test inspections, and involves tight cracks running down the boss in the web between the bolt hole and the boss surface. The cause of the second type of problem has not been firmly established but may be due to installation tolerances between bushings or dowels and the pedestal leading to excessive interference fits.

SCOPE OF INSPECTION:

- All of the bosses on all of subcover assemblies were PT examined.

RESULTS OF INSPECTIONS:

Two subcovers were found to have cracked bosses following the extended operation test. All of the others were free of defects.

SUMMARY:

Several cracked bosses were found and the affected subcover assemblies have been replaced. These cracks have not caused a loss of operability of the engines. A failure analysis is being performed by FaAA under TDI Owners Group direction. Until the cause of failure and the frequency of cracking are better established, the Catawba subcovers will be inspected as necessary to verify that additional cracking has not occurred.

3.2.7 Turbocharger Lube Oil Drain Line (Part No. 02-467A)

PROBLEM:

A temporary drain line on diesel 1A leaked during the extended operation test due to fatigue. It is being replaced with an improved design as part of the diesel reassembly.

SCOPE OF INSPECTION:

Not applicable.

SUMMARY:

This problem is being resolved by incorporation of an improved design.

3.2.8 <u>Turbocharger Exhaust Gas Inlet Bolts</u> (Part No. 02-380B)

PROBLEM:

Four 1/2 inch stainless mounting bolts were found broken (reference 1). The cause of the failure indicates that one bolt to have failed from creep rupture while the others failed from torsional overload (reference 21).

SCOPE OF INSPECTION:

All of the intact bolts and those replaced have been inspected by visual methods at a magnification of 5x to assure that no new cracks have initiated.

RESULTS OF INSPECTION:

Bolt inspections indicate no defects on installed bolts.

SUMMARY:

All bolts will be temporarily replaced with the same material. Bolt installation procedures have been revised to insure that proper preloads are applied during this installation. Long term fix is to replace these bolts with creep resistant A 286 material.

3.2.9 <u>Exhaust Valve Tappet (Rocker Arm Adjusting Screw Swivel Pad)</u> (Part No. 02-390B)

PROBLEM:

One of the swivel pads was found cracked on diesel 1B. Failure analysis (reference 21) indicates that the cracking occurred due to a one time overload. It is believed that the swivel pad cracked due to improper swaging at the factory during manufacture.

SCOPE OF INSPECTIONS:

All swivel pads were visually and liquid penetrant inspected on diesel 1A.

RESULTS OF INSPECTIONS:

No defects were found and the sockets were found to be correctly swaged.

SUMMARY:

The swivel pads are considered to be in satisfactory condition.

3.2.10 Fuel Line Fittings (Part No. 02-450B)

PROBLEM:

Failures have been reported as occurring on fittings, apparently as a result of vibration induced fatigue due to the absence of the supports required by the TDI drawing (reference 7). One fuel line had to be replaced on the Catawba 1A diesel due to leakage. However, inspection of the fuel line indicated that it was improperly swaged rather than failing from fatigue. A flat spot in the cone portion of the tube had been eroded away causing the leakage.

SCOPE OF INSPECTIONS:

The inspections of the fuel lines will include a walk down inspection to verify that the piping is installed per the applicable design drawing.

RESULTS OF INSPECTIONS:

This inspection will be performed after the engine is reassembled.

SUMMARY:

This inspection has not yet been performed; it will be performed when the engine is reassembled. Reassembly procedures will use Duke Power Co. special fitting installation instructions to guard against improper swaging.

3.3 General Inspection

In addition to inspections related to TDI generic problems and to Catawba specific problems, inspections have been performed of numerous other parts in order to verify the operability of the Catawba 1A diesel engine. The results of these inspections showed that the 1A diesel engine was in excellent condition, with a few relatively minor problems in addition to the problems discussed in sections 3.1 and 3.2 above. The only additional problems noted were as follows:

- Two intermediate rocker arm sockets had chipped or cracked edges.
- Nine valve stems had chipped or removed chrome plate.
- One air start valve had a jammed spring retaining nut and another had a missing roll pin.
- One rod box bushing was found to have a heavy circumferential gouge in it.
- Several bolts and capscrews were found to have missing heads or cracks.

These problems are discussed below.

3.3.1 Cracked Intermediate Rocker Arm Sockets (Part No. 02-390A)

PROBLEM:

Two sockets were found to have chipped and/or cracked lips. These chips and cracks did not affect functioning of the sockets since the push rods seat further in the socket, well inside the area with chips or cracks. The chips and cracks show no evidence of propagating into the functioning part of the socket. The problem is believed to be due to improper installation of the rocker arm prior to valve adjustment, such that excessive clearance existed, allowing pushrods to move in and contact with the lips.

SCOPE OF INSPECTION:

All of the sockets were visually examined.

RESULTS OF INSPECTIONS:

The two sockets mentioned above were found to be chipped and/or cracked. No other problems were noted.

SUMMARY:

The chipped and cracked sockets are considered to be a cosmetic problem and to not affect diesel operability. The affected socket lips will be ground smooth. In addition, procedure changes are being made to ensure that excessive clearance does not exist in the rocker arm at assembly; this is expected to preclude recurrence of this problem.

3.3.2 Valve Stem (Part No. 02-360B)

PROBLEM:

Nine exhaust valve stems had areas with chipped or removed chrome plate. This occurred at about 6 to 8 inches above the valve seat, at a location corresponding to where the stem enters the valve guide. The chrome plate chipping had no affect on diesel operability, and caused no observable damage to the valve guides.

SCOPE OF INSPECTIONS:

All valve stems were visually inspected.

RESULTS OF INSPECTIONS:

As discussed above, 9 exhaust valve stems had chipped or removed chrome plating in areas about 6 to 8 inches above the valve seat. No structural damage was observed.

SUMMARY:

Valve stem chrome plate chipping of a cosmetic nature occurred. The affected valve stems are being replaced. This condition will be monitored in the future during routine maintenance inspections.

3.3.3 Spring Retaining Nut and Roll Pin on Air Start Valves (Part No. 02-359)

PROBLEM:

The spring retaining nut on an air start valve was found to be jammed due to galled threads. A spring retaining nut roll pin was found to be missing on another valve. The galled threads and missing roll pin had not affected diesel operability.

SCOPE OF INSPECTIONS:

All of the air start valves were disassembled and visually inspected.

RESULTS OF INSPECTIONS:

The one jammed nut and one missing roll pin were the only inspection deficiencies found.

SUMMARY:

The jammed nut and missing roll pin are believed to be due to installation errors. These items have been replaced. Current installation procedures provide assurance that these problems will not recur.

3.3.4 Rod Box Bushing (Part No. 02-340A)

PROBLEM:

A rod box bushing (1L) was found to have a circumferential gouge over about 1/3 of the circumference, with a depth of 1/16 inch.

SCOPE OF INSPECTIONS:

All of the rod box bushings were visually and PT examined.

RESULTS OF INSPECTIONS:

The only problem noted was the one gouge described above.

SUMMARY:

The gouged rod box bushing is being replaced, even though the gouge did not affect operability. This problem is considered to have been an isolated case of damage by a piece of debris.

3.3.5 Clamp Bolts (Part No. 02-450D)

PROBLEM:

Several bolts on the fuel/lube oil triple clamp were found to have heads broken off or cracks.

SCOPE OF INSPECTIONS:

These bolts are being replaced and inspection is therefore not applicable.

RESULTS OF INSPECTIONS:

Not applicable.

SUMMARY:

Failure analysis of these bolts (reference 21) indicates that they failed due to fatigue as a result of under or overtorquing. The bolts are being replaced using new bolts of increased fatigue resistance. Reinstallation procedures include the provision to assure that under and overtorquing do not occur.

3.3.6 Fuel Injector Nozzle Holder Studs (Item 3, TDI dwg. 03-360-08)

PROBLEM:

While removing a cylinder head (7L) with the pulling fixture, the nozzle holder studs sheared off. During disassembly these studs hold the pulling fixture to the head. The pulling fixture is used both for reacting cylinder head stud torquing/untorquing loads and to lift the head. Investigation indicates that these capscrews were bent during untorquing of the heads leading to failure due to overload (reference 21) when the head weight was put on them during head removal. The reason the studs were bent is that the head was not cleaned properly prior to seating the handling fixtures so that the handling fixture rocked on the head.

SCOPE OF INSPECTIONS:

- Visual inspection of studs to determine if they are bent.
- Magnetic particle of studs to determine if they are cracked.

RESULTS OF INSPECTIONS:

- Studs in head 7L were sheared off (see above).
- Stud in head 5R had bad threads.
- Stud in head 6R was missing.

SUMMARY:

Defective and missing studs are being replaced. Procedure for installing head pulling fixture will assure that improper loads are not being applied. Problem occurred during disassembly and did not affect engine operation.

3.3.7 Turbocharger Bolting (Item 7, TDI dwg. 02-475-22)

PROBLEM:

One turbocharger to bracket, 5/8 x 11 NC x 2 long capscrew failed on diesel 1B. Failure analysis of the capscrew indicated fatigue failure.

SCOPE OF INSPECTIONS:

These bolts are being replaced on diesel 1A and inspections are therefore not applicable.

RESULTS OF INSPECTIONS:

Not applicable.

SUMMARY:
Failure analysis of the capscrew indicated that it failed due to fatigue. All capscrews are being replaced with new material of increased fatigue resistance. Reassembly procedures have been revised to assure that proper preloads are applied.

4.0 References

1. Duke Power Co. letter dated April 5, 1984 to H.R. Denton, NRC, with attached document entitled "Catawba Nuclear Station Extended Operation Tests and Inspections of Diesel Generators".

2. IE Information Notice No. 83-58, "Transamerica Delaval Diesel Generator Crankshaft Failure", NRC, August 30, 1983.

3. Bechtel Power Corporation, "Evaluation of Crankshaft Stresses for Duke Power Corporation, Catawba Nuclear Station", March 19, 1984.

4. Failure Analysis Associates, "Design Review of Connecting Rod Bearing Shells for Transamerica Delaval Enterprise Engines", March 12, 1984.

5. Delaval minutes of November 30, 1983 meeting with TDI Owners Group.

6. Failure Analysis Associates, "Investigation of Types AF and AE Piston Skirts", May 27, 1984.

7. Mississippi Power & Light Co., "Comprehensive report on Standby Diesel Generators -Significant Activities to Enhance and Verify Reliability", February 1984 transmittal to NRC by letter dated February 20, 1984.

8. Stone and Webster Engineering Corporation, "Emergency Diesel Generator Cylinder Head cap stud Stress Analysis", March 1984.

9. Stone and Webster Engineering Corporation, "Emergency Diesel Generator, Rocker Arm Capscrew, Stress Analysis", dated March 1984, and Supplement dated April 1984.

10. Stone and Webster Engineering Corporation, "Emergency Diesel Generator, Fuel Oil Injection Tubing, Qualification Analysis", April 1984.

11. Stone and Webster Engineering Corporation, "Emergency Diesel Generator, Engine Driven Jacket Water Pump, Design Review", April 1984.

12. Failure Analysis Associates, "Evaluation of Emergency Diesel Generator Crankshafts at Shoreham and Grand Gulf Nuclear Stations", April 19, 1984.

13. Failure Analysis Associates, "Design Review of Engine Base and Bearing Caps for Transamerica Delaval Diesel Engine", April 1984.

14. Stone and Webster Engineering Corporation, "Emergency Diesel Generator, Auxiliary Module Control Wiring and Termination, Qualification Review", April 1984.

15. Stone and Webster Engineering Corporation, "Emergency Diesel Generator Air Start Valve Capscrew, Dimension and Stress Analysis", March 1984 and Supplement, April 1984.

16. Failure Analysis Associates, "Torsiograph Test of Emergency Diesel Generator 1A at Catawba Nuclear Power Station," May 29, 1984.

17. Duke Power Co. Meeting Minutes, Diesel Generator Owners Group. Shoreham Nuclear Power Station, S. R. Ward author, May 24, 1984.

18. Stone & Webster Engineering Corporation, "Supplement to the Emergency Diesel Generator Auxiliary Module Control Wiring and Termination Qualification Review," June 1984.

19. Duke Power Co. letter from G. T. Lamb to K. S. Canady, "Catawba Nuclear Station IE Information Notice 80-08 States Sliding Link Terminal Block," File CN1412.11-1;EGS N-14.01, May 7, 1980.

20. Failure Analysis Associates, "Metallurgical Analysis of Catawba Injection Port Leak," June 1984.

21. Duke Power Co., "Failure Analysis Report Catawba Nuclear Diesels 1A and 1B," June 25, 1984.

22. Duke Power Co., "Special Procedure for Engineering Evaluation of Cylinder Heads on Catawba Diesel Generators," June 12, 1984.

23. Duke Power Co., "Special Procedure for Engineering Evaluation of Fuel Pump Valve Holder on Catawba Diesel Generator," June 19, 1984

24. Failure Analysis Associates, "Metallurgical Evaluation of Eddy Current Indications Found on DG 1A Crankshaft at Duke Power Co., Catawba Nuclear Power Station," FaAA-84-6-63, June 1984.

5.0 Appendices

APPENDIX A

INSPECTION REPORTS

Table of Contents

Table of Contents

Catawba Diesel 1A Inspection Report

Part Name: Air Start Valve Class: A

Part Number: 02-359 Work Request No. 0772 MNT

No. of Separate Inspections: 72

Attributes Verified and Sample Size

1. Measure as found torque of air start cap screws per 11.3.1, ref. 2, 32 insp.
2. Measure length air start valve cap screws per 11.3.2, ref. 1, 8 insp.
3. Visual inspect valve seat area each valve per 11.3.3, ref. 1, 16 insp.
4. Visual inspect valve internal surfaces per 11.3.4, ref. 1, 16 insp.

References

1. MP/0/A/1000/04 **Diesel Engine Cylinder Head and Associated Parts Special Inspection**
2. MP/0/A/1000/01 **Diesel Engine Cylinder Head Removal, Disassembly. Inspection and Reassembly**

Inspection Results

1. Capscrew as found torques - values ranged between 45-134 ft.-lbs.
2. Capscrew length - all capscrews met tolerance limits.
3. Valve seat area - several nicks and grooves were observed.
4. Valve internals - several valve stems were discolored or had slight carbon buildup on them. The spring retaining nut on one valve was galled.

Disposition of Inspection Findings

1. Capscrew as found torques - the observed values are acceptable
3. Valve seats - The observed seat conditions are considered normal considering the number of starts. The worst seat will be reground.
4. Valve internals - The amount of carbon buildup is normal considering the amount of operation. The galled spring retaining nut was replaced.

Catawba Diesel 1A Inspection Report

Part Name: Intake and Exhaust Valves Class: B

Part Number: 02-360B Work Request Nc. 0722 MNT

No. of Separate Inspections: 360

Attributes Verified and Sample Size

1. Visual inspections on seat area, valve guides, valve stem surface and top per 11.4.2,3,4,6 ref.1, 256 insp.
2. Measure valve steam length per 11.4.5 ref. 1*, 16 insp.
3. Visual exam of valve head weld per 11.4.7 ref. 1*, 8 insp.
4. PT exam of valve head radius per 11.4.7.1 ref. 1, 64 insp.
5. Perform material comparator test per 11.4.10, ref. 1*, 16 insp.

* 25% sample - valves from 4 cylinders

References

1. MP/0/A/1000/04 Diesel Engine Cylinder Head and Associated Parts Special Inspection

Inspection Results

1. a. Seat Areas - Minor pitting was present in many seats; there was one large pit in the right intake of 7R.
   b. Valve Guides - No significant conditions were observed.
   c. Valve stems - The chrome plate had peeled off at spots located 6" to 8" above the valve seat for 9 exhaust valves. The chrome plate also exhibited a dull color in this area. Miscellaneous scratches were observed in the chrome plate.
   d. Top of Stem - A variety of scratches, pits, grooves, etc., were observed.
2. Valve stem length - These results were obtained for information purposes.
3. Visual exam of valve head weld - No significant conditions were observed.
4. PT exam of valve head radius - No rejectable indications observed.
5. Material comparitor tests of the valves will be done when the standard material arrives from the Owners Group.

Disposition of Inspection Findings

1. a. Valve seat pitting - The minor pitting of the valves seat areas is normal and the valves will be reused as-is. The 7R intake valve with a large pit was still functional (the pit spanned less than 50% of the land width), but is being replaced because of chrome plate peeling (see 1. c. below).

c. Valve Stems - The peeling chrome plate has not caused any operational problems, and is not considered to be a cause for concern. However, valves with peeling chrome plate are being replaced.

d. Top of Valve Stem - The scratches, grooves, etc., in the top of the valve stem are considered normal and have not had any effect on diesel operation. The valve stems will be used as-is.

Catawba Diesel 1A Inspection Report

Part Name: Valve Springs Class: B

Part Number: 02-360D Work Request No. 0772 MNT

No. of Separate Inspections: 128

Attributes Verified and Sample Size

1. Check spring color code per 11.4.8, ref. 1, 64 insp.
2. Visual check intake and exhaust valve spring per 11.4.9, ref. 1, 64 insp.

References

1. MP/0/A/1000/04 Diesel Engine Cylinder Head and Associated Parts Special Inspection

Inspection Results

1. Spring color code - Springs for seven right cylinders have a yellow rather than white stripe.
2. Visual check - No cracks or other defects were detected.

Disposition of Inspection Results

1. TDI indicates that only springs painted grey with a brown stripe are unacceptable. Springs with a yellow stripe were supplied by an alternate acceptable vendor.

Catawba Diesel 1A Inspection Report

Part Name: Cylinder Head Class: B

Part Number: 02-360A Work Request No. 0772 MNT

No. of Separate Inspections: 336

Attributes Verified and Sample Size

1. Visual inspect intake and exhaust valve seats per 11.5.2, ref. 1, 64 insp.
2. Perform PT exam of intake & exhaust valve seats and fire deck area per 11.5.4, ref. 1, 80 insp
3. Perform ultrasonic thickness measurement of fire deck per 11.5.5, ref. 1, 96 insp.
4. Perform ultrasonic thickness measurement of fuel nozzle cavity per 11.5.6, ref. 1, 32 insp.
5. Visual inspect fuel injection nozzle studs per 11.12.1, ref.1, 32 insp.
6. MT inspect fuel injection nozzle studs per 11.12.2, ref 1, 32 insp.

References

1. MP/0/A/1000/04 Diesel Engine Cylinder Head and Associated Parts Special Inspection

Inspection Results

1&2 Valve seats - minor pitting observed in many seats. One large pit observed in the intake valve seat for 7R. No rejectable PT indications were observed.

3. Fire deck thickness - thickness ranged from 0.460" to 0.939".
4. Fuel nozzle cavity thickness - thickness ranged from 0.440" to 0.560".
5. Visual inspections showed bad threads on cylinder head 5R - left stud. The right stud in cylinder head 6R was missing.
6. MT examinations of the fuel injector nozzle studs showed no linear indications.

Disposition of Inspection Findings

1. Valve seats - The minor pitting observed in many seats is considered normal and the seats can be used as-is. The large pit in 7R spans less than 50% of the land width and can be used as-is; it should be observed at the next routine maintenance period.

3&4. Wall thickness - No unusually thin wall thicknesses were observed and all of the wall thicknesses are therefore considered to be acceptable.

5. The defective and missing studs will be replaced.

Catawba Diesel 1A Inspection Report

Part Name: Subcover Assembly Class: B

Part Number: 02-362A Work Request No. 0772 MNT

No. of Separate Inspections: 256

Attributes Verified and Sample Size

1. Visual inspect subcover per 11.6.2, ref. 1, 16 insp.
2. PT exam on each subcover per 11.6.3, ref. 1, 64 insp.
3. Record as found torques per 11.2.8, ref. 2, 176 insp.

References

1. MP/0/A/1000/04 Diesel Engine Cylinder Head and Associated Parts Special Inspection
2. MP/0/A/1000/01 Diesel Engine Cylinder Head Removal, Disassembly Inspection and Reassembly

Inspection Results

1. **Visual inspection - No visual defects were observed.**
2. **PT of pedestals - Subcovers 3L and 6L had 1" and 1 1/4" long cracks in the thin web between the bolt hole in the pedestal and the side surface.**
3. **Subcover bolt torques ranged from 30 to 194 ft-lbs.**

Disposition of Inspection Findings

2. PT of pedestals - The two cracked subcovers will be replaced. These cracks are also discussed in Section 3.
3. The bolt torques are considered acceptable. These bolts have been removed and reinstalled numerous times, using torque wrenches during reinstallation. There have been no problems as a result of low torque values. The bolts will be reinstalled, again using torque wrenches in order to assure that proper torques are used.

Catawba Diesel 1A Inspection Report

Part Name: Rocker Arm Assembly Class: B

Part No.: 02-390A Work Request No.: 0772 MNT

No. of Separate Inspections: 224

Attributes Verified and Sample Size

1. Visual inspect intake and int. rocker shaft assembly per 11.7.2, ref. 1, 16 insp.
2. Visual inspect intake and int. rocker arm lips per 11.7.3, ref. 1, 48 insp.
3. Measure distance lip to push rod socket per 11.7.4, ref. 1, 48 insp.
4. Visual inspect push rod sockets per 11.7.5, ref. 1, 48 insp.
5. PT exam adjusting screw swivel pads per 11.7.6, ref. 1, 32 insp.
6. Perform material comparitor test per 11.7.8, ref. 1, 16 insp.
7. Measure superficial hardness per 11.7.9, ref. 1, 16 insp.

References

1. MP/0/A/1000/04 Diesel Engine Cylinder Head and Associated Parts Special Inspection

Inspection Results

1. Visual inspection of shaft assembly - No significant conditions were noted (some minor pitting was noted on 7R, which was judged to be of no consequence).
2. Visual inspection of rocker arm lips - No significant conditions were noted.
3. Measurement of distance from lip to socket, if ground - None were measured since none were ground.
4. Visual inspection of intermediate rocker arm sockets -Edges of sockets on 4R and 6L were chipped and cracked.
5. PT of swivel pads - No indications were noted.
6. Material comparitor check of shafts - All shafts were acceptable.
7. Hardness check of shafts - Shaft hardness ranged from BHN 253 to 299.

Disposition of Inspection Findings

4. Chipped and cracked socket lips have no affect on diesel operation, but will be ground smooth for cosmetic reasons.

7. The specified hardness for the rocker arm shafts is BHN 260-331. The test results are considered acceptable within the limits of accuracy of the testing device.

Catawba Diesel 1A Inspection Report

Part Name: Rocker Arm Bushings Class: B

Part No.: 02-390E Work Request No.: 0772 MNT

No. of Separate Inspections: 48

Attributes Verified and Sample Size

1. Visual inspect Rocker Arm bushings per 11.7.7 and 11.8.7, ref. 1, 48 insp.

References

1. MP/0/A/1000/04 Diesel Engine Cylinder Head and Associated Parts Special Inspection

Inspection Results

1. Visual inspection of rocker arm bushings showed no significant indications.

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 1A Inspection Report

Part Name: Exhaust Rocker Arm Assembly Class: B

Part No.: 02-390B Work Request No.: 0772 MNT

No. of Separate Inspections: 112

Attributes Verified and Sample Size

1. Visual inspect exhaust rocker arm shaft per 11.8.2, ref. 1, 16 insp.
2. Visual inspect exhaust rocker arm lips per 11.8.3, ref. 1, 16 insp.
3. Measure distance lip to push rod socket per 11.8.4, ref. 1, 16 insp.
4. Visual inspect push rod sockets per 11.8.5, ref. 1, 16 insp.
5. PT exam adjusting screw swivel pads per 11.8.6, ref. 1, 32 insp.
6. Perform material comparitor test per 11.8.8, ref. 1, 16 insp.

References

1. MP/0/A/1000/04 Diesel Engine Cylinder Head and Associated Parts Special Inspection

Inspection Results

1. Visual inspection of shaft assembly - No significant conditions were noted (some machine marks sere noted around the socket of 1R; these were judged to be of no consequence).
2. Visual inspection of rocker arm lips - No significant conditions were noted.
3. Measurement of distance from lip to socket, if ground - None were measured since none were ground.
4. Visual inspection of sockets - No significant conditions were noted.
5. PT of swivel pads - No indications were noted.
6. Material comparitor check of shafts - All shafts were acceptable.
7. Hardness of shafts - Shaft hardness ranged from BHN 241 to 311.

Disposition of Inspection Findings

7. Although no hardness testing was required by the procedure, the hardness results are considered acceptable. (See Rocker Arm Assembly Part #02-390A)

Catawba Diesel 1A Inspection Report

Part Name: Pushrods Class: B

Part No.: 02-390C Work Request No.: 0772 MNT

No. of Separate Inspections: 192

Attributes Verified and Sample Size

1. Visual inspect intake and exhaust pushrods per 11.9.2, ref.1, 64 insp.
2. Liquid penetrant exam friction welds per 11.9.3, ref.1, 64 insp.
3. Visual inspect spherical surfaces per 11.9.4, ref.1, 64 insp.

References

1. MP/0/A/1000/04 Diesel Engine Cylinder Head and Associated Parts Special Inspection

Inspection Results

1. Visual inspection of pushrods - No significant conditions noted.
2. PT of friction welds - No indications were noted.
3. Visual inspection of spherical surfaces - No significant conditions were noted (some light scratches were noted on 3L intake pushrod; these are considered normal).

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Connector Pushrod Class: B

Part No.: 02-390D Work Request No.: 0772 MNT

No. of Separate Inspections: 80

Attributes Verified and Sample Size

1. Visual inspect connector pushrods per 11.10.2, ref.1, 16 insp.
2. Liquid penetrant exam friction welds per 11.10.3, ref.1, 32 insp.
3. Visual inspect spherical surfaces per 11.10.4, ref.1, 32 insp.

References

1. MP/0/A/1000/04 Diesel Engine Cylinder Head and Associated Parts Special Inspection

Inspection Results

1. Visual inspection of pushrods - No significant conditions noted.
2. PT of friction welds - No indications were noted.
3. Visual inspection of spherical surfaces - No significant conditions were noted (3 pushrod spherical surfaces had light scratches or grooves, which are considered normal and not deleterious).

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Rocker Arm Bolting   Class: B

Part No.: 02-390C   Work Request No.: 0772 MNT

No. of Separate Inspections: 320

Attributes Verified and Sample Size

1. Measure breakaway torque per 11.2.7, ref.1, 64 insp.
2. Perform material comparitor test per 11.11.2, ref. 2, 64 insp.
3. Measure superficial hardness per 11.11.3, ref. 2, 64 insp.
4. Magnetic particle test per 11.11.4, ref.2, 64 insp.
5. Visual inspect capscrews per11.11.5 ref.2, 64 insp.

References

1. MP/0/A/1000/01 Diesel Engine Cylinder Head Removal and Disassembly
2. MP/0/A/1000/04 Diesel Engine Cylinder Head and Associated Parts

Inspection Results

1. Bolt torques - Intermediate/intake assembly - bolt torque ranged between 276 and 336 ft-lbs. Exhaust assembly - bolt torque ranged between 324 and 336 ft-lbs. These values are considered acceptable.
2. Material comparitor - All results were acceptable.
3. Hardness ranged from Rockwell C 20 to 28
4. Magnetic Particle - No indications were noted.
5. Visual Inspection - No indications were noted.

Disposition of Inspection Findings

3. The specified hardness for the rocker arm bolts is Rockwell C 25 to 30. The results are considered acceptable within the limits of accuracy of the measuring device. This is further evidenced by the satisfactory operation of the bolting for extended periods.

Catawba Diesel 1A Inspection Report

Part Name: Connecting Rods and Bushings Class: A

Part Number: 02-340A Work Request No. 0773 MNT

No. of Separate Inspections: 476

Attributes Verified and Sample Size 100% inspection except where noted

1. Visual inspect per 11.3.2, ref.1, 24 insp.
2. Measure rod dimensions per 11.3.3, ref. 1+, 168 insp.
3. Perform material comparator test per 11.3.5, ref. 1*, 16 insp.
4. Perform hardness test per 11.3.6, ref. 1*, 12 insp.
5. Perform PT test per 11.3.7 and 11.5.4, ref. 1, 8 insp.
6. Eddy current test per 11.3.4, ref. 1, 16 insp.
7. Measure breakaway torques per 11.3.5 and 11.5.1, ref 2, 80 insp.
8. Inspect connecting rod oil passages per 11.3.13, and 11.4.7, ref. 2, 16 insp.
9. Inspect connecting rod bolt contact surfaces per 11.4.1, ref. 1, 40 insp.
10. MT inspect connecting rod bolts per 11.4.2, ref. 1, 40 insp.
11. Measure surface contact on each connecting rod serration by blueing [special engineering evaluation] 8 insp.
12. Measure connecting rod bolt elongation by UT [special engineering evaluation] 48 insp.

   * 25% sample basis inspection
   \+ 25% sample basis for piston pin bushing

References

1. MP/0/A/1000/05 Diesel Engine Piston, Rod, Bushing and Shells Special Inspection
2. MP/0/A/1000/02 Diesel Engine Piston Rod and Liner Disassembly

Inspection Results

1. Visual inspection of connecting rod boxes, master rods and link rods show several instances of scratching and pitting.
2. Measurement of piston pin bushings shows three bushings out of tolerance by .002".
3. Results of the material comparitor test of the connecting rod components were acceptable.
4. Hardness of the link rod pin was BHN 186-256. All other hardness test results ranged from BHN 241 to 291.
5. PT exam results showed one 1 1/4" long scratch on link rod bushing 1L. This is thought to have been caused in manufacture and is not considered a problem. All other results were satisfactory.
6. Eddy current tests of the rod box bolt holes showed no indications

7. Master rod breakaway torques ranged from 1260 to 2150 ft-lbs. One lock wire was found loose on cylinder #3. Link rod torques ranged from 880 to 1470 ft-lbs.
8. All connecting rod oil passages were found to be satisfactory.
9. Visual inspection of the connecting rod contact surfaces demonstrated galling under the bolt heads.
10. MT examinations of the connecting rod bolts found no rejectable indications.
11. Blueing results for connecting rods 1-8 showed the following percentage contact: 85, 99, 90, 95, 90, 90, 80, and 100 percent, respectively.
12. Bolt elongation measurements will be taken during engine reassembly.

Disposition of Inspection Findings

1. Visual inspection of connecting rod boxes, master rods, and link rods- these small pits and scratches are normal and have no adverse effects.
2. Piston pin bushings - The tolerance limits used for the inspection were for new parts. The small deviations noted are normal for parts that have been in service and have no effect on diesel operation.
4. Although no specified hardness values are available for this material, the measured values appear reasonable for the component materials and are considered acceptable.
7. The lockwire found on disassembly inspection had been loosened before final inspection and is not considered significant.
9. The extent of the observed bolt contact surface galling is believed to have been caused by torquing the bolts and is considered normal and acceptable.
11. As-machined TDI standards are 75% minimum contact area; hence, the results of the engineering evaluation are acceptable.

Catawba Diesel 1A Inspection Report

Part Name: Connecting Rod Bearing Shells   Class: A

Part Number: 02-340B   Work Request No. 0773 MNT

No. of Separate Inspections: 228

Attributes Verified and Sample Size 100% inspection except where noted

1. Visual inspect crankpin shells per 11.5.2, ref. 1, 20 insp.
2. Measure crankpin shells per 11.5.3, ref. 1, 160 insp.
3. Liquid penetrant inspect per 11.5.4, ref. 1 *, 32 insp.
4. X-ray inspection per 11.5.5, ref. 1, 8 insp.
5. Eddy current inspection per 11.5.6, ref. 1, 8 insp.

* 25% sample basis inspection for link rod end

References

1. MP/0/A/1000/05 Diesel Engine Piston, Rod, Bushing and Shell Special Inspection

Inspection Results

1. Results of the visual inspection showed some light scratches and galling in several shells; otherwise, the inspection was within normal limits.
2. Measurement of crankpin shells - All measurements of crankpin shells meet acceptance standards.
3. PT examination of shells revealed no indications.
4. Radiography of the bearing shells meet acceptance standards with the exception of five. These five shells have what appears to be crack like indications.
5. Eddy current inspection has not been accomplished.

Disposition of Inspection Findings

1. These small scratches and galled areas are considered a result of normal wear and are acceptable.

4. The bearing shells with rejectable conditions will be replaced. The rejectable shells will be the subject of further evaluation.

Catawba Diesel 1A Inspection Report

Part Name: Piston Class: A

Part Number: 02-341A Work Request No. 0773 MNT

No. of Separate Inspections: 560

Attributes Verified and Sample Size

1. Visual inspect fitup of crown to skirt per 11.6.2, ref. 1, 16 insp.
2. Inspect rings in grooves and measure axial clearance per 11.6.3, ref. 1, 288 insp.
3. Visually inspect pistons and piston rings for normal wear per 11.6.4, ref. 1, 16 insp.
4. Liquid penetrant inspect stud bosses in crown and skirt area and piston pin bosses on skirt per 11.6.5, ref. 1, 160 insp.
5. UT piston skirts per 11.9.2 if unsat. results from 11.9.1
6. PT/MT exam piston skirt per 11.9.1, and 11.9.3, ref.1, 16 insp.
7. Measure crown to skirt bolt breakaway torque per 11.7.3, ref. 2, 64 insp.

References

1. MP/0/A/1000/05 Diesel Engine Piston, Rod, Bushing and Shells Special Inspection
2. MP/0/A/1000/02 Diesel Engine Piston, Rod and Cylinder Liner Disassembly

Inspection Results

1. All visual inspections of crown to skirt fitups were satisfactory.
2. Axial clearance of piston rings in grooves were measured. Twenty rings out of 96 were out of tolerance by as much as .006".
3. Eight of sixteen piston assemblies demonstrated pitting or scratching on visual inspection.
4. PT exam of piston crown showed no indications. One 1/2" linear indication was found on piston skirt pin boss #1L.
5. UT not necessary as skirts will be replaced.
6. PT/MT exam demonstrated cracks in four of the piston skirts.
7. Torques of piston crown to skirt bolts ranged from 80 to 200 foot-pounds

Disposition of Inspection Findings

2. Axial clearance of piston rings in grooves - The tolerance used for this inspection were for new parts. The small deviations noted are normal for parts which have seen service and are considered acceptable.

3. Visual inspection of pistons and rings - The small scratches and pits observed are normal for parts which have seen service, have no effect on diesel operability, and are considered acceptable.

4,5,6. The piston skirts are to be replaced.

Catawba Diesel 1A Inspection Report

Part Name: Piston Pin Assembly   Class: A

Part Number: 02-341C   Work Request No. 0773 MNT

No. of Separate Inspections: 28

Attributes Verified and Sample Size 25% sample size except where noted

1. Visual inspect per 11.7.2, ref. 1*, 16 insp.
2. Dimensional inspect per 11.7.3, ref. 1, 4 insp.
3. Materials verification test per 11.7.4, ref. 1, 4 insp.
4. Hardness test per 11.7.4, ref. 1, 4 insp.

* 100% inspection

References

1. MP/0/A/1000/05 Diesel Engine Piston, Rod, Bushings and Shells Special Inspection

Inspection Results

1. Results of the visual inspection of the piston pins were satisfactory.
2. Dimensional inspection shows all dimensions satisfactory.
3. Material composition tests showed no significant findings.
4. Hardness test results for the piston pins were within the range of Rockwell C 54 to 58.

Disposition of Inspection Findings

4. The specified hardness is Rockwell C 57 to 60. The measured hardness is considered acceptable within the limits of accuracy of the testing device

Catawba Diesel 1A Inspection Report

Part Name: Piston Rings Class: A

Part Number: 02-341B Work Request No. 0773 MNT

No. of Separate Inspections: 96 25% sample basis inspection

Attributes Verified and Sample Size

1. Install rings in cylinders & measure butt gap per 11.8.2, ref. 1, 96 insp.

References

1. MP/0/A/1000/05 Diesel Engine Piston, Rod, Bushing and Shells Special Inspection

Inspection Results

1. 56 piston rings were found to have a butt gap out of tolerance.

Disposition of Inspection Findings

1. The tolerances used for the inspection were for new rings and pistons. The small deviations from these will not adversely affect the engine. However, the piston rings will be replaced before reassembly for other reasons.

Catawba Diesel 1A Inspection Report

Part Name: Crankshaft Thrust Bearing Ring   Class: A

Part Number: 02-310C   Work Request No. 0774 MNT

No. of Separate Inspections: 2

Attributes Verified and Sample Size

1. Measure thrust clearance per 11.3.2A, ref. 1, 2 insp.

References

1. MP/0/A/1000/06 Diesel Engine Crankshaft and Turning Gear, Gear, Crankshaft Bearings, Crankcase Assembly and Crankcase Covers Special Inspection

Inspection Results

1. Hot inspections have been performed, with satisfactory results. The cold inspections will be done later.

Disposition of Inspection Findings

1. There have been no significant findings to date, the cold inspections will follow.

Catawba Diesel 1A Inspection Report

Part Name: Main Bearing Caps Class: A

Part Number: 02-305D Work Request No. 0774 MNT

No. of Separate Inspections: 8

Attributes Verified and Sample Size

1. Visual inspect main bearing cap #4,5,6,8 per 11.4.1, ref. 1, 4 insp.
2. Liquid penetrant main bearing cap #4,5,6,8 per 11.4.2, ref. 1, 4 insp.

References

1. MP/0/A/1000/06 Diesel Engine Crankshaft and Turning Gear, Gear, Crankshaft Bearings, Crankcase Assembly and Crankcase Covers Special Inspection

Inspection Results

1. Visual inspections of the main bearing caps were satisfactory.
2. Liquid penetrant inspections of the main bearing caps was satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Main Bearing Base Assembly Class: A

Part Number: 02-305A Work Request No. 0774 MNT

No. of Separate Inspections: 8

Attributes Verified and Sample Size

1. Visual inspect main bearing base around main bearings 4,5,6,8 per 11.4.1, ref. 1, 4 insp.
2. Liquid penetrant examine base material around main bearings 4,5,6,8 per 11.4.4, ref. 1, 4 insp.

References

1. MP/0/A/1000/06 Diesel Engine Crankshaft and Turning Gear, Gear, Crankshaft Bearings, Crankcase Assembly and Crankcase Covers Special Inspection

Inspection Results

1. Visual inspections the of main bearing bases were satisfactory.
2. Liquid penetrant inspections of the main bearing bases were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Main Bearing Shells Class: A

Part Number: 02-310B Work Request No. 0774 MNT

No. of Separate Inspections: 90

Attributes Verified and Sample Size

1. Measure breakaway torque of upper bearing shell capscrews per 11.3.1, ref.2, 48 insp.
2. Visual inspect bearings 4,5,6,8 per 11.5.1, ref.1,
   a. Upper main bearing shell, 4 insp.
   b. Lower main bearing shell, 4 insp.
   c. Crankshaft journal, 4 insp.
3. Measure thickness of lower main bearing shell #4,5,6,8 per 11.5.2, ref. 1, 30 insp.

References

1.	MP/0/A/1000/06	Diesel Engine Crankshaft and Turning Gear, Gear Crankshaft Bearings, Crankcase Assembly and Crankcase Covers Special Inspection
2.	MP/0/A/1000/03	Diesel Engine Main Bearing Disassembly for Special Inspection and Reassembly

Inspection Results

1. Breakaway torque was zero for capscrews in bearing shells #5 & 8.

2. Visual inspections of main bearing shells and crankshaft journals were satisfactory.

3. Thickness measurements of the main bearing shells were acceptable.

Disposition of Inspection Findings

1. Cause of low breakaway torque is not known. Capscrews only serve to hold shell in place during assembly, and low torque does not affect diesel operability. The reassembly procedure assures that the proper torque is applied.

Catawba Diesel 1A Inspection Report

Part Name: Crankshaft   Class: A

Part Number: 02-310A   Work Request No. 0774 MNT

No. of Separate Inspections: 31

Attributes Verified and Sample Size

1. Visual inspect crankpins 1-8 bearing surfaces and crankpin fillets per 11.6.1, ref. 1, 8 insp.
2. Eddy current test crankpins fillets between crankpin journals and webbing per 11.6.2, ref. 1, 12 insp.
3. Sensitive PT test oil holes on main bearing journals #4,6,8 with supplemental eddy current and visual exams as necessary per 11.6.3 and 11.6.4, ref.1, 3 insp.
4. Measure web clearance per 11.3.2B, ref. 1, 8 insp.

References

1. MP/0/A/1000/06   **Diesel Engine Crankshaft and Turning Gear, Gear, Crankshaft Bearings, Crankcase Assembly, and Crankcase Covers Special Inspection**

Inspection Results

1. Visual inspection of the crankpin fillets was satisfactory
2. One indication was found on the generator end of rod journal #7 by eddy current testing; otherwise, no relevant indications were found.
3. Fluorescent PT inspection of oil holes showed an indication on #8 main bearing which was made up of a line of small pores a 1/4" long.
4. Hot inspections of web clearance were satisfactory, a cold inspection will be done later.

Disposition of Inspection Findings

2. The indication demonstrated by eddy current testing were ground out in .005 inch increments with metallographic replicas taken at each stage. The eddy current indication disappeared after polishing about .020" from the crankpin fillet.
3. The indication was polished out in less than .005" of depth.

Catawba Diesel 1A Inspection Report

Part Name: Crankcase Assembly Class: A

Part Number: 02-311A Work Request No. 0774 MNT

No. of Separate Inspections: 18

Attributes Verified and Sample Size

1. Visual inspect area between machined bolt hole surfaces and cast surfaces for smooth radii per 11.7.1, ref. 1, 18 insp.

References

1. MP/0/A/1000/06 Diesel Engine Crankshaft and Turning Gear, Gear, Crankshaft Bearings, Crankcase Assembly and Crankcase Covers Special Inspection

Inspection Results

1. Results of the visual inspection of the crankcase assembly machined surface were satisfactory.

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 1A Inspection Report

Part Name: Crankcase Covers Gaskets and Bolting   Class: C

Part No.: 02-386B   Work Request No.: 0774 MNT

No. of Separate Inspections: 16

Attributes Verified and Sample Size

1. Visual inspect crankcase covers per 11.7.2, ref 1, 16 insp.

References

1. MP/0/A/1000/06   Diesel Engine Crankcase and Turning Gear, Gear Crankshaft Bearings, Crankcase Assembly and Crankcase Covers Special Inspection

Inspection Results

1. The results of the visual inspection of the crankcase cover bolt holes were satisfactory

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 1A Inspection Report

Part Name: Main Bearing Cap Studs and Nuts Class:A

Part No.: 02-305C Work Request No.0774 MNT

No. of Separate Inspections: 57

Attributes Verified and Sample Size

1. Measure breakaway hydraulic pressure per 11.2.7, ref. 2, 42 insp.
2. Visual inspect main bearing nuts for forging laps 11.8.1, ref. 1, 12 insp.
3. Measure length one stud M.B. 5 per 11.8.2, ref. 1, 1 insp.
4. Measure height of cap where stud passes through per 11.8.2, ref. 1, 2 insp.

References

1.	MP/0/A/1000/06	Diesel Engine Cranksha.., and Turning Gear, Gear, Crankshaft Bearings, Crankshaft Assembly and Crankcase Covers Special Inspection
2.	MP/0/A/1000/03	Diesel Engine Main Bearing Disassembly for Special Inspection and Reassembly

Inspection Results

1. Breakaway hydraulic pressure was within normal limits.
2. Visual inspection of the nuts was acceptable.

3&4 Stud length and cap height measurements are satifactory.

Disposition of Inspection Findings

There have been no significant findings

Catawba Diesel 1A Inspection Report

Part Name: Crankshaft Pump Drive Gear Class: A

Part Number: 02-355A Work Request No. 0778MNT

No. of Separate Inspections: 4

Attributes Verified and Sample Size

1. Visual inspect crankshaft gear per 11.2.2 ref.1 1 insp.
2. Visual inspect pump drive gear per 11.2.4 ref. 1 1 insp.
3. Material comparitor inspect pump drive gear per 11.11.1, ref. 2, 1 insp.
4. Hardness test pump drive gear per 11.11.2, ref. 2, 1 insp.

References

1. MP/0/A/1000/07 Diesel Engine Idler Gears and Pump Drive Gears Inspections and Adjustments
2. MP/0/A/1000/06 Diesel Engine Crankshaft and Turning Gear, Gear, Crankcase Bearings, Crankcase Assembly and Crankcase Covers, Special Inspection

Inspection Results

1. The crankshaft gear was visually inspected and found to be in satisfactory condition.
2. The pump drive gear was visually inspected and found to be in satisfactory condition.
3. The material comparitor exam showed the pump drive gear to be of a different material than the sample supplied by the Owners Group.
4. The hardness of the pump drive gear was BHN 284.

Disposition of Inspection Findings

3. Although the material of the pump drive gear was different from the standard supplied by the Owners Group, the gear has performed satisfactorily under service and is considered acceptable.

4 No hardness was specified for this component. However, the part has performed well in service and is considered acceptable.

Catawba Diesel 1A Inspection Report

Part Name: Idler Gear Assembly   Class: A

Part Number: 02-355B   Work Request No. 0778MNT

No. of Separate Inspections: 7

Attributes Verified and Sample Size

1. Visual inspect idler gears per 11.2.3, ref. 1, 2 insp.
2. Measure superficial hardness of idler gears per 11.2.5, ref. 1, 6 insp.
3. Perform material comparitor test on idler gears per 11.2.6, ref. 1, 2 insp.
4. Measure backlash of assembly per 11.3, ref. 1, 7 insp.

References

1. MP/0/A/1000/07 Diesel Engine Idler Gears and Pump Drive Gears Inspections and Adjustments

Inspection Results

1. The left and right idler gears were found to be in satisfactory condition.
2. The hardness of the ge[illegible] was found to be BHN 320 - 360
3. Material comparitor exam results were satisfactory.
4. The backlash was found to range from .004" to .014".

Disposition of Inspection Results

2. The specified hardness for the idler gears is BHN 380 - 405. The test result is considered acceptable within the limits of accuracy of the testing device.

All other results showed no significant findings

Catawba Diesel 1A Inspection Report

Part Name: Front Gear Case Bolting Class: C

Part Number: 02-335B Work Request No. 0778MNT

No. of Separate Inspections: 2

Attributes Verified and Sample Size

1. Examine periphery for oil leakage per 11.1, ref. 1, 1 insp.
2. Visual inspect gear case capscrews per 11.2, ref. 1, 1 insp.

References

1. MP/0/A/1000/8 Diesel Engine Gear Case Gaskets and Bolting Special Inspection

Inspection Results

1. **No significant gear case cover leakage was found on visual inspection.**
2. **All gear case cover capscrews were found to be satisfactory.**

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 1A Inspection Report

Part Name: Gear Case Covers/Gaskets and Bolting Class: C

Part No.: 02-395B Work Request No.: 0778MNT

No. of Separate Inspections: 2

Attributes Verified and Sample Size

1. Visual inspect for oil leakage per 11.1, ref. 1, 1 insp.
2. Visual inspect capscrews per 11.2, ref. 1, 1 insp.

References

1. MP/0/A/1000/08 Diesel Engine Gear Case Gaskets and Bolting Special Inspection

Inspection Results

1. No significant leakage around the gear case covers was found on visual inspection.
2. All gear case cover capscrews were found to be satisfactory.

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 1A Inspection Report

Part Name: Fuel Pump Control Shaft Class: A

Part No.: 02-371A Work Request No.: 0842 MNT

No. of Separate Inspections: 4

Attributes Verified and Sample Size

1. Measure superficial hardness both shafts per 11.2.2, ref. 1, 2 insp.
2. Perform material comparitor test per 11.2.3, ref. 1, 2 insp.

References

1. MP/0/A/1000/09 Diesel Engine Fuel Pump and Linkage - Special Inspection

Inspection Results

1. Hardness test results ranged from BHN 216 to 229.
2. Material comparitor examination results were satisfactory.

Disposition of Inspection Findings

1. The measured hardness corresponds to a tensile strength of about 105 ksi. There were no specific acceptance standards available, however this strength is considered acceptable for the 4140 steel used.

Catawba Diesel 1A Inspection Report

Part Name: Fuel Pump Linkage, Bearings and Shaft   Class: A

Part No.: 02-371B   Work Request No.: 0842 MNT

No. of Separate Inspections: 3

Attributes Verified and Sample Size

1. Visual inspect fuel pump linkage per 11.3.2, ref. 1, 2 insp.
2. Check site documentation to ensure adequate lubrication per 11.3.3, ref 1, 1 insp.

References

1. MP/0/A/1000/09   Diesel Engine Fuel Pump and Linkage - Special Inspection

Inspection Results

1. Visual inspection of fuel pump linkage was satisfactory.
2. An adequate lubrication schedule was found to be established.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Fuel Injection Pump Class: B

Part No.: 02-365A Work Request No.: 0842 MNT

No. of Separate Inspections: 32

Attributes Verified and Sample Size

1. Measure superficial hardness of each fuel pump valve holder per 11.4.2, ref. 1, 16 insp.
2. Perform UT inspection each fuel pump valve holder per 11.4.3, ref. 1, 16 insp.

References

1. MP/0/A/1000/09 Diesel Engine Fuel Pump and Linkage Special Inspection

Inspection Results

1. Hardness test results ranged from Rockwell C 29 - 32.5.
2. Ultrasonic testing of the fuel pump valve holders was satisfactory

Disposition of Inspection Findings

There were no significant findings. The hardness results agree with those identified in the B&W failure analysis report (dated March 1, 1984) for typical "fatigue proof" medium-carbon free-machining steel of which the valve holders are made. Therefore, they are considered acceptable.

Catawba Diesel 1A Inspection Report

Part Name: Fuel Oil Filter Mounting Hardware Class: A

Part No.: 02-455C Work Request No.: 0842 MNT

No. of Separate Inspections: 2

Attributes Verified and Sample Size

1. Visual inspect mounting hardware per 11.4, ref. 1, 1 insp.

2. Measure or verify torque of bolt holding filter to side of engine per 11.5.1. ref. 2. 1 insp.

References

1.	MP/0/A/1000/27	Diesel Engine Fuel Piping System Special Inspection
2	MP/0/A/1000/09	Diesel Engine Fuel Pump and Linkage Special Inspection

Inspection Results

1. This inspection will be performed when the engine is reassembled.

2. The fuel oil filter mounting bolt torque was verified as correct.

Disposition of Inspection Findings

There are no significant findings to date

Catawba Diesel 1A Inspection Report

Part Name: Lube Oil Internal Headers Class: A

Part No.: 02-307A Work Request No.: 0832 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect headers per 11.3, ref. 1, 1 insp.

References

1. MP/0/A/1000/10 Diesel Engine Lube Oil System Piping and Sump Special Inspection

Inspection Results

1. Visual examination of the lube oil internal headers showed some minor disagreement with the owners group isometric drawings.

Disposition of Inspection Findings

1. Plant-specific drawings were obtained and the walkdown was repeated. The results of this second walkdown were satisfactory pending Stone and Webster review.

Catawba Diesel 1A Inspection Report

Part Name: Lube Oil Tubing and Fittings   Class: A

Part No.: 02-307B   Work Request No.: 0832 MNT

No. of Separate Inspections: 2

Attributes Verified and Sample Size

1. Visual inspect internal lube oil system piping, tubing and fittings per 11.3, ref. 1, 1 insp.

2. Visual inspect external lube oil system piping, tubing and fittings per 11.4.1, ref.1, 1 insp.

References

1. MP/0/A/1000/10   Diesel Engine Lube Oil System Piping and Supports Special Inspection

Inspection Results

1&2 The visual examination of the internal and external lube oil tubing and fittings was satisfactory

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 1A Inspection Report

Part Name: Lube Oil Line Supports Class: B

Part No.: 02-307D Work Request No.: 0832 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect supports per 11.3, ref. 1, 1 insp.

References

1. MP/0/A/1000/10 Diesel Engine Lube Oil System Piping and Sump Special Inspection

Inspection Results

1. Visual inspection of the lube oil line supports demonstrated two supports that were loose. Otherwise, the examination was within normal limits.

Disposition of Inspection Findings

1. The loose supports will be retorqued using torque wrenches to prevent reoccurrence.

Catawba Diesel 1A Inspection Report

Part Name: External Lube Oil Lines Class: A

Part No.: 02-465A Work Request No.: 0832 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect lube oil lines per 11.4, ref. 1, 1 insp.

References

1. MP/0/A/1000/10 Diesel Engine Lube Oil System Piping and Sump Special Inspection

Inspection Results

1. Visual examination of the external lube oil lines was satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: External Lube Oil Supports Class: A

Part No.: 02-465B Work Request No.: 0832 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect supports per 11.4, ref. 1, 1 insp.

References

1. MP/0/A/1000/10 Diesel Engine Lube Oil System Piping and Sump Special Inspection

Inspection Results

1. Visual examination of the external lube oil supports was satisfactory with the exception of the triple header clamp bolts on cylinders 8R and 1R. Some of these bolts were found broken off.

Disposition of Inspection Findings

1. All triple header clamp bolts were replaced with higher quality bolts and retorqued to specifications. Also, the associated pipe lines will be reinspected to verify proper support to prevent excessive vibration.

Catawba Diesel 1A Inspection Report

Part Name: Turbocharger Lube Oil Piping Class: B

Part No.: 02-467A Work Request No.: 0832 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect piping, tubing and fittings per 11.5, ref. 1, 1 insp.

References

1. MP/0/A/1000/10 Diesel Engine Lube Oil Piping and Sump - Special Inspection

Inspection Results

1. The turbocharger lube oil piping will be inspected when the turbocharger is reassembled.

Disposition of Inspection Findings

Catawba Diesel 1A Inspection Report

Part Name: Turbo Lube Oil Piping Supports Class: B

Part No.: 02-467B Work Request No.:0832 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect turbo lube oil piping supports per 11.5, ref. 1, 1 insp.

References

1. MP/0/A/1000/10 Diesel Engine Lube Oil Piping and Sump - Special Inspection

Inspection Results

1. The turbocharger lubc oil piping supports will be inspected when the turbocharger is reassembled.

Disposition of Inspection Findings

Catawba Diesel 1A Inspection Report

Part Name: Lube Oil Sump Tank Class: B

Part No.: 02-540A Work Request No.: 0832 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect lube oil sump per 11.4.2, ref. 1, 1 insp.

References

1. MP/0/A/1000/10 Diesel Engine Lube Oil System Piping and Sump - Special Inspection

Inspection Results

1. Visual inspection of the lube oil sump tank was satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Lube Oil Sump Tank Bolting Class: B

Part No.: 02-540B Work Request No.: 0832 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Verify mounting bolt torque per 11.4.2, ref.1, 1 insp.

References

1. MP/0/A/1000/10 Diesel Engine Lube Oil System Piping and Sump - Special Inspection

Inspection Results

1. The lube oil sump tank mounting bolts were verified from existing documentation as having the correct applied torque.

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 1A Inspection Report

Part Name: Lube Oil Sump Tank Mounting Hardware   Class: B

Part No.: 02-540C   Work Request No.: 0832 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect sump tank supports per 11.4.1, ref. 1, 1 insp.

References

1. MP/0/A/1000/10   Diesel Engine Lube Oil System Piping and Sump - Special Inspection

Inspection Results

1. Visual inspection of the lube oil sump tank mounting hardware was satisfactory.

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 1A Inspection Report

Part Name: Turbo. Thrust Bearing Lube Oil System   Class:C

Part No.: 02-CFR   Work Request No.:0832 MNT

No. of Separate Inspections:1

Attributes Verified and Sample Size

1. Visual inspect turbo. thrust bearing lube oil system per 11.5, ref.1, 1 insp.

References

1. MP/0/A/1000/10 Diesel Engine Lube Oil Piping and Sump Special Inspection

Inspection Results

1. The turbocharger thrust bearing lube oil system will be inspected when the turbocharger is reassembled.

Disposition of Inspection Findings

Catawba Diesel 1A Inspection Report

Part Name: Cylinder Block Class: A

Part Number: 02-315A Work Request No. 0773 MNT

No. of Separate Inspections: 127

Attributes Verified and Sample Size

1. Liquid penetrant inspect cylinder block top per 11.2.1, ref. 1, 16 insp.
2. Eddy current inspect cylinder block holes per 11.2.2, ref. 1, 32 insp.
3. UT inspect cylinders per 11.2.3, ref. 1, 16 insp.
4. Dimensional inspect cylinder liner landing area per 11.6.1, ref. 1, 56 insp.
5. PT inspect cylinder liner landing area per 11.6.2, ref. 1, 7 insp.

References

1. MP/0/A/1000/11 Diesel Engine Cylinder Block, Cylinder Liner and Jacket Water Manifold and Piping Special Inspections

Inspection Results

1. The PT examination of cylinder block top was satisfactory.
2. Eddy current exam of the cylinder head stud holes showed no indications.
3. Ultrasonic exam was not required due to satisfactory ECT and PT exams.
4. Dimensions of the liner landing areas were taken and will be forwarded to the Owners Group.
5. The PT examination of the liner landing area were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Cylinder Liner Class: A

Part Number: 02-315C Work Request No. 0773 MNT

No. of Separate Inspections: 226

Attributes Verified and Sample Size

1. Visual inspect cylinder liner per 11.3.1, ref. 1, 16 insp.
2. Measure bore per 11.3.2, ref. 1, 120 insp.
3. Perform Materials Comparator Test per 11.3.3, ref. 1, 6 insp.
4. Perform hardness test per 11.3.3, ref. 1, 6 insp.
5. Measure dist. cylinders protrude above block per 11.3.4, ref. 1, 64 insp.
6. Supplement visual inspect liner per 11.6.3, ref. 1, 7 insp.
7. Dimensional insp. cylinder liner per 11.6.4, ref. 1, 7 insp.

References

1. MP/0/A/1000/11 Diesel Engine Cylinder Block, Cylinder Liner and Jacket Water Manifold and Piping Special Inspection

Inspection Results

1. All cylinders have ring scuffing and scratching. Seven cylinders showed polish lines.
2. Twenty eight of 120 measurements of cylinder liner bore were not to specification. The dimensions ranged from 16.994" to 17.009".
3. Material comparitor tests showed discrepancies with the Owners Group standard.
4. Hardness test results ranged from BHN 241 to 275. The specified hardness is BHN 277-311.
5. Twenty one of 64 measurements of liner protrusion were not to specifications. The protrusions ranged from .003" to .009".
6. The supplemental visual inspection of cylinder liners were satisfactory.
7. The dimensional inspections yielded the following results: O.D. Lip - 19.494"-19.498", O.D. Seat Surf. - 18.991"-18.998", Height 1.505"-1.506".

Disposition of Inspection Findings

1. The various scratches and marks are the results of normal wear and are not a problem.

2&5. The specifications were for new parts. The small discrepancies are considered normal for parts that has seen service and are acceptable.

3. Although the material of the cylinder liner is not the same as that of the standard supplied by the Owners Group, the liners have performed well in service and are considered acceptable.
4. The hardness is considered acceptable within the limits of accuracy of the measuring device.

Catawba Diesel 1A Inspection Report

Part Name: Cylinder Head Studs Class: B

Part Number: 02-315E Work Request No. 0773MNT

No. of Separate Inspections: 332

Attributes Verified and Sample Size

1. Record breakaway torque cylinder head nuts per 11.2.12, ref. 1, 128 insp.
2. Record breakaway torque cylinder head studs per 11.2.14, ref. 1, 32 insp.
3. Inspect head studs for ID marks per 11.4.1, ref. 2, 32 insp.
4. Visual inspect head studs per 11.4.2, ref. 2, 32 insp.
5. Perform material test comp. per 11.4.3, ref. 2, 4 insp.
6. Perform superficial hardness test per 11.4.3, ref. 2, 4 insp.

References

1. MP/0/A/1000/01 Diesel Engine Cylinder Head Removal and Disassembly
2. MP/0/A/1000/11 Diesel Engine Cylinder Block, Cylinder Liner and Jacket Water Manifold and Piping Special Inspection

Inspection Results

1. The breakaway torque of the cylinder head nuts was measured and found to range from 2780 to 4190 ft-lbs.
2. The breakaway torque of the cylinder head studs was measured and found to range from 1100 to 1930 ft-lbs.
3. The head stud ID numbers were inspected and found satisfactory.
4. Nine studs showed pitted areas, One stud had a nick in the threads.
5. The material comparitor test results were satisfactory.
6. Hardness test results ranged from Rockwell C 29 to 30

Disposition of Inspection Findings

4. The indications described above were determined to have resulted from normal service and to not affect stud integrity; the studs will be reused.

6. The hardness results are within normal limits.

Catawba Diesel 1A Inspection Report

Part Name: Cylinder Block Jacket Water Manifold Nuts   Class: B

Part Number: 02-315F   Work Request No. 0773 MNT

No. of Separate Inspections: 26

Attributes Verified and Sample Size

1. Visual inspect all 5/8" nuts per 11.5.1, ref. 1, 22 insp.
2. Visual inspect 25% water manifold nuts per 11.5.2, ref. 1, 4 insp.

References

1. MP/0/A/1000/11 Diesel Engine Cylinder Block, Cylinder Liner and Jacket Water Manifold and Piping Special Inspection

Inspection Results

1&2. Visual inspections of the jacket water manifold nuts were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Cylinder Block Jacket Water Manifold   Class: A

Part Number: 02-315D   Work Request No. 0773 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect water manifold and piping per 11.5.4, ref. 1, 1 insp.

References

1. MP/0/A/1000/11 Diesel Engine Cylinder Block, Cylinder Liner and Jacket Water Manifold and Piping Special Inspection

Inspection Results

1. The jacket water manifold and piping were inspected and found to be satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Jacket Water Discharge Manifold　　　Class: B

Part Number: 02-317A　　　Work Request No. 0773MNT

No. of Separate Inspections: 2

Attributes Verified and Sample Size

1. Visual inspect jacket water manifold per 11.5.4, ref. 1, 1 insp
2. Visual inspect manifold per 11.5, ref. 2, 1 insp.

References

1. MP/0/A/1000/11 Diesel Engine Cylinder Block, Cylinder Liner and Jacket Water Manifold and Piping Speciel Inspection
2. MP/0/A/1000/25 Diesel Engine Jacket Water System Piping Standpipe and Manifold Special Inspection

Inspection Results

1. Visual inspection of the jacket water manifold was satisfactory.
2. Walkdown inspections of the jacket water manifold were satisfactory.

Disposition of Inspection Findings

There are no significant findings to date.

Catawba Diesel 1A Inspection Report

Part Name: Starting Air Distributor Assembly Class: A

Part No.: 02-442A Work Request No.: 0778 MNT

No. of Separate Inspections: 32

Attributes Verified and Sample Size

1. Visual inspect each spool per 11.7, ref. 1, 16 insp.
2. Measure smallest diameter of each spool per 11.10, ref. 1, 16 insp.
3. Measure superficial hardness of each spool per 11.11, ref. 1, if diameter ratios are not within specifications

References

1. MP/0/A/1000/12 Diesel Engine Starting Air Distributor Disassembly and Special Inspection

Inspection Results

1. Visual inspection of the spools was satisfactory.
2. All spool diameter ratios are within specified limits.
3. Hardness not required since diameter ratios were satisfactory.

Disposition of Inspection Findings

1. There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Jacket Water Pump Class: A

Part No.: 02-425A Work Request No.:0776 MNT

No. of Separate Inspections: 9

Attributes Verified and Sample Size

1. Visual inspect driven gear, coupling and spline per 11.3.1, ref.1, 1 insp.
2. PT coupling and external spline per 11.3.2, ref.1, 1 insp.
3. Visual inspect volute wear ring per 11.4.1, ref.1, 1 insp.
4. Visual inspect and PT inspect shaft per 11.4.2, ref.1, 2 insp.
5. Perform material comparitor test per 11.4.3, ref. 1, 2 insp.
6. Perform superficial hardness test per 11.4.3, ref.1, 2 insp.

References

1. MP/0/A/1000/13 Diesel Engine Jacket Water Pump - Special Inspection

Inspection Results

1. Visual inspection of the driven gear, coupling and external spline was satisfactory.
2. PT examination of the coupling and external spline was satisfactory.
3. Visual inspection of the volute wear ring was satisfactory.
4. Visual inspection of the impeller shaft was satisfactory. PT examinations of the shaft and impeller were satisfactory.
5. Material comparitor exams of the jacket water pump was satisfactory.
6. Hardness of the shaft was found to be BHN 170.

Disposition of Inspection Findings

6. Although no hardness was specified for this component, a minimum hardness for the shaft material was found to be BHN 160. In light of this, the hardness is considered satisfactory.

Catawba Diesel 1A Inspection Report

Part Name: Cylinder Block Cover, Gskts, and Bolts Class: C

Part No.: 02-385B Work Request No.: 0777 MNT

No. of Separate Inspections: 252

Attributes Verified and Sample Size

1. Record breakaway torque per 11.2.2, ref. 1, 242 insp.
2. Inspect gaskets for damage per 11.2.4, ref. 1, 10 insp.

References

1. MP/0/A/1000/14 Diesel Engine Camshaft, Camshaft Gear and Tappet Assembly Special Inspection.

Inspection Results

1. Cam cover bolt breakaway torques ranged from 0 to 86 ft.lbs. Cam gear cover torque ranged from 9 to 42 ft.lbs.
2. Visual inspection of all gaskets showed no signs of leaks or damage.

Disposition of Inspection Findings

1. The cam and cam cover bolting is being replaced with higher strength bolts and will be reinstalled to specifed torque.

Catawba Diesel 1A Inspection Report

Part Name: Camshaft Supports, Bolting and Gear Class: A

Part Number: 02-350C Work Request No. 0777 MNT

No. of Separate Inspections: 6

Attributes Verified and Sample Size

1. Visual inspect left and right camshaft gears per 11.5.4, ref. 1, 2 insp.
2. Perform Material Comparator Test camshaft gear per 11.5.5, ref. 1, 2 insp.
3. Perform hardness test camshaft gear per 11.3.5, ref. 1, 2 insp.

References

1. MP/0/A/1000/14 Diesel Engine Camshaft, Camshaft Gear and Tappet Assembly Special Inspection

Inspection Results

1. Visual inspection of camshaft gears show only a slight amount of pitting in the gear contact surface.
2. The results of the material comparitor test showed material different from the sample supplied by the Owners Group.
3. Hardness of the camshaft gear was found to be BHN 269-339. The specified hardness was BHN 290-320.

Disposition of Inspection Findings

1. The cam and cam gear cover bolting is being replaced with higher strength bolts and will be reinstalled to specified torques.
2. Although the material of the cam gear is different from the sample supplied by the Owners Group, the part has performed well in service and is considered acceptable.
3. The reported hardness is considered acceptable within the limits of accuracy of the testing device.

Catawba Diesel 1A Inspection Report

Part Name: Camshaft Assembly Class: A

Part Number: 02-350A Work Request No. 0777 MNT

No. of Separate Inspections: 50

Attributes Verified and Sample Size

1. Visual inspect camshaft lobes per 11.3, ref. 1, 48 insp.
2. Inspect locking clips both camshafts per 11.4.3, ref. 1, 2 insp.

References

1. MP/0/A/1000/14 Diesel Engine Camshaft, Camshaft Gear and Tappet Assembly Special Inspection

Inspection Results

1. The visual inspection of the camshaft was satisfactory with the exception of two small pits in one lobe, which are not significant.
2. Visual inspection of the locking clips showed the locking clips to be in place.

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 1A Inspection Report

Part Name: Camshaft Bearing Class: A

Part Number: 02-350B Work Request No. 0777 MNT

No. of Separate Inspections: 4

Attributes Verified and Sample Size

1. Visual inspect left and right outboard support bushings per 11.4.2, ref.1, 4 insp.

References

1. MP/0/A/1000/14 Diesel Engine Camshaft, Camshaft Gear and Tappet Assembly Special Inspection

Inspection Results

1. Visual inspection of the outboard support bushings was satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Fuel Tappets Class: A

Part Number: 02-345B Work Request No. 0777 MNT

No. of Separate Inspections: 12

Attributes Verified and Sample Size

1. Visual inspect tappet rollers per 11.4.1, ref. 1, 12 insp.

References

1. MP/0/A/1000/14 Diesel Engine Camshaft, Camshaft Gear and Tappet Assembly Special Inspection

Inspection Results

1. Visual inspection of the fuel tappet rollers showed one scratch in the 8L roller, otherwise they were satisfactory.

Disposition of Inspection Findings

1. The scratch was evaluated as being the result of normal service and the tappet roller was evaluated as being acceptable.

Catawba Diesel 1A Inspection Report

Part Name: Intake Tappets Class: A

Part Number: 02-345A Work Request No.0777 MNT

No. of Separate Inspections: 12

Attributes Verified and Sample Size

1. Visual inspect tappet rollers per 11.6.1, ref. 1, 12 insp.

References

1. MP/0/A/1000/14 Diesel Engine Camshaft, Camshaft gear and Tappet Assembly Special Inspection

Inspection Results

1. Visual inspection of the intake and exhaust tappet rollers was satisfactory.

Disposition of Inspection Findings

There were no significant indications

Catawba Diesel 1A Inspection Report

Part Name: Intake Manifolds Class: B

Part No.: 02-375 Work Request No.: 0772 MNT

No. of Separate Inspections: 32

Attributes Verified and Sample Size

1. Visual inspect surfaces and bolt holes per 11.2.2, ref. 1, 32 insp.

References

1. MP/0/A/1000/15 Diesel Engine Intake and Exaust Manifolds Special Inspection

Inspection Results

1. Visual inspection of the manifold surfaces and bolt holes was satisfactory.

Disposal of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Exhaust Manifold Bolting   Class: B

Part No.: 02-380B   Work Request No.:0772 MNT

No. of Separate Inspections:6

Attributes Verified and Sample Size

1. Visual inspect capscrews per 11.3.2, ref.1, 3 insp.
2. Measure depth of capscrew hole and flange thickness per 11.3.3, ref.1, 3 insp.

References

1. MP/0/A/1000/15   Diesel Engine Intake and Exaust Manifolds Special Inspection

Inspection Results

1. Visual inspection of the capscrews was satisfactory.
2. The depth of the flanges plus the capscrew holes in the exhaust manifolds were satisfactory.

Disposal of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Exhaust Manifold Class: B

Part No.: 02-380A Work Request No.: 0772 MNT/0921 MNT

No. of Separate Inspections: 17

Attributes Verified and Sample Size

1. Visual inspect exhaust manifold to flange weld per 11.3.4, ref.1, 16 insp.
2. Visual inspect exhaust manifold per 11.3, ref. 2, 1 insp.

References

1. MP/0/A/1000/15 Diesel Engine Intake and Exhaust Manifolds - Special Inspection
2. MP/0/A/1000/28 Diesel Engine Exhaust Manifold - Special Inspection

Inspection Results

1. Visual inspection of the exaust manifold to flange welds was satisfactory.

2. Walkdown inspections of the exhaust manifold were satisfactory.

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 1A Inspection Report

Part Name: Overspeed Trip Drive Coupling   Class: A

Part No.: 02-410C   Work Request No.: 0841MNT

No. of Separate Inspections: 4

Attributes Verified and Sample Size

1. Verify coupling halves are snug against spider per 11.2.7, ref.1, 1 insp.
2. Check both couplings to ensure tapered pin is tight per 11.3.1.1, ref 1, 2 insp.
3. Note condition of elastomer piece per 11.3.1.4, ref. 1, 1 insp.

References

1. MP/0/A/1000/16   Diesel Engine Governor and Overspeed Trip Accessory Drives Disassembly Inspection and Reassembly

Inspection Results

1. The coupling snugness was checked and found to be satisfactory.
2. The tapered pin was found to be satisfactory.
3. The elastomer piece was found to have small indentations.

Disposal of Inspection Findings

3. The indentations in the elastomer piece do not affect the operability of the engine. However, it will be replaced as part of routine annual maintenance.

Catawba Diesel 1A Inspection Report

Part Name: Overspeed Trip and Accessory Drive   Class: A

Part No.: 02-410B   Work Request No.:0841 MNT

No. of Separate Inspections: 36

Attributes Verified and Sample Size

1. Remove drive assembly per 11.2, ref. 1, 13 insp.
2. Disassemble overspeed trip drive per 11.3, ref.1, 3 insp.
3. Visual inspect O.S. trip drive drive shaft for deterioration per 11.3.10.1 ref.1, 1 insp.
4. Perform material comparitor on O.S. trip drive drive shaft per 11.3.10.2, ref. 1, 1 insp.
5. PT inspect O.S. trip drive drive shaft per 11.3.10.3, ref.1, 1 insp.
6. Visual inspect O.S. trip drive drive shaft per 11.3.10.4, ref.1, 1 insp.
7. Perform material comparitor test on O.S. trip drive driven shaft per 11.3.10.5, ref. 1, 1 insp.
8. PT inspect O.S. trip drive driven shaft per 11.3.10.6, ref.1, 1 insp.
9. Visual inspect O.S. trip drive drive gear per 11.3.10.7, ref.1, 1 insp.
10. Perform material comparitor test on O.S. trip drive drive gear per 11.3.10.8, ref.1, 1 insp.
11. Perform hardness test on O.S. trip drive drive gear per 11.3.10.9, ref. 1, 1 insp.
12. Visual inspect O.S. trip drive driven gear per 11.3 10.10, ref.1, 1 insp.
13. Perform material comparitor on O.S. trip drive driven gear per 11.3.10.11, ref. 1, 1 insp.
14. Perform hardness test on O.S. trip drive driven gear per 11.3.10.12, ref.1, 1 insp.
15. Visual inspect O.S. drive antifriction bearings per 11.3.10.13, ref.1, 1 insp.
16. Measure end play of accessory drive drive shaft per 11.4.2, ref. 1, 1 insp.
17. Visual inspect accessory drive shaft per 11.4.5.1, ref. 1, 1 insp.
18. Perform material comparitor test on accessory drive shaft per 11.4.5.2, ref. 1, 1 insp.
19. PT inspect accessory drive shaft per 11.4.5.3, ref. 1, 1 insp.
20. Visual inspect accessory drive gear per 11.4.5.4, ref. 1, 1 insp.
21. Perform material comparitor on accessory drive gear per 11.4.5.5, ref. 1, 1 insp.
22. Perform hardness test on accessory drive gear per 11.4.5.6, ref. 1, 1 insp.

References

1. MP/0/A/1000/16   Diesel Engine Governor and Overspeed Trip Accessory Drive - Disassembly, Inspection, and Reassembly

Inspection Results

1. The drive assembly was removed according to procedure.
2. The overspeed trip drive was disassembled according to procedure.
3. The visual inspection of the OS trip drive shaft was satisfactory.
4. The material comparitor results on the OS trip drive showed material different from the sample supplied by the Owners Group.
5. The PT inspection of the OS trip drive was satisfactory.
6. Visual inspection of the OS trip driven shaft was satifactory.
7. The material comp. results of the OS trip driven shaft showed material different from the sample supplied by the Owners Group.
8. The PT inspections of the OS trip driven shaft were satisfactory.
9. Visual inspections of the OS trip drive gear were satisfactory.
10. Material comp. results of the OS trip drive gear showed material different from the sample supplied by the Owners Group.
11. The hardness of the OS trip drive gear was BHN 252 (UTS about 124 ksi.)
12. Visual inspection of the OS trip driven gear was satisfactory.
13. Material comp. results for the OS trip driven gear showed material different from the sample supplied by the Owners Group.
14 The hardness test result for the OS trip driven gear was BHN 218 (UTS about 106 ksi.)
15. Visual inspection of the OS trip drive antifriction bearings showed a rough spot in the bearing.
16. The end play of the accessory drive shaft was satisfactory.
17. Visual inspection of the accessory drive shaft was satisfactory.
18. Material comp. results for the accessory drive shaft showed material different from the sample supplied by the Owners Group.
19. The PT inspection of the accessory drive shaft was satisfactory.
20. Visual inspection of the accessory drive gear was satifactory.
21. Material comp. inspection results of the accessory drive gear were satisfactory.
22. Hardness of the accessory drive gear was BHN 321.

Disposition of Inspection Findings

4,7,10,13,18 Although these components had material different from the samples supplied by the Owners Group, they have performed well under extended service and are therefore considered acceptable.

11,14,22 No hardness values were specified for these components. However, the parts have performed well in service and are considered acceptable.

15. The damage to the bearing occurred during disassembly. The bearing has been replaced.

Catawba Diesel 1A Inspection Report

Part Name: Governor Heat Exchanger Assembly   Class: A

Part No.: 02-415C   Work Request No.: 0841MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Verify oil cooler is mounted below oil level per 11.5.1, ref.1, 1 insp.

References

1. MP/0/A/1000/16   Diesel Engine Governor and Overspeed Trip Accessory Drives Disassembly Inspection and Reassembly

Inspection Results

1. The location of the oil cooler was inspected and found to be satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Sp ed Regulating Governor Drive Gear/Shaft   Class: A

Part No.: 02-411A   Work Request No.: 0841 MNT

No. of Separate Inspections: 13

Attributes Verified and Sample Size

1. Measure end play of horizontal shaft per 11.6.4, ref. 1, 1 insp.
2. Visual inspect larger horizontal shaft drive gear per 11.6.7.1, ref. 1, 1 insp.
3. Perform material comparitor test on larger horizontal shaft drive gear per 11.6.7.2, ref. 1, 1 insp.
4. Perform hardness test on larger horizontal shaft drive gear per 11.6.7.3, 1 insp.
5. Visual inspect small horizontal shaft drive gear per 11.6.7.4, ref. 1, 1 insp.
6. Perform material comparitor test on small horizontal shaft drive gear per 11.6.7.5, ref.1, 1 insp.
7. Perform hardness test on small horizontal shaft drive gear per 11.6.7.6, ref.1, 1 insp.
8. Visual inspect horizontal shaft per 11.6.7.7, ref.1, 1 insp.
9. Perform material comparitor test on horizontal shaft per 1.6.7.8, ref. 1, 1 insp.
10. PT exam horizontal shaft per 11.6.7.7, ref.1, 1 insp.
11. Visual inspect vertical shaft per 11.6.7.10, ref. 1, 1 insp.
12. Perform material comparitor test on vertical shaft per 11.6.7.11, ref. 1, 1 insp.
13. PT exam vertical shaft per 11.7.7.12, ref. 1, 1 insp.

References

1. MP/O/A/1000/16   Diesel Engine Governor and Overspeed Trip Accessory Drive-Disassembly, Inspection, and Reassembly

Inspection Results

1. The end play of the horizontal shaft was satisfactory.
2. The visual inspection of the large horizontal shaft drive gear was satisfactory.
3. Material comparitor results for the large horizontal shaft drive gear showed material different from the standard supplied by the Owners Group.
4. The hardness of the large horizontal shaft drive gear was BHN 468-472 (UTS if about 240 ksi) vs. an expected hardness of Rockwell A 76-79 (UTS of about 250 to 300 ksi).
5. Visual inspection of the small , horizontal shaft drive gear was satisfactory.

6. Material comp. test results for the small horizontal shaft drive gear were acceptable.
7. The hardness of the small horizontal shaft gear was BHN 457 to 460 (UTS of about 235 ksi) vs. an expected Rockwell A hardness of 76-79 (UTS of about 250-300 ksi).
8. The visual inspection of the horizontal shaft was satisfactory.
9. Material comp. test results for the shaft were satisfactory.
10. PT exam results of the horizontal shaft were satisfactory.
11. Visual inspection of the vertical shaft was satisfactory.
12. Material comp. test results for the vertical shaft were satisfactory.
13. The PT inspection of the vertical shaft was satisfactory.

<u>Disposition of Inspection Findings</u>

3. Although the material is different from the standard supplied by the Owners Group, the component has performed well in service and is considered acceptable.

4&7 The measured hardness is considered acceptable within the limits of accuracy of the measuring device.

Catawba Diesel 1A Inspection Report

Part Name: Speed Regulating Gov. Drive Coupling Class: A

Part No.: 02-411B Work Request No.: 0841MNT

No. of Separate Inspections: 3

Attributes Verified and Sample Size

1. Visual inspect coupling halves, shaft ends and spacers per 11.6.7.13, ref. 1, 2 insp.
2. Visual inspect female drive coupling per 11.6.7.14. ref.1, 1 insp.

References

1. MP/0/A/1000/16 Diesel Engine Governor and Overspeed Trip Accessory Drives Disassembly Inspection and Reassembly.

Inspection Results

1&2 Visual inspections of the governor drive couplings and related hardware were satisfactory.

Disposal of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Fuel Pump Linkage and Shutdown Cylinder Class: B

Part No.: 02-413B Work Request No.: 0841 MNT

No. of Separate Inspections: 2

Attributes Verified and Sample Size

1. Check linkage action per 11.7.1, ref. 1, 1 insp.
2. Visual inspect cross shaft assembly per 11.7.2, ref. 1, 1 insp.

References

1. MP/0/A/1000/16 Diesel Engine Governor and Overspeed Trip Accessory Drives - Disassembly, Inspection, and Reassembly

Inspection Results

1. The linkage action was inspected and found to be satisfactory.
2. The visual inspection of the cross shaft assembly was satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Speed Regulating Gov. Linkage   Class: A

Part No.: 02-413A   Work Request No.: 0841MNT

No. of Separate Inspections: 2

Attributes Verified and Sample Size

1. Check Linkage Action per 11.7.1., ref. 1, 1 insp.
2. Visual inspect cross shaft per 11.7.2., ref. 1, 1 insp.

References

1. MP/0/A/1000/16 — Diesel Engine Governor and Overspeed Trip Accessory Drives Disassembly Inspection and Reassembly

Inspection Results

1. The linkage was inspected and found to be acceptable.
2. The visual inspection of the cross shaft assembly was satisfactory.

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 1A Inspection Report

Part Name: Flywheel Bolting   Class: A

Part Number: 02-330B   Work Request No. 0841MNT

No. of Separate Inspections: 24

Attributes Verified and Sample Size

1. Visual inspect for loose roll pins per 11.2.1, ref. 1, 12 insp.
2. Torque test per 11.2.3, ref. 1, if correct torque was not previously documented, 12 insp.

References

1. MP/0/A/100017 Diesel Engine Flywheel Bolting Special Inspection

Inspection Results

1. Visual inspections of the roll pins were satisfactory.
2. Documented torque values were located in documentation of previous work with the minimum torque being 4500 foot-pounds.

Disposition of Inspection Findings

There were no specific findings

Catawba Diesel 1A Inspection Report

Part Name: Turbocharger Class: A

Part No.: MP/022/3 Work Request No.: 0775 MNT

No. of Separate Inspections: 30

Attributes Verified and Sample Size

1. Visual inspect assembly per 11.2.2, ref. 1, 6 insp.
2. Visual inspect journal bearings per 11.2.3, ref. 1, 4 insp.
3. Measure ID of journal bearings per 11.2.4, ref. 1, 4 insp.
4. Visual inspect turbo exhaust gas inlet bolts per 11.7.1, ref.1, 16 insp.

References

1. MP/0/A/1000/18 Diesel Engine Turbocharger and Intercooler - Special Inspection

Inspection Results

1. The right nozzle of the right bank turbocharger has a chipped spot, otherwise the visual exam is satisfactory.
2. The right journal bearing has a chip in it and the left journal bearing is satisfactory. The thrust bearings are severely worn and damaged.
3. The I.D. of the journals was measured with satisfactory results.
4. The turbocharger exhaust gas inlet bolts were inspected and found satisfactory. However, the bolts are to be replaced with ones of improved material.

Disposition of Inspection Findings

1. The chip on the nozzle was evaluated as not being significant.
2. New bearings will be installed. In addition, a new lubrication system will be installed to prevent recurrence of this problem.

Catawba Diesel 1A Inspection Report

Part Name: Turbocharger Air Butterfly Valve   Class: A

Part No.: 02-475B   Work Request No.: 0775 MNT

No. of Separate Inspections: 14

Attributes Verified and Sample Size

1. Perform disassembly inspection per 11.3, ref. 2, 2 insp.
2. Visual inspect roll pins per 11.3.2, ref. 1, 8 insp.
3. Visual inspect valve shaft per 11.3.3, ref. 1, 2 insp.
4. Check to ensure no cold springing required on reassembly per 11.3.4, ref. 1, 2 insp.

References

1. MP/0/A/1000/18 Diesel Engine Turbocharger and Intercooler - Special Inspection

2. MP/0/A/1000/22 Diesel Engine Air Butterfly Valve Removal Disassembly, Reassembly and Inspection

Inspection Results

1. Disassembly of the butterfly valve was done according to procedure, and revealed no problems
2. Visual inspections of roll pins were satisfactory.
3. Visual inspections of the shafts indicated they were satisfactory.
4. Checks of cold spring indicated that the piping was satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Turbocharger Bracket Class: B

Part No.: 02-475A Work Request No.: 0775 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visually inspect support bracket per 11.4.2, ref.1, 1 insp.

References

1. MP/0/A/1000/18 Diesel Engine Turbocharger and Intercooler - Special Inspection

Inspection Results

1. Visual inspection of turbocharger bracket shows no signs of distress or distortion.

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 1A Inspection Report

Part Name: Turbocharger Bracket Bolting Class: B

Part No.: 02-475D Work Request No.: 0775 MNT

No. of Separate Inspections: 20

Attributes Verified and Sample Size

1. Measure breakaway torque per 11.5.2, ref. 1, 6 insp.
2. Material comparitor test per 11.5.3, ref. 1, 6 insp.
3. Visual inspect bolted joint per 11.5.4, ref. 1, 2 insp.
4. Check torque on reassembly per 11.5.5, ref. 1, 6 insp.

References

1. MP/0/A/1000/18 Diesel Engine Turbocharger and Intercooler - Special Inspection

Inspection Results

1. Breakaway torque of turbocharger bracket bolts ranged from 0 to 250 ft-lbs.
2. Material comparitor test of turbocharger bracket bolts were acceptable.
3. Visual inspection of the bolt joint was satisfactory.
4. The turbo bracket bolts were reinstalled according to procedure.

Disposition of Inspection Findings

1. Several of the bracket bolts were found to have low torques. All of the bolts will be checked and bolts with low torques will be retorqued using a torque wrench and loctite.

Catawba Diesel 1A Inspection Report

Part Name: Intercooler Class: B

Part No.: F-086 Work Request No.: 0775 MNT

No. of Separate Inspections: 8

Attributes Verified and Sample Size

1. Visual inspection of intercooler and inlet and outlet adaptors per 11.6.2, ref. 1, 6 insp.

2. Perform PT or MT exam of each intercooler inlet adaptor flange weld per 11.6.3, ref. 1, 2 insp.

References

1. MP/0/A/1000/18 Diesel Engine Turbocharger and Intercooler - Special Inspection

Inspection Results

1. Visual inspection of the intercooler was satisfactory.
2. MT examination of the weld was satisfactory

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 1A Inspection Report

Part Name: Intercooler Piping Coupling, Bolting/Gasket Class: A

Part No.: 02-436B Work Request No.: 0775 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Check dresser coupling on piping per 11.6.4, ref. 1, 1 insp.

References

1. MP/0/A/1000/18 Diesel Engine Turbocharger and Intercooler - Special Inspection

Inspection Results

1. Dresser coupling found on inspection was a 90 degree elbow straight coupling. This information will be forwarded to the Owners Group.

Disposition of Inspection Findings

1. There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Jacket Water Standpipe Fittings & Gaskets   Class: B

Part No.: 00-700A   Work Request No.: 0920 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect system per 11.3, ref. 1, 1 insp.

References

1. MP/0/A/1000/25   Diesel Engine Jacket Water System, Piping, Standpipe and Manifold - Special Inspection

Inspection Results

1. Results of the visual examination of the jacket water standpipe fittings and gaskets were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Jacket Water Standpipe Supports   Class: B

Part No.: 00-700C   Work Request No.: 0920 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect supports per i1.3, ref. 1, 1 insp.

References

1. MP/0/A/1000/25   Diesel Engine Jacket Water System, Piping, Standpipe and Manifold - Special Inspection

Inspection Results

1. Result cf the visual inspection of the jacket water standpipe supports were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Jacket Water Standpipe Bolting Materials   Class: B

Part No.: 00-700F   Work Request No.: 0920 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect bolting per 11.4, ref. 1, 1 insp.

References

1. MP/0/A/1000/25   Diesel Engine Jacket Water System, Piping, Standpipe and Manifold - Special Inspection

Inspection Results

1. Results of the visual inspection of the jacket water standpipe bolting material were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Jacket Water Manifold Assembly   Class: B

Part No.: 02-316A   Work Request No.:0920 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect assembly per 11.3, ref. 1, 1 insp.

References

1. MP/0/A/1000/25   Diesel Engine Jacket Water System, Piping, Standpipe and Manifold - Special Inspection

Inspection Results

1. Results of the visual inspection of the jacket water manifold assembly were satifactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Jacket Water Inlet Manifold Coupling Class: B

Part No.: 02-316B Work Request No.:0920 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect coupling per 11.4, ref. 1, 1 insp.

References

1. MP/0/A/1000/25 Diesel Engine Jacket Water System, Piping, Standpipe and Manifold - Special Inspection

Inspection Results

1. Results of the visual inspection of the jacket water inlet manifold coupling were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Jacket Water Discharge Manifold Coupling   Class: B

Part No.:   02-317B   Work Request No.:0920 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect coupling per 11.5, ref. 1, 1 insp.

References

1. MP/0/A/1000/25   Diesel Engine Jacket Water System, Piping, Standpipe and Manifold - Special Inspection

Inspection Results

1. Result of the visual inspections of the jacket water discharge manifold couplings were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Jacket Water Discharge Manifold Supports   Class: B

Part No.: 02-317C   Work Request No.: 0920 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect supports per 11.5, ref. 1, 1 insp.

References

1. MP/0/A/1000/25   Diesel Engine Jacket Water System, Piping, Standpipe and Manifold - Special Inspection

Inspection Results

1. Results of the visual inspection of the jacket water discharge manifold supports were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Turbo Cooling Water Pipe and Fittings   Class: B

Part No.: 02-437A   Work Request No.: 0920 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect system per 11.6, ref. 1, 1 insp.

References

1. MP/0/A/1000/25   Diesel Engine Jacket Water System, Piping, Standpipe and Manifold - Special Inspection

Inspection Results

This inspection will be perfo med when the engine is reassembled.

Disposition of Inspection Findings

Catawba Diesel 1A Inspection Report

Part Name: Turbo Cooling Water Pipe Supports   Class: A

Part No.: 02-437B   Work Request No.:0920 MNT

No. of Separate Inspections:1

Attributes Verified and Sample Size

1. Visual inspect supports per 11.6, ref. 1, 1 insp.

References

1. MP/0/A/1000/25   Diesel Engine Jacket Water System Piping Standpipe and Manifold - Special Inspection

Inspection Results

This inspection will be performed when the engine is reassembled.

Disposition of Inspection Findings

Catawba Diesel 1A Inspection Report

Part Name: Start Air Manifold Pipe, Tubing & Fittings Class: A

Part No.: 02-441A Work Request No.:0919 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect system per 11.3, ref. 1, 1 insp.

References

1. MP/0/A/1000/26 Diesel Engine Air Start Piping System - Special Inspection

Inspection Results

1. Results of visual inspections of the start air manifold system showed several minor discrepancies with the drawings.

Disposition of Inspection Findings

1. The minor discrepancies found on inspection have not affected the start air system to date and are not considered a problem.

Catawba Diesel 1A Inspection Report

Part Name: Start Air Manifold Pipe Supports   Class: A

Part No.: 02-441C   Work Request No.: 0919 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect supports per 11.3, ref. 1, 1 insp.

References

1. MP/0/A/1000/26   Diesel Engine Air Start Piping System - Special Inspection

Inspection Results

1. Visual inspection of the start air manifold pipe supports showed several minor discrepancies with the drawings.

Disposition of Inspection Findings

The minor discrepancies revealed by the inspections have not affected the start air system and are not considered a problem.

Catawba Diesel 1A .nspection Report

Part Name: Start Air Distributor Tubing, Ftngs, & Gskts Class: A

Part No.: 02-442B Work Request No.:0919 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect distributor tubing system per 11.4, ref.1, 1 insp.

References

1. MP/0/A/1000/26 Diesel Engine Air Start Piping System - Special Inspection

Inspection Results

1. Visual inspection of the start air distributor tubing, fittings and gaskets showed several minor discrepancies with the drawing.

Disposition of Inspection Findings

1. The minor discrepancies found on inspections have not affected performance of the start air system and are not considered a problem.

Catawba Diesel 1A Inspection Report

Part Name: Fuel Injection Tubing   Class: B

Part No.: 02-365C   Work Request No.:

No. of Separate Inspections: 17

Attributes Verified and Sample Size

1. Visual inspect tubing per 11.3 ref. 1, 1 insp.
2. Eddy current inspect tubing per 11.5 ref. 1, 16 insp.

References

1. MP/0/A/1000/27   Diesel Engine Fuel Oil Piping System-Special Inspection.

Inspection Results

1. This inspection will be performed when the engine is reassembled.
2. This inspection will be performed by Failure Analysis Associates in early July.

Disposition of Inspection Findings

Catawba Diesel 1A Inspection Report

Part Name: Fuel Injection Tubing Supports Class:B

Part No.: 02-365D Work Request No.:

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect tubing supports per 11.3, ref. 1, 1 insp.

References

1. MP/0/A/1000/27 Diesel Engine Fuel Oil Piping System - Special Inspection.

Inspection Results

1. This inspection will be performed when the engine is reassembled.

Disposition of Inspection Findings

Catawba Diesel 1A Inspection Report

Part Name: Fuel Oil Piping and Tubing Class: A

Part No.: 02-45 B Work Request No.:

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect system per 11.3, ref. 1, 1 insp.

References

1. MP/0/A/1000/27 Diesel Engine Fuel Oil Piping System - Special Inspection

Inspection Results

1. This inspection will be performed when the engine is reassembled.

Disposition of Inspection Findings

Catawba Diesel 1A Inspection Report

Part Name: Fuel Oil Piping Supports Class: A

Part No.: 02-450D Work Request No.:

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect supports per 11.3, ref. 1, 1 insp.

References

1. MP/0/A/1000/27 Diesel Engine Fuel Oil Piping System - Special Inspection

Inspection Results

1. This inspection will be performed when the engine is reassembled.

Disposition of Inspection Findings

Catawba Diesel 1A Inspection Report

Part Name: Control Panel Piping, Tubing, and Fittings   Class: B

Part No.: 02-500M   Work Request No.: 0922 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect tubing and fittings per 11.4, ref. 1, 1 insp.

References

1. MP/O/A/1000/29   Diesel Engine Shutdown Tubing and Electrical Conduit - Special Inspection.

Inspection Results

1. Visual inspection of the control panel piping, tubing, and fittings were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Engine and Auxiliary Module Wiring Conduit Class: A

Part No.: 02-688A Work Request No.: 0922 MNT

No. of Separate Inspections: 1

Attributes Verified and Sample Size

1. Visual inspect conduit per 11.5, ref.1, 1 insp.

References

1. MP/0/A/1000/29 Diesel Engine Shutdown Tubing and Electrical Conduit Special Inspection

Inspection Results

1. Visual inspection of the Electrical Conduit was satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 1A Inspection Report

Part Name: Engine Shutdown Tubing and Fittings Class: B

Part No.: 02-695A Work Request No.: 0922 MNT

No. of Separate Inspections: 2

Attributes Verified and Sample Size

1. Visual inspect engine mounted tubing per 11.3, ref.1, 1 insp.
2. Visual inspect panel mounted tubing per 11.4, ref. 1, 1 insp.

References

1. MP/0/A/1000/29 Diesel Engine Shutdown Tubing and Electrical Conduit Special Inspection

Inspection Results

1. The engine mounted tubing will be reinspected after reassembly.
2. Visual inspection of the panel mounted tubing was satisfactory.

Disposition of Inspection Findings

There have been no significant findings to date.

APPENDIX B

ENGINEERING VALIDATION REPORT

SELECTED CATAWBA 1A DIESEL PARTS

TABLE OF CONTENTS

Tables

B1.0 Introduction

The purpose of this report is to document the results of the engineering validation performed for selected parts of the Catawba 1A Diesel. The parts were selected for this review if their quality was not being verified by detailed inspections. This validation was performed for the parts listed in Table B2-1; Information for the validation was obtained by visual observation of the parts, review of test results, review of maintenance records, and discussions with operating and maintenance personnel regarding performance of the parts. An engineering evaluation was then performed of this information to assess the condition and quality of the parts.

The detailed results of this review are presented in Section B3.0.

B2.0 Identification of Parts

The parts covered by this review are listed in Table B2-1. Parts were listed in Table B2-1 if they met the following criteria:

* The parts are identified as category A or B per reference 1 (or approved modifications); and

* The quality of the parts is not being verified as part of detailed inspections (e.g., per Catawba Special Inspection Procedures MP/0/A/1000/01 through 18); and

* The quality of the parts is not being verified as part of piping installation checks covered by Catawba Special Inspection Procedures MP/0/A/1000/25 through 29).

In essence, the parts listed in Table B2-1 are intended to cover items important to operability of the diesels but which have not been covered by detailed inspections because no specific need for inspection was developed owing to failure history or general diesel experience.

TABLE B2-1

List of Parts Covered by Engineering Validation Review

Part No.	Part Name	Class
00-420	LUBE OIL PRESSURE REGUALTING VALVE	A
00-700B	JACKET WATER STANDPIPE VALVES	B
00-700E	JACKET WATER STANDPIPE SWITCHES	B
02-311D	CRANKCASE MOUNTING HARDWARE	B
02-315B	CAM BEARING CAPS AND DOWELS	B
02-315E	CYLINDER BLOCK STRUCTURAL BOLTS	B
02-315G	CYLINDER BLOCK SEALS AND GASKETS	B
02-330A	FLYWHEEL	A
02-345C	FUEL PUMP BASE	B
02-360C	CYLINDER HEAD BOLTING AND GASKETS	B
02-365A	FUEL INJECTION PUMP	B
02-365B	FUEL INJECTION TIPS	B
02-410A	GOVERNOR - OVERSPEED TRIP	A
02-410D	OVERSPEED TRIP VENT VALVES	A
02-415A	SPEED REGULATING GOVERNOR	A
02-415B	GOVERNOR BOOSTER SERVOMOTOR	B
02-420	LUBE OIL PUMP	A
02-441B	START AIR MANIFOLD VALVES, STRAINERS, FILTERS	A
02-445	FUEL OIL BOOSTER PUMP	A
02-455A	FUEL OIL FILTERS	B
02-455B	FUEL OIL STRAINERS	B
02-465C	EXTERNAL LUBE OIL VALVES	A
02-500A	CONTROL PANEL CABINET	A
02-500F	CONTROL AIR ACCUMULATOR	A
02-500G	CONTROL AIR SYSTEM VALVES	A
02-500H	CONTROL AIR SYSTEM PRESSURE SWITCHES	B
02-500J	CONTROL SYSTEM RELAYS	A
02-500K	CONTROL SYSTEM SOLENOID VALVES	A
02-500N	CONTROL PANEL WIRING	A
02-550	FOUNDATION BOLTS AND ANCHORS	B
02-630D	INSTRUMENTATION THERMOCOUPLES	B
02-688B	ENGINE AND AUX MODULE WIRING	A
02-688C	ENGINE AND AUX MODULE WIRING BOXES	A
02-689	OFF ENGINE SAFETY ALARM SENSORS-WIRING	B
02-690	ENGINE ALARM SENSORS	B
02-691A	OFF ENGINE SAFETY ALARM SENSORS-SWITCHES	B
02-695B	ENGINE SHUTDOWN VALVES, REGULATORS, ORIFICES	A
02-695C	ENGINE SHUTDOWN TRIP SWITCHES	A
02-825D	FUEL OIL DUPLEX STRAINER	B

Table B2-1 cont.

C 136/40	THERMOSTATIC VALVE	B
CN-106	INTAKE AIR FILTER	B
CN-107	INTAKE AIR SILENCER	B
CN-109	BEFORE AND AFTER LUBE OIL PUMP	A
CN-110	FUEL FLOW LUBE OIL FILTER	A
CN-111	LUBE OIL HEAT EXCHANGER	B
CN-119A	GENERATOR SHAFT AND BEARINGS	A
CN-120	JACKET WATER HEAT EXCHANGER	B
CN-122	OIL PRELUBE FILTER	A
CN-131	LUBE OIL KEEPWARM STRAINER	A
F-068	INTERCOOLER	B
SE-025	LUBE OIL FULL PRESSURE STRAINER	A

B3.0 Detailed Review of Part Validation

This section contains the results, detailed review and engineering validation of the quality of parts indentified as requiring quality validation per Section 1.0.

It should be noted that the "visual observation" listed in this section was not done using detailed checklists and quantified acceptance criteria. Rather, it was a brief qualitative engineering scan directed at detecting obvious abnormalities.

B3.1 Part No.: 00-420

Part Name: Lube Oil Pressure Regulating Valve

Function: This valve controls lube oil pressure.

Drawings: TDI Drawing 00-420-01, Valve Assembly-Pressure Regulator

Operating History: This valve has performed satisfactorily with no reported problems.

Maintenance History: Valve was disassembled and adjusted prior to initial diesel operation at Catawba per recommendations of TDI representative. No unscheduled maintenance has been required.

Visual Observation: The valve was visually observed by J. Gorman on May 10, 1984 and found to be of the type shown on TDI drawing 00-420-01. No abnormal conditions were noted.

Conclusions: Pressure regulating valve 00-420 is considered to be satisfactory as demonstrated by satisfactory performance for extended periods of operation.

B3.2 Part No.: 0G-700B

Part Name: Jacket Water Standpipe Valves

Function: These valves serve to isolate the jacket water standpipe when needed.

Drawings: TDI drawing 100546, Jacket Water Piping Schematic

Operating History: These valves have performed satisfactorily with no reported problems.

Maintenance History: No maintenance has been performed on these valves.

Visual Observation: The valve installations were observed on May 10, 1984 by J. Gorman and appeared to be normal.

Conclusions: The valves are considered to be satisfactory as demonstrated by the absence of any reported problems and the satisfactory operating history of the jacket water system for extended periods of operation.

B3.3 Part No.: 00-700E

Part Name: Jacket Water Standpipe Switches

Function: The jacket water standpipe is a pressure switch which indicates a low level of water in the jacket water standpipe.

Drawings: TDI drawing No. 09-691-75017

Operating History: Tubing to the switch has clogged several times due to precipitation of chromates. The tubing is not considered part of the jacket water standpipe switch, and was supplied by Duke Power Company. Periodic inspection and maintenance has corrected this situation.

Visual Observations: Since no problems with the switch itself have been reported, observation of this device is not considered appropriate.

Conclusions: The jacket water standpipe switch, Part No. 00-700E, is considered to be satisfactory for its intended service by the absence of any reported problems with the switch and its satisfactory performance for extended periods of operation.

B3.4 Part No.: 02-311D

Part Name: Crankcase Mounting Hardware

Function: This hardware consists of the main crankcase studs, nuts and washers (parts 19, 20, 21, 22, 23, and 29 on TDI drawing 02-311-03) and capscrews (part 18 on TDI drawing 02-311-03). The main studs serve to hold the crankcase to the base, while the capscrews serve to clamp the crankcase seal.

Drawings: TDI drawing 02-0311-03 , Crankcase Assembly

Operating History: This hardware has performed satisfactorily without adjustment since initial delivery from TDI.

Maintenance History: No maintenance has been performed on this hardware. No adjustment has been required since initial delivery from TDI.

Visual Observation: The hardware was visually observed on May 2, 1984 by J. Gorman, and was found to all be properly in place and of the type shown on the drawing.

Conclusion: The crankcase mounting hardware is considered to be satisfactory as demonstrated by satisfactory performance for extended periods of operation.

B3.5 Part No.: 02-315B

Part Name: Cam Bearing Caps and Dowels

Function: This hardware consists of the bearing assemblies used to position the camshafts in the crankcase assembly.

Drawings: TDI Drawing 02-311-03, Crankcase Assembly

Operating History: This hardware has performed satisfactorily since initial delivery as evidenced by inspection of the camshafts after 810 hours of operation. Camshafts showed no wear of cam lobes, hence cam bearings are fullfilling their function.

Maintenance History: No maintenance has been performed or required on this hardware.

Visual Observation: Due to camshaft inspection results, no visual observation of the cam bearings is required.

Conclusions: The cam bearing caps and dowels are considered to be satisfactory as demonstrated by satisfactory performance for extended periods of operation.

B3.6 Part No.: 02-315E, 02-315G

Part Name: Cylinder Block Seals, Gaskets and Structural Bolts

Function: The cylinder block seals and gaskets provide:

1. An oil seal between the cylinder block and crankcase (part 8 of TDI drawing 02-315-04)
2. A water seal between the cylinder block and cylinder liner (part 6 of TDI drawing 02-315-5001); and
3. A seal between the cylinder block and water manifold (part 14 of TDI drawing 02-315-5001).
4. The bolts serve as structural bolting holding the cylinder block to the crankcase. (Part 10 of TDI dwawing 02-315-04)

Drawings: TDI drawings 02-315-04, Cylinder Block Assembly, and 02-315-5001, Cylinder Block and Liner Assembly.

Operating History: The cylinder block to crankcase bolts and oil seal have performed satisfactorily without any evidence of oil leakage. The water seals are hydrostatically tested after each reassembly to ensure that there is no water leakage. All o-rings and gaskets are replaced each time the joint is disassembled.

Maintenance History: No corrective maintenance has been performed on any of the joints. The cylinder block to crankcase oil seal and bolts have not been disturbed since shipment in the assembled condition from TDI. As stated above the o-rings and gaskets are replaced each time a water joint is disassembled.

Visual Observation: These parts are inaccessable for visual observation.

Conclusions: The cylinder block bolts, seals and gaskets are considered to be satisfactory as demonstrated by satisfactory performance for extended periods of operation.

B3.7 <u>Part No.</u>: 02-330A

<u>Part Name</u>: Flywheel

<u>Function</u>: The flywheel provides rotating momentum for smooth operation of the diesel engine.

<u>Drawings</u>: TDI drawing 101505, Flywheel Assembly

<u>Operating History</u>: The flywheel has performed satisfactorily during engine operation.

<u>Maintenance History</u>: No maintenance has been performed on this part.

<u>Visual Observation</u>: The flywheel was visually observed on May 10, 1984 by J. Gorman and appeared to be normal.

<u>Conclusion</u>: The flywheel is considered to be satisfactory as demonstrated by satisfactory performance for extended periods of operation.

B3.8 Part No.: 02-345C

Part Name: Fuel Pump Base Assembly

Function: This assembly provides a base to which the fuel injection pump is attached.

Drawings: TDI drawings 02-345-05, Tappets and Guides; and 02-345-3443, Base Assembly-Fuel Pump.

Operating History: The fuel pump base assemblies have performed satisfactorily as evidenced by the satisfactory operation of the fuel injection pumps during engine operation. No problems have been reported for this part.

Maintenance History: No maintenance has been performed on the fuel pump base assemblies. The assemblies have not been disturbed since initial delivery from TDI.

Visual Observation: A sample of bases was visually observed on May 10, 1984 by J. Gorman and appeared to be normal.

Conclusions: The fuel pump base assemblies are considered to be satisfactory as demonstrated by satisfactory performance of the fuel injection pumps for extended periods of operation.

B3.9 Part No.: 02-360C

Part Name: Cylinder Head Bolting

Function: This bolting attaches the subcover assemblies to the cylinder heads.

Drawings: TDI drawing 02-362-04, Covers Assembly-Cylinder Head

Operating History: The cylinder head bolting has performed satisfactorily as evidenced by the satisfactory functioning of the intake valves, exhaust valves, and rocker arms that attach to the subcover assemblies.

Maintenance History: No maintenance has been performed on the cylinder head bolting. No cylinder head bolting has been replaced.

Visual Observation: A sample of this bolting was visually observed on May 11, 1984, by J. Gorman and appeared normal.

Conclusion: The cylinder head bolting is considered to be satisfactory as demonstrated by satisfactory performance for extended periods of operation.

B3.10 Part No.: 02-365A

Part Name: Fuel Injection Pump

Function: The fuel injection pump increases fuel oil pressure to inject it into the cylinder. It is operated by tappet motion induced by camshaft rotation.

Drawings: TDI drawing 02-365-01, Fuel Injection Equipment

Operating History: The valve holder of one fuel injection pump cracked. Consequently, the valve holder of each pump was ultrasonically inspected and tested for hardness as part of the inspection program. Otherwise, the fuel injection pumps have operated satisfactorily with no other problems reported.

Maintenance History: The only maintenance performed on the fuel injection pumps has consisted of:

1. Replacement of the pump with the cracked valve holder as identified above, and
2. disassembly of all 16 pumps prior to engine operation to ensure that the pumps were free from gummy fuel oil residues after long periods (well over one year) of inoperation.

Visual Observations: Several pumps were visually observed on May 10, 1984 by J. Gorman and appeared to be normal.

Conclusions: The fuel injection pumps are considered to be satisfactory as demonstrated by satisfactory performance for extended periods of operation.

B3.11 Part No.: 02-365B

Part Name: Fuel Injection Tips

Function: The fuel injection tips spray high pressure fuel oil into the cylinders.

Drawings: TDI drawing 02-365-01, Fuel Injection Equipment

Operating History: These tips have performed satisfactorily with no problems.

Maintenance History: The tips have been periodically removed for routine cleaning.

Visual Observation: One tip was visually observed on May 10, 1984 by J. Gorman and appeared normal.

Conclusion: The tips are considered to be satisfactory as demonstrated by satisfactory performance for extended periods of operation.

B3.12 Part No.: 02-410A

Part Name: Governor - Overspeed Trip

Function: The overspeed trip governor senses engine speed (revolutions) by direct mechanical coupling to the drive train of the engine. When the engine speed exceeds the setting on the device, the centrifugal force of the internal flyweights actuate a lever which causes a vent valve to open in the control air system, and shutdown the engine via the auto shutdown cylinder.

Drawings: Woodward Bulletin No. 04026A

Operating History: The overspeed trip governor has demonstrated satisfactory performance since initial adjustments were made during startup. No further adjustments have been required.

Maintenance History: No maintenance has been performed or been required on the overspeed trip governor since initial adjustments were made during startup.

Visual Observations: The overspeed trip governor has been completely removed from the engine for the inspection of the drive mechanism as required by Special Inspection Procedure No. MP/0/A/1000/16. No abnormal conditions have been reported.

Conclusions: The overspeed trip governor is considered to be satisfactory as demonstrated by its satisfactory performance during extended periods of operation.

B3.13 Part No.: 02-410D

Part Name: Overspeed Trip Vent Valves

Function: Upon actuation by the governor overspeed trip mechanism (Woodward Governor), the overspeed trip vent valves vent the control air thus causing actuation of the fuel shutdown cylinder, tripping the engine.

Drawings: Amot Controls Corp. Form 675, Rev. 1, Model 4095B Vent valve.

Operating History: This vent valve has performed satisfactorily with no reported problems.

Maintenance History: No maintenance has been performed on these vent valves.

Visual Observation: No visual observation of these valves have been made.

Conclusion: The overspeed trip vent valves are considered to be satisfactory for intended service as demonstrated by satisfactory performance for extended periods of operation.

B3.14 Part No.: 02-415A

Part Name: Speed Regulating Governor

Function: The speed regulating governor controls the engine speed by regulating the fuel supply based on load demand on the generator (via an electrohydraulic actuator) and current engine speed (via direct mechanical coupling to the drive train and internal flyweights).

Drawings: Woodward Bulletin No. 25004H

Operating History: Over all, the speed regulating governor has performed satisfactorily. An adjustment to set droop at 5 % was made by the Woodward factory service representative during the extended run test (2-21-84). No other adjustments have been required since startup.

Maintenance History: No maintenance has been performed on the speed regulating governor other than the factory representative adjustment described above.

Visual Observation: The speed regulating governor has been disassembled to the extent necessary to perform the inspection on the drives as required by Special Inspection Procedure MP/0/A/1000/16. No abnormalities have been reported.

Conclusions: The speed regulating governor is considered to be satisfactory as demonstrated by its satisfactory performance for extended operating periods.

B3.15 Part No.: 02-415B

Part Name: Governor Booster Servomotor

Function: The governor booster servomotor aids in starting the engine by using starting air to increase governor oil pressure which in turn results in the govenor engine going to the full fuel on position.

Drawings: Woodward Service Bulletin 36684 B and TDI dwg. 101414

Operating History: This servomotor has performed satisfactorily with no reported problems.

Maintenance History: No maintenance has been performed on this part.

Visual Observation: No visual observations have been accomplished.

Conclusion: The governor booster servomotor is considered to be satisfactory for its intended service as demonstrated by satisfactory performance for extended periods of operation.

B3.16 Part No.: 02-420

Part Name: Lube Oil Pump

Function: This pump is a diesel engine attached pump that supplies engine lube oil during engine operation.

Drawings: TDI drawings 02-420-2674, Pump Assembly-Lube Oil, and Figure titled "Model 35K-437 IMO Lube Oil Pump" in Volume III of the TDI diesel manual.

Operating History: The lube oil pump has performed satisfactorily as evidenced by the satisfactory operation of the lube oil system. No engine bearings show degradation resulting from a lack of lube oil during diesel operation.

Maintenance History: No maintenance has been performed on the lube oil pump.

Visual Observation: The lube oil pump was observed on May 10, 1984 by J. Gorman and appeared normal.

Conclusion: The lube oil pump is considered to be satisfactory as demonstrated by satisfactory performance for extended periods of operation.

B3.17 Part No.: 02-441B

Part Name: Starting Air Manifold Valves, Strainers and Filters

Function: Starting air is used to turn the engine during startup. The starting air system is comprised of the starting air manifolds, manifold valves, strainers and filters, starting air distributors, piping from the distributors to the air start valves and the air starting valves. Inspections for various parts of the starting air system are as follows: Starting Air Manifold and Distributor Piping (Procedure MP 0/A/1000/26); Air Starting Valves (Procedure MP 0/A/1000/04); and Starting Air Distributor (Procedure MP 0/A/1000/12). Hence, this engineering validation is limited to the manifold valves, strainer, and fillets.

Drawings: TDI drawing 101815, Starting Air Manifold (Valves and Strainers), and TDI drawing 51825, Tubing Arrangement Starting Air Distributor (Filter).

Operating History: The starting air manifold valves, strainers and filters have performed satisfactorily with no problems.

Maintenance History: No maintenance other than periodic cleaning as part of routine maintenance procedures have been performed on these items.

Visual Observation: The components listed on the attachment were observed by R. Reyns on May 23, 1984 with the results indicated on the attachment.

Conclusion: The starting air manifold valves, strainers, and filters are considered to be satisfactory as demonstrated by extended periods of satisfactory operation.

Attachment to B3.17

Manufacturer Part No.	Description	Qty.	Visual Observations
KE-800-000	Check Valve-3"	4	Valves were observed to be of the type shown on the reference Drawing. No abnormal conditions were noted other than the absence of factory "Blue" paint.
SE-007-001	Strainer	4	Strainers were observed to be of the type shown on the reference drawing. No abnormal conditions were noted.
KB-002-000	Valve, Air Start	4	Valves were observed to be of the type shown on the reference drawing. No abnormal conditions were noted.
SB-006-000	Filter (Air Supply Line to Distributor)	2	Filters were observed to be of the type shown on the reference drawing. No abnormal conditions were noted. It was noted that some pipe fittings had been replaced.
F-573-413	Valve, Shuttle	1	The shuttle valve to the governor oil boost was observed to be the type designated on parts list 02-441 for 75017. No abnormal conditions were noted.
F-573-348	Valve, Check	2	The check valve on the line to the starting air distributors were observed to be the type designated on Parts List 02-441 for 75017. No abnormal conditions were noted.

B3.18 Part No.: 02-445

Part Name: Fuel Oil Booster Pump

Function: The fuel oil booster pump transfers fuel oil from the day tank to the diesel.

Drawings: 02-445-06, Fuel Oil Booster Pump

Operating History: The fuel oil booster pump has performed satisfactorily as evidenced by the satisfactory diesel engine operation for extended periods.

Maintenance History: No major maintenance has been performed on this pump, other than tightening a fitting to correct a leakage problem. (Ref. W.R. No. 8058 OPS, 2-2-84).

Visual Observations: The fuel oil booster pump was observed on May 10, 1984 by J. Gorman and appeared normal.

Conclusions: The fuel oil pump is considered to be satisfactory as demonstrated by satisfactory performance for extended periods of operation.

B3.19 Part No.: 02-455A

Part Name: Fuel Oil Filter

Function: This filter is a duplex cartridge filter which removes particles from the fuel oil prior to its introduction to the fuel oil headers.

Drawings: The Hilliard Corp. Drawing DD-297-46, and TDI drawing 09-825-75017-H, Fuel Oil Piping Schematic

Operating History: The fuel oil filter has performed satisfactorily as evidenced by the satisfactory performance of the fuel oil system and the diesel engine.

Maintenance History: No corrective maintenance has been required. Filters are periodically replaced as needed based on increasing pressure drop.

Visual Observations: The installation of the filter was observed on May 10, 1984 by J. Gorman and appeared normal.

Conclusions: The fuel oil filter is considered to be satisfactory as demonstrated by satisfactory performance for extended periods of operation.

B3.20 Part No.: 02-455B

Part Name: Fuel Oil Strainers

Function: These strainers filter the fuel oil to the fuel oil booster pump.

Drawings: Air Maze Drawing R9W1752 and TDI drawing 09-825-75017-H, Fuel Oil Piping Schematic

Operating History: The fuel oil strainer has performed satisfactorily as evidenced by the satisfactory performance of the fuel oil system and the diesel engine.

Maintenance History: The only maintenance required has been to periodically clean the filter elements.

Visual Observation: The installation of the strainer was observed on May 10, 1984 by J. Gorman and appeared normal.

Conclusions: The fuel oil strainer is considered to be satisfactory as demonstrated by satisfactory performance for extended periods of operation.

B3.21 Part No.: 02-465C

Part Name: External Lube Oil Valves

Function: These valves are used to direct lube oil flow, isolate components, etc.

Drawings: TDI drawing 09-820-75017-E, Lube Oil Piping Schematic

Operating History: These valves have operated satisfactorily with no problems.

Maintenance History: No maintenance has been required.

Visual Observation: These valves were observed by J. Gorman on May 10, 1984 and appeared normal.

Conclusions: These valves are considered to be satisfactory as demonstrated by satisfactory performance during extended operation.

B3.22 Part No.: 02-500A

Part Name: Control Panel Cabinet

Function: The control panel cabinet houses essential control components for both off-engine electrical and off-engine pneumatic systems and provides barriers between Class 1E circuits and components within the cabinet and non 1E circuits and components.

Drawings: TDI drawing 52213

Operating History: No problems have been encountered with the panel.

Maintenance History: No maintenance has been done on the panel.

Visual Observation: Since the panel has had no maintenance or operating problems, no visual observations were deemed necessary.

Conclusion: The control panel cabinet, Part No. 02-500A, is considered to be satisfactory for its intended service as demonstrated by satisfactory performance.

B3.23 Part No.: 02-500F

Part Name: Control Air Accumulator

Function: The Control Air Accumulator acts as a timing device for some engine pneumatic control functions. Control air is admitted to these devices allowing a time delay for pressure to build which will then actuate other pressure activated devices in the pneumatic control system.

Drawings: There are no drawings available describing the accumulators. The capacity and circuit locations are described on TDI Drawing 52216, Panel Pneumatic Schematic.

Operating History: The three control air accumulators have performed satisfactorily with no reported problems.

Maintenance History: No maintenance has been performed on the control air accumulators.

Visual Observations: No visual observations have been accomplished as a part of this engineering validation.

Conclusions: The control air accumulators, part no. 02-500F, are considered to be satisfactory for their intended service as demonstrated by their satisfactory performance for extended periods of operation.

B3.24 Part No.: 02-500G

Part Name: Control Air System Valves

Function: The control air system valves open and close upon a signal (pneumatic) from the pneumatic shutdown logic board, either permitting the engine to start and run or trip the engine by actuating the auto shutdown cylinder.

Drawings: TDI Drawings 52216, Panel Pneumatic Schematic, and 52215, Engine Pneumatic Schematic.

Operating History: Most of the control air system valves have performed satisfactorily with no maintenance required. One shuttle valve in the low low lube oil pressure circuit periodically stuck, preventing the engine from starting. This was corrected by replacing the valve.

Maintenance History: Other than the valve replacement described above, no maintenance has been required on the control air system valves.

Visual Observation: Visual observations have not been conducted as a part of the engineering validation.

Conclusions: These valves are considered to be satisfactory for their indended service as demonstrated by satisfactory performance for extended periods of operation.

Note-This review and discussion applies only to control air valves essential for engine operation and engine trip.

B3.25 Part No.: 02-500H

Part Name: Control Air System Pressure Switches

Function: The control air system pressure switches open and close depending on control air pressure in the pneumatic control system. These devices are also actuated by control air and serve both control system functions and supervisory functions.

Drawings: TDI drawing 52216, Panel Pneumatic Schematic

Operating History: All pressure switches have demonstrated satisfactory performance with no problems.

Maintenance History: No maintenance has been performed on the control air system pressure switches.

Visual Observation: As the pressure switches have operated satisfactorily, no visual observation was deemed necessary for this engineering evaluation.

Conclusion: The control air system pressure switches are considered to be satisfactory for their intended service as demonstrated by their satisfactory performance during extended operation.

B3.26 Part No.: 02-500J

Part Name: Control System Relays

Function: The Control System Relays provide electrical signals to various elements of the engine control system.

Drawings: TDI Drawing 52218, Panel Electrical Schematic.

Operating History: The control system relays have demonstrated satisfactory performance with no problems since modifications were made to the control panel wiring. (See Part No. 02-500N)

Maintenance History: There has been no required maintenance on these relays since the wiring modification.

Visual Observation: No visual observations were conducted as part of this engineering validation.

Conclusion: The control system relays are considered to be satisfactory for their intended service as demonstrated by their satisfactory performance during extended operation since the wiring modification.

B3.27 Part No.: 02-500K

Part Name: Control System Solenoid Valves

Function: The control system solenoid valves open or close when energized by the pneumatic or electrical control system, permitting the flow of control air in the system.

Darwings: TDI Drawing 52216, Panel Pneumatic Schematic, and 52218, Panel Electrical Schematic.

Operating History: The control system solenoid valves have performed satisfactorily with no problems.

Maintenance History: No maintenance has been required or performed on the control system solenoid valves.

Visual Observation: No visual observations were conducted as part of this engineering validation.

Conclusion: The control system solenoid valves are considered to be satisfactory for their intended service as demonstrated by their satisfactory performance during extended operation.

B3.28 Part No.: 02-500N

Part Name: Control Panel Wiring

Function: The control panel wiring interconnects the electrical components in the control panel system.

Drawings: TDI Drawing 52218, Panel Electrical Schematic and the attached listing of Duke Power Co. drawings.

Operating History: The control panel wiring was extensively modified by Duke Power Company at installation, startup and check out. Panel wiring changes installed by Duke Power Co. under their quality assurance system are documented in Duke Power Co. drawings listed in the attachment. Since these modifications, the wiring has performed satisfactorily and required no maintenance.

Maintenance History: No maintenance has been required or been performed since the modifications to the control panel wiring.

Visual Observations: No visual observations of the control panel wiring were made during this engineering validation as Duke Power Co. Quality Assurance has inspected all wiring modifications.

Conclusion: The control panel wiring is considered to be satisfactory as demonstrated by the absence of problems for an extended period of operation.

ATTACHMENT TO B3.28

Duke Power Company Elementary Diagrams updated for Control Panel Wiring changes:

- CNEE-0120-01.01-01
- CNEE-0120-01.01-02
- CNEE-0120-01.01-03
- CNEE-0120-01.01-04
- CNEE-0120-01.01-05
- CNEE-0120-01.01-06
- CNEE-0120-02.01
- CNEE-0120-02.01-01
- CNEE-0120-03.01
- CNEE-0120-04.01
- CNEE-0120-04.01-01
- CNEE-0120-04.01-02
- CNEE-0120-05.01
- CNEE-0120-05.01-02
- CNEE-0120-05.01-03
- CNEE-0120-05.01-04
- CNEE-0120-05.01-05
- CNEE-0120-05.01-06
- CNEE-0120-05.02-01
- CNEE-0120-06.01
- CNEE-0120-07.01
- CNEE-0120-07.01-01
- CNEE-0120-07.01-03

B3.29 Part No.: 02-550

Part Name: Foundation Bolts and Anchors

Function: The foundation bolt and anchor assemblies serve to fasten the diesel base to the diesel room floor structure.

Drawings: TDI drawings 02-550-03, Engine Mounting; and 00-550-b005, Anchor, Foundation Bolt, Front and Rear

Operating History: These bolts and anchors have performed satisfactorily with no problems.

Maintenance History: No maintenance has been required.

Visual Observations: All of the bolts were observed on May 10, 1984 by J. Gorman and appeared normal.

Conclusions: The foundation bolts and anchors are considered to be satisfactory as demonstrated by the absence of problems for an extended period of operation.

B3.30 Part No.: 02-630D

Part Name: Instrumentation Thermocouples

Function: The instrumentation thermocouples sense the temperatures in the lube oil system, jacket water system and exhaust system and provide signals to the control panel, giving indications and activating annunciators where appropriate. The thermocouples cannot cause the engine to trip or to fail to start on an emergency signal.

Drawings: TDI Drawing 09-688-75017, Engine Electrical Diagram and Schematic, and 09-691-75017, Off-Engine Electrical.

Operating History: Instrumentation thermocouples have indicated erroneous readings when the engine heated up at full load (jacket water and lube oil), and read accurately at slightly below full load. This situation was corrected by replacing the thermocouples. The replacement thermocouples have performed satisfactorily.

Maintenance History: Other than the replacements described above, no other maintenance has been performed of the instrumentation thermocouples.

Visual Observation: No visual observations have been made.

Conclusion: The instrumentation thermocouples are considered satisfactory for their intended service as demonstrated by their satisfactory performance (since replacement) for extended periods of operation.

B3.31 Part No.: 02-688B

Part Name: Engine and Auxiliary Module Wiring

Function: The engine and auxiliary module wiring connects the engine electrical sensors to the termination boxes. Also, power is provided to the engine electrical controls (solenoids, etc.) via this wiring.

Drawings: TDI drawing 09-688-75017, Engine Electrical Diagram and Schematic

Operating History: The engine and auxiliary module wiring have performed satisfactorily and required no maintenance.

Maintenance History: No maintenance has been required or performed on the engine and auxiliary module wiring.

Visual Observation: The engine and auxiliary module wiring was inspected by representatives of the diesel generator Owners Group during the week of May 7, 1984. Their report is expected to be available on June 15, 1984.

Conclusion: Preliminary conclusions indicate that the engine and auxiliary wiring is satisfactory for its intended service as demonstrated by its satisfactory performance during extended periods of operation.

B3.32 Part No.: 02-688C

Part Name: Engine and Auxiliary Module Wiring Boxes

Function: These boxes serve as termination points for the engine and auxiliary module wiring, via the engine mounted conduit. These boxes are connected to the control panel via Duke Power supplied conduit.

Drawings: TDI Drawing 09-688-75017, Engine Electrical Diagram and Schematic

Operating History: The engine and auxiliary module wiring boxes have performed satisfactorily and required no maintenance.

Maintenance History: No maintenance has been required or performed on the engine and auxiliary module wiring boxes.

Visual Observations: The engine and auxiliary module wiring boxes are to be inspected as part of the walkdown of engine conduit, Special Inspection Procedure No. MP/0/A/1000/29.

Conclusions: Preliminary conclusions indicate that the engine and auxiliary module wiring boxes are satisfactory for their intended services as demonstrated by satisfactory performance for extended periods of operation.

B3.33 Part No.: 02-689

Part Name: Off Engine Safety Alarm Sensors-Wiring

Function: The off engine safety alarm sensor wiring connects the sensors which are located off the engine to the local engine control panel. This wiring was supplied by Duke Power Company and is not part of the engineering validation.

B3.34 Part No.: 02-690

Part Name: Engine Alarm Sensors

Function: The engine alarm sensors provide signals to the supervisory alarms on the engine control panel during an emergency startup and run. These alarms do not shut the engine down during an emergency run. The sensors for these alarms are mounted on the engine. These alarms are tabulated in the attachment to this section. Refer to Part No. 02-360D for thermocouples derived from this section.

Drawings: TDI drawings 52218, Panel Electrical Schematic, 52216, Panel Pneumatic Schematic, and 52215, Engine Pneumatic Schematic.

Operating History: The engine alarm sensors have performed satisfactorily and required no maintenance.

Maintenance History: No maintenance has been performed on the engine alarm sensors other than thermocouples. (See Part No. 02-360D)

Visual Observation: No visual observation has been made.

Conclusion: The engine alarm sensors are considered satisfactory for their intended service as demonstrated by their satisfactory performance for extended periods of operation.

ATTACHMENT TO B3.34

ENGINE ALARMS

High Differential Pressure Lube Oil Filter
High Differential Pressure Lube Oil Strainer
Low Pressure Lube Oil
Low Temperature Oil Inlet
Low Temperature Oil Outlet
High Temperature Oil Inlet
High Temperature Oil Outlet
Low Pressure Turbo Oil RF
Low Pressure Turbo Oil LF
Fuel Pump Overspeed Drive Failure
High Differential Pressure Fuel Oil Filter
High Differential Pressure Fuel Oil Pump Strainer
Low Pressure Fuel Oil
Low Pressure Jacket Water
High Temperature After Cooler Water In
Low Temperature Jacket Water In
High Temperature Jacket Water In
Exhaust Temperature High/Low
Barring Device Engaged

B3.35 Part No.: 02-691A

Part Name: Off Engine Safety Alarm Sensors-Switches

Function: The off engine safety alarm sensors provide signals to the supervisory alarm annunciators on the engine control panel. These alarms do not trip the engine during an emergency run. The sensors are located off the engine and are tabulated in the attachment to this section. Thermocouple sensors in the attachment are under Part No. 02-630D.

Drawings: TDI drawings 52218, Panel Electrical Schematic, 52216, Panel Pneumatic Schematic, 52215, Engine Pneumatic Schematic, and 09-691-75017, Off Engine Electrical.

Operating History: The off engine safety alarm sensors have performed satisfactorily.

Maintenance History: No maintenance has been performed on the off engine safety alarm sensors.

Visual Observation: Because of their satisfactory past performance and the non-critical nature of these items, visual observation is not required.

Conclusion: The off engine safety alarm sensors and switches are considered to be satisfactory for their intended service, as demonstrated by their satisfactory performance for extended periods of operation.

ATTACHMENT TO B3.35

OFF ENGINE SAFETY ALARM SENSORS

Low Level Lube Oil Tank
High Level Main Fuel Tank
Low Level Main Fuel Tank
Main Fuel Oil Tank Tech. Spec. WARN
High Level Day Tank
Low Level Day Tank
Low Level Jacket Water
Low Temperature Jacket Water Out
High Temperature Jacket Water Out
Panel Intrusion
Aux Equip Not In Auto
Refer To Operational Mode
Building Ventillation Malfunction
High Level Deisel Generator Sump
High High Level Diesel Generator Sump
Unit Failed To Start
Low Pressure Starting Air
Low Pressure Control Air

B3.36 Part No.: 02-695B

Part Name: Engine Shutdown Valves, Regulators, Orifices

Function: The engine shutdown valves, regulators and orifices control the flow of air in the pneumatic shutdown control system on the diesel engine.

Drawings: TDI drawing 52215, Engine Pneumatic Schematic, and 52216, Panel Pneumatic Schematic.

Operating History: During the extended run test, an orifice supplying air to the low low lube oil pressure sensor clogged, causing the pressure sensor to trip the engine. The orifices were cleaned and the engine performed satisfactorily. All other orifices, valves and regulators have demonstrated satisfactory performance requiring no maintenance.

Maintenance History: Other than cleaning the orifices described above, no maintenance has been performed or required on the engine shutdown valves, regulators and orifices.

Visual Observation: No visual observations were made.

Conclusions: The engine shutdown valves, regulators and orifices are considered satisfactory for their intended service as demonstrated by their satisfactory performance for extended periods of operation, with the one exception described above. Preventive maintenance schedules will be reviewed to assure that procedures are being followed to keep the air adequately filtered.

B3.37 Part No.: 02-695C

Part Name: Engine Shutdown Trip Switches

Function: The engine shutdown trip switches shut the engine down and annunciate the cause of the trip. During emergency run only three trips shut down the engine, low low lubricating oil pressure, overspeed, and generator to switchgear differential (fault). During manual or remote run, six other trips in addition to the three mentioned above shut the engine down, two low pressure lube oils, high temperature lube oil out, high pressure crankcase, high temperature bearings, high temperature jacket water out, low pressure turbo oil and high vibration. The six manual run trips cannot shut down the engine during an emergency run.

Drawings: TDI drawings 52218, Panel Electrical Schematic, 52216, Panel Pueumatic Schematic and 52215, Engine Pneumatic Schematic.

Operating History: The engine shutdown trip switches have performed satisfactorily requiring no maintenance.

Maintenance History: No maintenance has been performed on the engine shutdown trip switches.

Visual Observation: Because of their satisfactory performance of their function, visual observation of the engine shutdown trip switches is not required.

Conclusion: The engine shutdown trip switches are considered satisfactory for their intended service as demonstrated by their satisfactory performance for extended periods of operation.

B3.38 Part No.: 02-825D

Part Name: Fuel Oil Duplex Strainer

Function: This strainer filters fuel oil which is supplied to the auxiliary (engine mounted) fuel oil pump.

Drawings: TDI drawing 09-825-75017-H, Fuel Oil Piping

Operating History: The duplex strainer has performed satisfactorily as evidenced by the satisfactory performance of the fuel oil system.

Maintenance History: The only maintenance required has been to periodically clean the strainer elements.

Visual Observation: The installation of the strainer was observed on May 10, 1984 by J. Gorman and appeared normal.

Conclusion: The fuel oil duplex strainer is considered to be satisfactory as demonstrated by satisfactory performance.

B3.39 Part No.: C 136/40

Part Name: Thermostatic Valve

Function: This valve automatically controls the flow of jacket water through the jacket water heat exchanger in order to control jacket water temperature.

Drawings: TDI drawing 100546, Jacket Water Piping Schematic

Operating History: This valve has worked satisfactorily after an initially incorrect installation direction was corrected.

Maintenance History: No maintenance has been required other than to correct the valve's initially incorrect flow direction.

Visual Observation: The valve was observed by J. Gorman on May 10, 1984 and appeared normal.

Conclusion: The valve is considered to be satisfactory as demonstrated by its satisfactory performance for extended periods of operation.

B3.40 Part No.: CN-106 and CN-107

Part Name: Intake Air Filter

Function: This component serves to filter the intake air.

Drawings: American Air Filter Co. Drawing A-92553

Operating History: The intake air filter has performed satisfactorily as evidenced by the satisfactory operation of the diesel engine.

Maintenance History: Filters have been replaced periodically as required based on pressure drop increases.

Visual Observation: No visual observation was made.

Conclusions: The intake air filter is considered to be satisfactory as demonstrated by satisfactory performance for extended periods of operation.

B3.41 Part No.: CN-107

Part Name: Intake Air Silencers

Function: The silencers minimize noise generated by intake air.

Drawings: None available.

Operating History: There have been no problems with these silencers.

Maintenance History: No maintenance has been required.

Visual Observation: The silencers were observed on May 10, 1984 by J. Gorman and appeared normal.

Conclusion: The silencers are considered to be satisfactory as demonstrated by satisfactory performance for a extended period of operation.

B3.42 Part No.: CN-109

Part Name: Before and After Lube Oil Pump

Function: This pump provides heated lube oil to the diesel engine parts prior to engine operation and after the engine has shut down. This lube oil pump is also known as the keep warm lube oil pump.

Drawings: TDI drawing 09-820-75017-E, Lube Oil Piping Schematic

Operating History: The before and after lube oil pump has performed satisfactorily as evidenced by the satisfactory condition of the diesel engine bearing surfaces. The diesel has experienced a large number of start/stop operations during startup testing.

Maintenance History: The pump motor was replaced due to suspected water damage (W.R. No. 60000PS, 9-6-83).

Visual Observation: The pump installation was observed on May 10, 1984 by J. Gorman and appeared normal.

Conclusion: The before and after (keepwarm) lube oil pump is considered to be satisfactory as demonstrated by satisfactory performance during the startup testing start/stop engine operations.

B3.43 Part No.: CN-110

Part Name: Full Flow Lube Oil Filters

Function: These components filter the lube oil at the discharge of the lube oil pump.

Drawings: TDI drawing 09-820-75017-E, Lube Oil Piping Schematic

Operating History: The full fow lube oil filters have performed satisfactorily as evidenced by the satisfactory operation of the lube oil system. No engine bearings showed degradation attesting to the lack of particulate matter in the lube oil.

Maintenance History: No corrective maintenance has been required. Filter elements have been periodically replaced.

Visual Observation: The filter installation was observed on May 10, 1984 by J. Gorman and appeared normal.

Conclusions: The full flow lube oil filters are considered to be satisfactory as demonstrated by satisfactory performance for extended periods of operation.

B3.44 Part No.: CN-111

Part Name: Lube Oil Heat Exchanger (Cooler)

Function: The lube oil heat exchanger serves to cool lube oil to keep it in the desired temperature range.

Drawings: TDI drawings 09-820-75017-E, Lube Oil Piping Schematic; and 100546, Jacket Water Piping Schematic

Operating History: This heat exchanger has performed satisfactorily as evidenced by the satisfactory condition of the diesel bearings, and satisfactory lube oil temperature.

Maintenance History: No maintenance has been required.

Visual Observation: The heat exchanger installation was observed on May 10, 1984 by J. Gorman and appeared to be normal.

Conclusions: The lube oil heat exchanger is considered to be satisfactory as demonstrated by satisfactory operation for extended periods of operation.

B3.45 Part No.: CN-119 A

Part Name: Generator Shaft and Bearing

Function: The generator shaft and bearing serve to support the generator.

Drawings: None available.

Operating History: No problems have been experienced with the generator shaft and bearing.

Maintenance History: No maintenance has been required except for periodic oil changes. Alignment of the generator shaft is checked during routine web deflection measurements made on the diesel.

Visual Observation: The generator shaft and bearing were observed, to the extent accessible without disassembly, on May 10, 1984 by J. Gorman and appeared normal.

Conclusions: The generator shaft and bearings are considered to be satisfactory as demonstrated by satisfactory operation of the generator for an extended period of operation.

B3.46 Part No.: CN-120 (75017-120)

Part Name: Jacket Water Heat Exchanger (Jacket Water Cooler)

Function: This is a shell and tube heat exchanger which serves to cool jacket water during engine operation. Service water is supplied to the tube side to remove heat. A thermostatic 3-way valve directs as much of the jacket water flow as required through the cooler to keep the jacket water at the desired temperature.

Drawings: TDI drawing 100546-F, Jacket Water Piping Schematic (no part drawing is available)

Operating History: This heat exchanger has performed satisfactorily (except for one minor head to shell gasket leak - see below) as evidenced by satisfactory jacket water temperatures during diesel operation.

Maintenance History: The head to gasket bolts were retorqued to correct a minor head-shell gasket leak. (The bolts had initially not been torqued to specific values).

Visual Observation: The jacket water heat exchanger installation was observed on May 10, 1984 by J. Gorman and appeared to be normal.

Conclusion: The jacket water heat exchanger is considered to be satisfactory as demonstrated by satisfactory operation for extended periods of operation.

B3.47 Part No.: CN-122 (75017-131)

Part Name: Oil Prelube Filter

Function: This filter is located downstream of the keepwarm pump and upstream of the keepwarm strainer (CN-131). It serves to filter the keepwarm lube oil (prelube system).

Drawings: TDI drawing 09-820-75017-E, Lube Oil Piping Schematic (no part drawing is available)

Operating History: This filter has performed satisfactorily with no problems.

Maintenance History: No corrective maintenance has been required. The filter element and O-ring seal have been replaced periodically.

Visual Observation: The filter installation was observed on May 10, 1984 by J. Gorman and appeared to be normal.

Conclusions: The prelube oil filter is considered to be satisfactory as demonstrated by satisfactory operation for extended periods of operation.

B3.48 Part No.: CN-131 (75017-131)

Part Name: Lube Oil Keepwarm Strainer

Function: This strainer is located downstream of the filter on the keepwarm prelube lube oil line. It serves to filter the lube oil prior to its introduction to the main lube oil header.

Drawings: TDI drawing 09-820-75017, Lube Oil Piping Schematic; and Air Maze Drawing "Model 07W231735 Simplex Lube Oil Strainer"

Operating History: This strainer has performed satisfactorily with no problems.

Maintenance History: No corrective maintenance has been required. Periodic strainer cleaning and occasional filter element replacement have been performed.

Visual Observation: The keepwarm strainer installation was observed on May 10, 1984 by J. Gorman and appeared to be normal.

Conclusion: The keepwarm strainer is considered to be satisfactory as demonstrated by extended periods of satisfactory operation.

B3.49 Part No.: F-068

Part Name: Intercoolers

Function: These are air-water heat exchangers located between the turbochargers and the engine intake air manifolds which cool the turbocharged air to the desired temperature.

Drawings: Young Radiator Co. drawing D 264836, Intercooler Assembly

Operating History: The intercoolers have performed satisfactorily with no problems.

Maintenance History: No maintenance has been required.

Visual Observation: The intercoolers were observed on May 10, 1984 by J. Gorman and appeared normal.

Conclusions: The intercoolers are considered to be satisfactory as demonstrated by satisfactory performance for an extended period of operation.

B3.50 Part No.: SE-025

Part Name: Lube Oil Full Pressure Strainers

Function: These two strainers filter the lube oil downstream of the main lube oil filters prior to the lube oil being introduced into the main lube oil headers.

Drawings: TDI drawing 09-820-75017-E, Lube Oil Piping Schematic; and Air Maze drawing E-00736-R9W1752, Strainer, Lube Oil-Simplex

Operating History: These strainers have performed satisfactorily with no problems, as evidenced by the satisfactory condition of the diesel bearings.

Maintenance History: No corrective maintenance has been required. Periodic strainer cleaning and occasional filter element replacement have been performed.

Visual Observation: The lube oil full pressure strainers were observed on May 10, 1984 and appeared to be installed normally.

Conclusion: The lube oil full pressure strainers are considered to be satisfactory as demonstrated by satisfactory performance for an extended period of operation.

B4.0 References

1. Duke Power Company letter to NRC dated April 5, 1984, Re: Catawba Nuclear Station, Docket Nos. 50-413 and 50-414, forwarding report entitled "Catawba Nuclear Station, Extended Operation Tests and Inspection of Diesel Generators".

ATTACHMENT 13

G. W. Hallman

RECEIVED

JUL 10 '84 PM

NUCLEAR MAINTENANCE

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

HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

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:

- 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.

- 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

NAR/php

cc: Mr. James P. O'Reilly, Regional Administrator
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

NRC Resident Inspector
Catawba Nuclear Station

Robert Guild, Esq.
Attorney-at-Law
P.O. Box 12097
Charleston, South Carolina 29412

Palmetto Alliance
2135½ Devine Street
Columbia, South Carolina 29205

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

bcc: D/G Task Force
J. M. McCarry
A. V. Carr
C. Newton
J. M. Hart
C. L. Ray
C. L. Hartzell
M. S. Tully
N. A. Rutherford
R. C. Futrell
L. T. Parker
R. O. Sharpe
SREC
NC MPA-1
NCEMC
Group File: CN-801.01

Table 5-1. Catawba Unit 1 Diesels Inspection Plan Matrix

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, Ftngs, Gasket	00-700A	B	–	100	–	–	–	–	–	–
Jacket Water Standpipe Valves	00-700B	B	–	–	–	–	–	–	X	9
Jacket 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	38(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	–	–	–	–	–	–
Jacket Water Discharge Manifold	02-317A	B	–	100	–	–	–	–	–	–
Jacket 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
Subcover Assembly	02-362A	B	–	100	100	–	–	–	–	–
Fuel Injection Pump	02-365A	B	–	100	–	100(0)	–	100(0)	X	9
Fuel Injection Tips	02-365B	B	–	–	–	–	–	–	X(0)	9

Table 5-1. Catawba Unit 1 Diesels Inspection Plan Matrix

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 Asmbly.	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
Lube 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

Table 5-1. Catawba Unit 1 Diesels Inspection Plan Matrix

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, Ftngs	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 136-40	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	MP-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.

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

HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

TELEPHONE
(704) 373-4531

July 16, 1984

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commision
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. <u>Planned Program</u>

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 rods 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. Duke Power Planned Action. 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

cc: Mr. James P. O'Reilly, Regional Administrator
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

NRC Resident Inspector
Catawba Nuclear Station

Robert Guild, Esq.
Attorney-at-Law
P. O. Box 12097
Charleston, South Carolina 29412

Palmetto Alliance
2135½ Devine Street
Columbia, South Carolina 29205

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

Walt Laity
Pacific Northwest Laboratories
P.O. Box 999
Battelle Blvd.
Richland Washington 99352

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 ASSE
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 DISSASSEMBLY
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	5X 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.

ATTACHMENT 15

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
Columbia, S.C. 29205

cc: NRC Resident Inspector
Catawba Nuclear Station

Robert Guild, Esq.
Attorney-at-Law
P.O. Box 12097
Charleston, South Carolina 29412

Mr. Jesse L. Riley
Carolina Environmental Study Group
854 Henly Place
Charlotte, North Carolina 28207

Walt Laity
Pacific Northwest Laboratories
P.O. Box 999
Battelle Blvd.
Richland, Washington 99352

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

bcc: C.L. Hartzell - CNS
M.S. Tully - WC-8
N.A. Rutherford - WC-17
R.C. Futrell - WC-11
L.T. Parker
SREC
NC MPA-1
NCEMC
Group File: CN-801.01
Mac McCollough - CNS
M.D. Gilmore - CNS
L.E. Suther - EC-1119
A.V. Carr - Legal-PB
G.W. Hallman - WC-12
J.A. Gorman - WC-12
K.S. Canddy - WC-17
R.O. Sharpe - WC-17
J.W. Hampton - CNS
J.M. McGarry - Washington, DC
C.J. Wylie - EC-0204
D.G. Owen - EC-0205
J.M. Lines - EC-0203-4
J.M. Curtis - EC-1220
R.P. Muschick - WC-12
W.W. McCullum - CNS
R. MacElwee - CNS
J.M. Lambert - PB-3037
R.L. Gill - WC-17
W.H. Owen - PB-3

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

1. JACKET WATER SYSTEM DEPOSITS

<u>Item</u>: 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.

<u>Discussion</u>: 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.

<u>Response</u>: 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

<u>Item</u>: 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.

<u>Response</u>: 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.

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

ATTACHMENT 16

D. W. Hallman

Duke Power Company

P.O. BOX 33189
CHARLOTTE, N.C. 28242

HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

TELEPHONE
(704) 373-4531

NUCLEAR MAINTENANCE MANAGER

AUG 9 1984

NAME	CODE	INITIAL
DHG		
CAL		
SHS		
RLW		
GAC		
FWM		

TICKLE DATE
I - Info R - Retain
C - Copy A - Action

August 3, 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 provide information as to the load history associated with the operation of the 1B diesel engine at Catawba. That information is as follows:

Hours of Operation (hrs)	Generator Load (KW)
4.13	7700
576.97	7000
14.67	6800
12.06	6500
2.48	6000
10.5	5000
0.5	4200
19.91	4000
0.33	3800
1.0	3700
0.33	3000
2.69	2500
0.63	2000
0.17	1600
3.02	1200
116.9	0

We hope that this information satisfies the NRC needs. Please call if I can be of any further service.

Very truly yours,

Hal B. Tucker, Vice President
Nuclear Production

HBT:RPM:rmm

cc: Mr. James P. O'Reilly, Regional Administrator
U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

Melanie Miller, Project Manager
U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

NRC Resident Inspector
Catawba Nuclear Station

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

Palmetto Alliance
2135 1/2 Devine Street
Charleston, S.C. 29412

Robert Guild, Esq.
Attorney-at-Law
P.O. Box 12097
Charleston, South Carolina 29412

Mr. Jesse L. Riley
Carolina Environmental Study Group
853 Henley Place
Charlotte, North CArolina 28207

Walt Laity
Pacific Northwest Laboratories
P.O. Box 999
Battelle Blvd.
Richland, Washington 99352

bcc: C.L. Hartzell - CNS
M.S. Tully - WC-8
N.A. Rutherford - WC-17
R.C. Futrell - WC-11
L.T. Parker
SREC
NC MPA-1
NCEMC
Group File: CN-801.01
Mac McCollough - CNS
M.D. Gilmore - CNS
L.E. Suther - EC-1119
A.V. Carr - Legal-PB
G.W. Hallman - WC-12
J.A. Gorman - WC-12
K.S. Canddy - WC-17
R.O. Sharpe - WC-17
J.W. Hampton - CNS
J.M. McGarry - Washington, DC
C.J. Wylie - EC-0204
D.G. Owen - EC-0205
J.M. Lines - EC-0203-4
J.M. Curtis - EC-1220
R.P. Muschick - WC-12
W.W. McCullum - CNS
R. MacElwee - CNS
J.M. Lambert - PB-3037
R.L. Gill - WC-17
W.H. Owen - PB-3

ATTACHMENT 17 BWH

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

HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

TELEPHONE
(704) 373-4531

August 8, 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 one of the TDI emergency diesel engine issues raised by NRC and Battelle personnel during a visit to the Catawba Nuclear Station on July 26, 1984. The attachments contain the responses promised by August 8, 1984 and a revision to our August 1, 1984 letter.

Please call me if I can be of further service.

Very truly yours,

HAL B. TUCKER BY [signature]

Hal B. Tucker, Vice President
Nuclear Production

HBT:WWG: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
Columbia, S.C. 29205

cc: NRC Resident Inspector
Catawba Nuclear Station

Robert Guild, Esq.
Attorney-at-Law
P.O. Box 12097
Charleston, South Carolina 29412

Mr. Jesse L. Riley
Carolina Environmental Study Group
854 Henly Place
Charlotte, North Carolina 28207

Walt Laity
Pacific Northwest Laboratories
P.O. Box 999
Battelle Blvd.
Richland, Washington 99352

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

Melanie Miller
ONRR, U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

bcc: C.L. Hartzell - CNS
M.S. Tully - WC-8
N.A. Rutherford - WC-17
R.C. Futrell - WC-11
L.T. Parker
SREC
NC MPA-1
NCEMC
Group File: CN-801.01
W.W. McCollough - CNS
M.D. Gilmore - CNS
L.E. Suther - EC-1119
A.V. Carr - Legal-PB
G.W. Hallman - WC-12
J.A. Gorman - WC-12
K.S. Canady - WC-17
R.O. Sharpe - WC-17
J.W. Hampton - CNS
J.M. McGarry - Washington, DC
C.J. Wylie - EC-0204
D.G. Owen - EC-0205
J.M. Lines - EC-0203-4
J.M. Curtis - EC-1220
R.P. Muschick - WC-12
W.R. McCollum - CNS
M.R. McElwee - CNS
J.M. Lambert - PB-3037
R.L. Gill - WC-17
W.H. Owen - PB-3

ATTACHMENT 1
August 8, 1984

Responses to NRC Questions and Recommendations at the July 26, 1984 meeting at Catawba Nuclear Station Concerning Diesel Engines.

1. Revision to August 1, 1984 response:

   In the August 1, 1984 response, item 2 described the specific lubricating oil grade to be used. This should be changed to read Exxon Tro-Mar SD-40 rather than the Mobil Product. Both products meet TDI's new recommendations.

2. Identification of Cylinder Heads on 1A and 1B Engines:

   Item: NRC requested that the cylinder heads used on Catawba 1A and 1B diesels be identified by groups as described on page 1-2 of the May 1984 report prepared by FaAA entitled "Evaluation of Cylinder Heads of Transamerica Delaval Inc. Series R-4 Diesel Engines".

   Discussion: As described in the FaAA report, Group I and II cylinder heads are subject to leakage problems due to manufacturing defects. The FaAA report further describes a program of inspections and periodic engine roll and cylinder venting to ensure that head defects are detected and internal leakage will not adversely affect diesel availability.

   Response: Attachment 2 contains the information requested in the July 26, 1984 meeting. The information listed for the 1B engine is as of July 31, 1984. The 1B engine is currently disassembled and the heads are being inspected.

   Most of Catawba 1A and 1B engine cylinder heads are in Group II with a small percentage in Group I and III. In any case, all heads have or will be thoroughly examined to verify that defects are not present. In addition, engine roll and cylinder venting procedures will be performed periodically as described in our letter dated July 16, 1984 on this subject.

ATTACHMENT 2
CATAWBA NUCLEAR STATION
DIESEL GENERATOR 1A
CYLINDER HEAD CLASSIFICATION

CYL NO.	BANK (L/R)	FaAA CLASS	MFG. DATE	WT/SN
8	L	I	9/21/78	H13/739W
7	L	I	1/6/78	J5/56D
6	L	II	11/7/78	H62/937W
5	L	II	6/11/79	L77/860D
4	L	II	11/30/78	H96/32D
3	L	III	4/12/82	G89A/417J
2	L	II	11/9/78	H69/949W
1	L	I	1/24/78	J1/44D
8	R	II	12/4/78	H98/44D
7	R	I	9/28/78	H21/767N
6	R	II	11/12/78	H59/916W
5	R	II	11/9/78	H71/959W
4	R	II	12/6/78	J6/56D
3	R	II	11/7/78	H63/937W
2	R	II	11/1/78	H55/910W
1	R	II	11/27/78	H89/18D

DIESEL GENERATOR 1B
CYLINDER HEAD CLASSIFICATION

CYL NO.	BANK (L/R)	FaAA CLASS	MFG. DATE	WT/SN
8	L	III	4/19/82	H18/446J
7	L	II	11/9/78	H74/959W
6	L	II	8/3/79	M61/97E
5	L	II	11/15/78	H76/975W
4	L	II	10/19/78	H42/859W
3	L	II	11/21/78	H48/4D
2	L	II	10/24/78	H45/878W
1	L	II	11/2/78	H57/916W
8	R	III	8/18/83	J66/270K
7	R	*	*	*
6	R	II	11/16/78	H82/984W
5	R	II	10/3/78	H26/786W
4	R	I	9/21/78	H12/739W
3	R	II	11/16/78	H79/984W
2	R	II	11/28/78	H91/22D
1	R	II	11/8/78	H68/942W

*NOTE: Diesel engine 1B is currently disassembled. Upon reassembly, cylinder head 7R will be replaced with a class II or III head.

August 20, 1984

ATTACHMENT 18

Diesel 1A Operational Loads

Generator Load (KW)	Hours At Load	% of Total (862.72 Hours)
7700	4.75	0.55%
7000	656.58	76.11%
6500	6.00	0.70%
5000	1.00	0.12%
4500	1.17	0.14%
4100	1.10	0.13%
4000	29.00	3.36%
3000	0.25	0.03%
(No Load)	162.87	18.88%
Total -	862.72	100.00%

77.36% of all hours run before the tear down inspection were above the new 5750 KW (185 BMEP) limit.