

CATAWBA NUCLEAR STATION
DIESEL ENGINE 2B COMPONENT REVALIDATION INSPECTION

Prepared by
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2-1	Summary of Catawba Diesel 2B Revalidation Inspection Results	
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This report describes the results of inspections and evaluations performed on the Catawba 2B diesel engine. These tests and 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 the table included in Section 2.

The inspections of the 2B diesel engine discussed herein were performed in September through November 1985. 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 are as described in reference 1.

The diesel disassembly, reassembly, and inspections were performed in accordance with the Duke Power Quality Assurance Program. The disassembly, inspection work and assembly was largely performed by Duke Power personnel, with selected inspections performed by Failure Analysis Associates (FaAA) and Law Engineering personnel.

Detailed results of the inspections are contained in Section 5.0 and are discussed in Section 3.0. Summary and conclusions resulting from the inspections is contained in Section 2.0 of this report.

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 was performed and is discussed in Section 5.

2.0

Summary and Conclusions

2.1 Overview of Operations

The Unit 2B diesel generator is essentially a new engine which had been run at Catawba only for acceptance testing required by the technical specifications. At the time of the revalidation inspections, the engine had 183 hours of operation at Catawba.

2.2 Overview of Inspection Results

Although the 2B engine did not have a significant operating history, 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. It should be noted that the inspections of some items were of limited value since the diesel had only been operated during factory tests, and during preliminary acceptance testing at the plant. Therefore, significant service induced degradation would not be expected to have occurred. However, the inspections did serve to verify that manufacturing or material flaws are not present. Also, re-assembly of parts following the inspections using controlled procedures served to provide increased assurance that the diesel is properly assembled, e.g., that bolts have the correct torque.

These inspections are now completed. The results of the inspections are summarized in the table accompanying this section. Engineering and quality assurance evaluations of the inspection results have been performed. This work is considered to have identified all significant conditions.

The only significant conditions noted as a result of the inspections were that:

- o The bearings in the turbochargers were severely worn due to oil starvation. The bearings were replaced on the right turbocharger. The left turbocharger was replaced. The problem was due to heavy walled tubing that had been installed in the lube oil runs of this engine. This tubing has been replaced. This problem is further discussed in Section 3.1.15.
- o Two rocker arm swivel pads were cracked necessitating replacement. At the time of inspection, the swivel pads although cracked part way were still functional and did not affect operability of the engine. This problem is further discussed in Section 3.2.10.
- o One valve guide was found cracked necessitating replacement. The guide was completely captured in the engine and did not affect engine operability. This problem is further discussed in Section 3.3.2.

Referring to the table of this section, some parts were to be subject to an engineering validation. These parts, which are important to diesel operability, were not inspected to conventional non-destructive techniques since they were not specified in the TDI Owners Group program and there has been no history of problems. An engineering validation consisting of an evaluation of the operating and maintenance history of these parts was performed to assure that there were no problems. On the 2B diesel since the engine had very few hours there was little operating or maintenance history. The engineering validation of the parts is listed in the table of this section is included as Appendix B in Section 5.

2.3 Lessons Learned from Unit 1 Inspections

The extended operation tests and revalidation inspections of the 1A and 1B diesels (references 2 and 3) resulted in certain modifications or changes to these diesels. These same modifications and changes have been accomplished on the 2B diesel, except for one item, which will be accomplished by the end of the first refueling availability. These items include the following:

- o Piston skirts were changed from the AN type to the AE type.
- o A new turbocharger prelube system was installed to assure that the turbocharger bearings get adequate lubrication during engine starting.
- o Modifications to the turbocharger prelube oil lines were accomplished to reduce vibration.
- o Permanent turbocharger lube oil drain lines have been incorporated.
- o Turbocharger exhaust gas inlet bolts have been changed to SA543, Grade 660 to guard against creep rupture failures.
- o Turbocharger to bracket mounting bolts have been changed to a new material of increased fatigue resistance.
- o New turbocharger air inlet adapters with flexible couplings were installed.
- o Rigid hangers were added to the jacket water piping going to the intercooler to reduce vibration.
- o Crankcase and camshaft cover capscrews were replaced with improved fatigue strength materials.
- o Starting air distributor cover capscrews will be changed to a material of improved fatigue strength during the first availability and prior to the end of the first refueling outage.

2.4 Conclusions

With the exception of the turbocharger bearings, the results of the revalidation inspections of diesel 2B have shown the engine to be in excellent working order. The failure of the turbocharger bearings was due to an installation error on tubing which has now been corrected. Lessons learned from the extended operation tests of both the Catawba diesels 1A and 1B have been incorporated into the 2B diesel such that it will be capable of producing reliable standby electric power.

Catawba Unit 2 Inspection Matrix

Sample Size (percent)

page

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Part Name	Part No.	Class	Visual	Dimen.	S.HOE	V.HOE	Eng.Eval.	Notes	Results
Lube Oil Pressure Regulating Valve	00-420	A	-	-	-	-	I	9	
Jacket Water Standpipe, Fittings, Gasket	00-700A	B	100	-	-	-	-	8	Satisfactory
Jacket Water Standpipe Valves	00-700B	B	-	-	-	-	I	9	
Jacket Water Standpipe Supports	00-700C	B	100	-	-	-	-	8	Satisfactory
Jacket Water Standpipe Switches	00-700E	B	-	-	-	-	I	9	
Jacket Water Standpipe Bolting Materials	00-700F	B	100	-	-	-	-	8	Satisfactory
Main Bearing Base Assembly	02-305A	A	30*	-	-*	-	-	-	Satisfactory
Main Bearing Studs and Nuts	02-305C	A	-*	30*	-	-	-	-	Satisfactory
Main Bearing Caps	02-305B	A	30*	-	-	-	-	-	Satisfactory
Lube Oil Internal Headers	02-307A	A	100	-	-	-	-	8	Satisfactory
Lube Oil Tubing and Fittings-Internal	02-307B	A	100	-	-	-	-	8	Satisfactory
Lube Oil Line Supports-Internal	02-307D	B	100	-	-	-	-	8	Satisfactory
Crankshaft	02-310A	A	100	100*	30*	-	-	3	Satisfactory
Main Bearing Shells	02-310B	A	30*	30*	-	-	-	-	Satisfactory
Crankshaft Thrust Bearing Ring	02-310C	A	-	100	-	-	-	-	Satisfactory
Crankcase Assembly	02-311A	A	100	-	-	-	-	-	Satisfactory
Crankcase Mounting Hardware	02-311B	B	-	-	-	-	I	9	
Cylinder Block	02-315A	A	-	25	100*	-	-	4	Satisfactory
Cam Bearing Caps and Dowels	02-315B	B	-	-	-	-	I	9	
Cylinder Liner	02-315C	A	700	100	-	-	-	-	Satisfactory
Cylinder Block Jacket Water Manifold	02-315D	B	100	-	-	-	-	-	Satisfactory
Cylinder Head Studs	02-315E	B	25	25*	-	-	-	-	Satisfactory
Cylinder Head Nuts	02-315F	B	100	-	-	-	-	-	Satisfactory
Cylinder Block Seals and Gaskets	02-315G	B	100*	-	-	-	2*	9	Satisfactory
Jacket Water Inlet Manifold Assembly	02-316A	B	100	-	-	-	-	8	Satisfactory
Jacket Water Inlet Manifold Coupling	02-316B	B	100	-	-	-	-	8	Satisfactory
Jacket Water Discharge Manifold	02-317A	B	100	-	-	-	-	-	Satisfactory
Jacket Water Disch. Manifold Coupling	02-317B	B	100	-	-	-	-	8	Satisfactory
Jacket Water Disch. Manifold Supports	02-317C	B	100	-	-	-	-	8	Satisfactory
Flywheel	02-330A	A	-	-	-	-	I*	9	
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	-	-	-	One link rod bushing was replaced
Connecting Rod Bearing Shells	02-340B	A	100	100	100	100	-	-	Satisfactory
Pistons	02-341A	A	100	100*	100	-	-	-	Satisfactory
Piston Rings	02-341B	A	-	100	-	-	-	-	New rings installed
Piston Pin Assembly	02-341C	A	100	-	-	-	-	-	Satisfactory
Intake Tappets	02-345A	A	25*	-	-	-	-	-	Satisfactory
Fuel Tappets	02-345B	A	25*	-	-	-	-	-	Satisfactory
Fuel Pump Bases	02-345C	B	-	-	-	-	I*	9	
Camshaft Assembly	02-350A	A	100	-	-	-	-	-	Satisfactory
Camshaft Bushing	02-350B	B	100	-	-	-	-	-	Satisfactory
Camshaft Gears	02-350C	A	100	-	-	-	-	-	Satisfactory
Pump Drive Gear	02-355A	A	100	100*	-	-	-	-	Satisfactory

Catawba Unit 2 Inspection Matrix

Sample Size (percent)

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Part Name	Part Nr.	Class	Visual	Dimen.	S.NDE	V.NDE	Eng.Eval.	Notes	Results
Idler Gear Assembly	02-355B	A	100	100*	-	-	-	-	Satisfactory
Air Start Valve	02-359	A	100	25*	-	-	-	-	Satisfactory
Cylinder Head	02-360A	B	100	100	100	100	-	2	One nozzle stud was replaced due to MI indication
Intake and Exhaust Valves	02-360B	B	100	100	100*	-	-	-	One valve guide was found broken, 1 valve replaced
Cylinder Head Bolting and Gaskets	02-360C	B	-	-	-	-	1*	9	
Valve Springs	02-360D	B	100	-	-	-	-	1	Satisfactory
Subcover Assembly	02-362A	B	100	-	100	-	-	-	Satisfactory
Fuel Injection Pump	02-365A	B	100	-	100*	-	-	-	One valve holder was replaced-linear indications
Fuel Injection Tips	02-365B	B	-	-	-	-	3*	9	
Fuel Injection Tubing	02-365C	B	100	-	100	-	-	4	Satisfactory
Fuel Injection Tubing Supports	02-365D	B	100	-	-	-	-	8	Satisfactory
Fuel Pump Linkage	02-371A/B	A	100	-	-	-	-	-	Satisfactory
Intake Manifolds	02-375	B	100	-	-	-	-	-	Satisfactory
Exhaust Manifolds	02-380A	B	100	-	-	-	-	-	Satisfactory
Exhaust Manifold Bolting	02-380B	B	100	9	-	-	-	-	Satisfactory
Crankcase Covers Gaskets and Bolting	02-386B	C	100	-	-	-	-	-	Satisfactory
Intake and Intermediate Rocker Arm Assemblies	02-390A	B	100	-	-	-	-	-	Two swivel pads were cracked and replaced
Exhaust Rocker Arm Assembly	02-390B	B	100	-	-	-	-	-	Satisfactory
Intake and Exhaust Pushrods	02-390C	B	100	-	100	-	-	-	Satisfactory
Connector Pushrods	02-390D	B	100	-	100	-	-	-	Satisfactory
Rocker Arm Bushings	02-390E	B	100	-	-	-	-	-	Satisfactory
Rocker Arm Bolting	02-390G	B	100	-	100	-	-	-	One capscrew was replaced due to an MI indication
Overspeed Trip Governor	02-410A	A	-	-	-	-	1*	9	
Overspeed Trip and Accessory Drive	02-410B	A	100	-	-	-	-	-	Satisfactory
Overspeed Trip Couplings	02-410C	A	100	-	-	-	-	-	Replaced due to chipped spots on visual inspection
Overspeed Trip Vent Valves	02-410D	A	-	-	-	-	1*	9	
Speed Regulating Governor Drive	02-411A	A	100	-	-	-	-	-	Satisfactory
Governor Drive Couplings	02-411B	A	100	-	-	-	-	-	Satisfactory
Governor Linkage	02-413A	A	100	-	-	-	-	-	Satisfactory
Fuel Pump Linkage-Auto Shutdown Cylinder	02-413B	B	100	-	-	-	-	-	Satisfactory
Speed Regulating Governor	02-415A	A	-	-	-	-	1*	9	
Governor Booster Servomotor	02-415B	B	100	-	-	-	-	-	Satisfactory
Governor Heat Exchanger Assembly	02-415C	A	100	-	-	-	-	-	Satisfactory
Lube Oil Pump	02-420	A	-	-	-	-	1*	9	
Jacket Water Pump	02-425A	A	100*	100*	-	-	-	-	Satisfactory
Intercooler Piping-Coupling,Bolt,Gaskets	02-436B	A	100	-	-	-	-	-	Satisfactory
Turbo Cooling Water Pipe and Fittings	02-437A	B	100	-	-	-	-	8	Satisfactory
Turbo Cooling Water Supports	02-437B	A	100	-	-	-	-	8	Satisfactory
Start Air Manifold Pipe, Tubing & Fittings	02-441A	A	100	-	-	-	-	8	Satisfactory
Start Air Manifold-Valves,Filters	02-441B	A	-	-	-	-	1*	9	
Start Air Manifold Pipe Supports	02-441C	A	100	-	-	-	-	8	Satisfactory
Start Air Distributor Tubing	02-442B	A	100	-	-	-	-	8	Satisfactory
Fuel Oil Booster Pump	02-445	A	-	-	-	-	1*	9	
Fuel Oil Filters	02-445B	B	-	-	-	-	1*	9	
Fuel Oil Strainers	02-445B	B	-	-	-	-	1*	9	

Part Name	Part No.	Class	Visual	Dimen.	S.NDE	V.NDE	Eng.Eval.	Notes	Results
Fuel Injection Piping	02-450B	A	100	-	-	-	-	8	Satisfactory
Fuel Oil Piping Supports	02-450D	A	100	-	-	-	-	8	Satisfactory
Fuel Oil Filter Mounting Hardware	02-455C	A	100	-	-	-	-	8	Satisfactory
External Lube Oil Lines	02-465A	A	100	-	-	-	-	8	Satisfactory
External Lube Oil Line Supports	02-465B	A	100	-	-	-	-	8	Satisfactory
External Lube Oil Valves	02-465C	A	-	-	-	-	I	9	
Turbocharger Lube Oil Piping	02-467A	B	100	-	-	-	-	8	Satisfactory
Turbocharger Lube Oil Piping Supports	02-467B	B	100	-	-	-	-	8	Satisfactory
Turbocharger Bracket	02-475A	B	100	-	-	-	-	-	Satisfactory
Turbocharger Bracket Bolting	02-475B	B	8	-	-	-	-	7	Satisfactory
Control Panel Cabinet	02-500A	A	-	-	-	-	I	9	
Control Air Accumulator	02-500F	A	-	-	-	-	I	9	
Control Air System Valves	02-500G	A	-	-	-	-	I	9	
Control Air System Pressure Switches	02-500H	B	-	-	-	-	I	9	
Control System Relays	02-500J	A	-	-	-	-	I	9	
Control System Solenoid Valves	02-500K	A	-	-	-	-	I	9	
Control Air System Piping, Tubing, Fitting	02-500M	B	100	-	-	-	-	8	Satisfactory
Control Panel Wiring	02-500N	A	-	-	-	-	I	9	
Lube Oil Sump Tank	02-540A	B	100	-	-	-	-	3	Satisfactory
Lube Oil Sump Tank Bolting	02-540B	B	100	-	-	-	-	8	Satisfactory
Lube Oil Sump Tank Mounting Hardware	02-540C	B	100	-	-	-	-	8	Satisfactory
Foundation Bolts and Anchors	02-550	B	-	-	-	-	I*	9	
Instrumentation Thermocouples	02-610B	B	-	-	-	-	I	9	
Engine & Auxiliary Module Wiring Conduit	02-688A	A	100	-	-	-	-	8	Satisfactory
Engine & Auxiliary Module Wiring	02-688B	A	-	-	-	-	I	9	
Engine & Auxiliary Module Wiring Boxes	02-688C	A	-	-	-	-	I	9	
Oil Engine Safety Alarm Sensors-Wiring	02-689	B	-	-	-	-	I*	9	
Engine Alarm Sensors	02-690	A	-	-	-	-	I	9	
Oil Engine Safety Alarm Sensors-Switches	02-691A	B	-	-	-	-	I	9	
Engine Shutdown Tubing and Fittings	02-695A	B	100	-	-	-	-	6	Satisfactory
Engine Shutdown Valves, Regs, & Orifice	02-695B	A	-	-	-	-	I	9	
Engine Shutdown Trip Switches	02-695C	A	-	-	-	-	I	9	
Fuel Oil Duplex Strainer	02-825B	A	-	-	-	-	I	9	
Turbocharger Thrust Bearing Lube System	02-CFR	C	100	-	-	-	-	-	Satisfactory
Intake Air Filter	CN-106	B	-	-	-	-	I	9	
Intake Air Silencer	CN-107	B	-	-	-	-	I	9	
before and After Lube Oil Pump	CN-109	A	-	-	-	-	I	9	
Full Flow Lube Oil Filter	CN-110	A	-	-	-	-	I	9	
Lube Oil Heat Exchanger	CN-111	B	-	-	-	-	I	9	
Generator Shaft and Bearings	CN-119A	A	-	-	-	-	I	9	
Jacket Water Heat Exchanger	CN-120	B	-	-	-	-	I	9	
Oil Pre-lube Filter	CN-122	A	-	-	-	-	I	9	
Lube Oil Keepwarm Strainer	CN-131	A	-	-	-	-	I	9	
Thermostatic Valve	CN-136/40	B	-*	-	-	-	I*	9	
Intercooler	F-04B	A	100	-	100	-	-	-	Satisfactory

Calaveras Unit 2 Inspection Matrix

Sample Size (percent)

page

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Part Name	Part No.	Class	Visual	Diagn.	S.NDE	V.NDE	Eng.Eval.	Notes	Results
Turbocharger	MP-022/3	A	100	100	100	-	-	10	Severe bearing wear
Lube Oil Full Pressure Strainer	SE-025	A	-	-	-	-	1	9	

Notes to Table

1. Intake and exhaust valve springs have proper color code.
- *2. Ultrasonic wall thickness measurement of fire deck, ECT and visual examination of fuel nozzle area to determine if the head has been partial penetration weld repaired.
- *3. Crankshaft web deflections and thrust clearances to be measured with the diesel hot and cold.
- *4. Microstructure of the block will be determined by replication technique.
- *5. Camshaft bearings will be inspected only if the cam lobes show abnormal wear. Outboard support bushing will be inspected regardless of camshaft conditions.
6. ECT inspections will be done of both ends of high pressure injection lines.
7. Turbocharger bracket bolting will be replaced if necessary.
8. Walkdown inspection to verify as-built condition.
9. Engineering validation of part to determine if there are any significant unresolved maintenance or operational problems associated with the part.
10. Teardown and inspection of new or rebuilt turbochargers which have accumulated less than 50 hours of operation will not be performed.

* Represents changes between initial Unit 2 inspection procedure submitted April 30, 1985 and the final Unit 2 inspection procedures.

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 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 not covered by the first two parts. All of these inspections are documented in Appendix A, Section 5.0. In addition, Section 3.4 provides results of an engineering evaluation of parts not inspected by traditional nondestructive techniques. These engineering evaluations are documented in Appendix B, Section 5.

3.1 Inspection 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 was high cycle fatigue cracks initiating from fillets in the crankshaft at the junction of a crankpin and web (reference 5). 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 6 and 7). Due to satisfactory inspection of the Catawba Diesel 1A (reference 3), only visual inspections of crankpin web fillets on Catawba Diesel 2B were performed.

At San Onofre, a TDI diesel engine experienced cracks in main bearing journal oil holes. The V-16 Catawba diesel crankshafts are also different than the San Onofre V-20 crankshafts. However, as this failure was nuclear service related, inspections of the highest load main bearing journal oil holes on 2B were performed.

SCOPE OF INSPECTIONS:

The crankshaft inspections consisted of:

- o Web deflection measurements.
- o Visual inspections of the crankpin journals on all eight crankpins.

- o Liquid penetrant inspection of oil holes in main bearing journals #4, #6, and #8.
- o Eddy current testing of main bearing journals #6, #7 and #8.

RESULTS OF INSPECTIONS:

The results of all inspections were satisfactory.

SUMMARY:

In summary, the inspections of the crankshaft indicate that it is free of significant defects.

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 7) 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:

- o Visual inspection of bearing and back surfaces of all bearing shells.
- o Dimensional inspection of shell thickness.
- o PT examination of the bearing shells.
- o X-ray examination of all bearing shells.

RESULTS OF INSPECTIONS:

Visual and dimensional inspections of the bearing shells were satisfactory. No cracks were detected by liquid penetrant inspection. One bearing shell was rejected by X-ray inspection.

SUMMARY:

Penetrant inspection results indicate that connecting rod bearing shells are acceptable for operation. The shell

rejected by X-ray inspection was replaced. All other shells were evaluated as acceptable for reuse.

3.1.3 Pistons (Part No. 02-341A)

PROBLEM:

Inspection (reference 3) of the Catawba 1A diesel type AN skirts indicated that 4 out of 16 skirts had cracks at the circumferential rib to piston pin boss fillet. As a result, all Catawba piston skirts are being replaced with type AE skirts. In diesel 2B the replacement type AE skirts were inspected.

SCOPE OF INSPECTIONS

The inspection performed on all the replacement type AE pistons skirts for diesel 2B are listed below:

- o Visual inspection of fitup of crown to skirt.
- o PT examination of stud bosses on the piston crowns.
- o PT examination of piston pin bosses, bella ille seat surface and the O.D. of the skirt next to the piston pin bosses.
- o MT examination of areas adjacent to piston pin bosses on the I.D. of the skirts.
- o Hardness tests of piston skirts.

RESULTS OF INSPECTIONS:

Results of all inspections performed on the pistons with new AE skirts were satisfactory.

SUMMARY:

No problems were found with the existing piston crowns or the replacement type AE skirts.

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

PROBLEM:

Severe grooving has been noted in at least one TDI nuclear diesel engine (reference 11). 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% visually 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 scratching was observed which is normal. These scratches are considered to have no effect on diesel operability.

SUMMARY:

The inspections indicate that the cylinder liners are in satisfactory condition. Honing to break up the glaze in order to allow new piston rings to seat has eliminated the scratches observed in the liners.

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 11).

SCOPE OF INSPECTIONS:

The cylinder block inspections included the following:

- o The area between the cylinder studs and the liner and the area around the studs were PT examined for all cylinders.
- o The cylinder liners were removed from four cylinders (4 and 5 right; 4 and 5 left) and the cylinder liner landing area within the block was PT examined.
- o Replica tests of the blocks at each end and in the middle were taken.

RESULTS OF INSPECTIONS:

No significant indications were noted. Replica tests of the blocks indicated normal grey cast iron, Class 40.

SUMMARY:

Cylinder block cracks were not detected on diesel engine 2B. Replica tests of the microstructure were within normal limits.

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 11 and 12).

SCOPE OF INSPECTIONS:

The main bearing saddle area around and between the stud holes was PT examined for bearings 4, 5, 6, and 8 on diesel 1A. In addition, the stud tension required to permit removal of the nuts was measured on diesel 1A. Owing to the fact that all inspection results on diesel 1A (reference 3) were satisfactory, only visual inspections of the main bearing caps and the base were carried out on main bearings 4, 6, and 8 on follow engines.

RESULTS OF INSPECTIONS:

Results of inspections were satisfactory.

SUMMARY:

No cracking around stud holes on diesel 2B was found.

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 13). Hence, visual inspections on a sampling basis were performed of the Catawba diesels. In addition, the free length of the studs were measured.

SCOPE OF INSPECTIONS:

- o Studs from four cylinders (3, 4, 5, and 6L) were removed and visually inspected and dimensionally examined.

RESULTS OF INSPECTIONS:

All cylinder head studs inspected satisfactorily passed the visual examinations and were of correct length.

SUMMARY:

A sampling inspection of cylinder head studs indicates that they are acceptable.

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 11). This failure was attributed to undertorquing. Reference 22 indicates that properly torqued capscrews have satisfactory fatigue resistance.

SCOPE OF INSPECTIONS:

- The rocker arm capscrews were visually and MT examined.

RESULTS OF INSPECTIONS:

No indications were noted in the visual examinations. One axial indication was found by MT examination. This indication was not in the threaded area.

SUMMARY:

The capscrew with the MT indication was replaced. All other screws were satisfactory.

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 11).

SCOPE OF INSPECTIONS:

The inspections of the connecting rods included the following:

- o Visual inspection was performed of all connecting rods.
- o Magnetic particle inspection of all connecting rod link rod and rod-to-box bolts was accomplished.
- o The areas of the rod box which have been reported as being subject to cracking were LP examined.
- o 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.

- o Connecting rod rack-teeth (serrations) degree of contact with mating part was measured by bluing the part on all connecting rods.
- o Dimensional inspection of link rod to pin with link rod bolts torque to 1050 ft.lbs. was accomplished.
- o Additional ECT inspections were performed by Failure Analysis Associates at female rod box threads on four connecting rods.

RESULTS OF INSPECTION

All connecting rods passed the above inspections with the exception of one link rod bushing that was found heavily gouged. The gouges were circumferential and limited to one end of the bushing. It is thought that the gouging was possibly the result of foreign material introduced at the time of manufacture. On inspection, no foreign material could be found. The degree of contact along the rack-teeth (serrations) was greater than 80%, which is considered acceptable. The ECT inspections were satisfactory.

SUMMARY:

The damaged link rod pin and bushing were replaced. All oil holes were checked and found to be clear. After reassembly in the engine, connecting rod capscrews were checked to assure that preloads were adequate.

3.1.10 Electrical Cables (Part No. 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 11 and 19).

SCOPE OF INSPECTION:

Stone and Webster, as part of TDI Owners Group activities, reviewed the Catawba electrical cable installation (reference 19).

RESULTS OF INSPECTION:

The Stone & Webster inspections (reference 14) were completed in May 1984 with the following results.

- o TDI SIM 361 had 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.
- o Duke Power should certify 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 has been completed on all Catawba diesels. With this replacement, all wiring is of acceptable temperature rating and adequately sized for circuit ampacities. Duke Power Company (reference 15) 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 Company already has a program for uncovering defective terminal blocks and therefore find it unnecessary 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 a pre-existing .006" draw seam at the tubing ID. (reference 16).

SCOPE OF INSPECTIONS:

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

RESULTS OF INSPECTIONS:

All lines were satisfactory on visual and ECT inspection.

SUMMARY:

The diesel engine 2B fuel injection lines were satisfactory.

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

PROBLEM:

Several jacket water pump shaft failures occurred at Shoreham (reference 17). 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 diesel 1A jacket water pump (reference 3). Because of satisfactory inspections of diesel 1A, inspections of the 2B pump were abbreviated.

SCOPE OF INSPECTIONS:

- o Visually inspect coupling and spline
- o Verify torque on impeller nut is 80 ft.lbs.
- o Verify torque on spline nut is 120 ft.lbs. or greater
- o Check end play of external spline

RESULTS OF INSPECTIONS:

All inspections were satisfactory. Torque on impeller nut was 80 ft.lbs. and torque on spline nut was 120 ft.lbs.

SUMMARY:

The 2B jacket water pump met all inspection requirements and was returned to service.

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 21). TDI noted that capscrews should be 2 3/4 inch long rather than 3 inches.

SCOPE OF INSPECTION:

The inspections for the capscrews included the following:

- o Measure breakaway torque

- o Measure length of capscrews for 4 valves as a check that capscrews were of the correct length
- o Visual inspection of the valve seat areas on the heads for all valves

RESULTS OF INSPECTIONS:

Capscrew lengths were acceptable, and the valves showed no signs of insufficient clamping force. The capscrew torques ranged from 35-105 ft-lbs. All capscrews were torqued to 150 ft-lbs on reassembly. In addition, capscrews have been checked during engine operation and retorqued where necessary to achieve 150 ft-lbs.

SUMMARY:

There appeared to be no problems with airstart valve capscrew bottoming out in the Catawba 2B 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.

SCOPE OF INSPECTIONS:

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

- o Visual inspection of the shaft end welds to verify that the desired new type friction welds were used.
- o 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 since the friction welded design has operated over 900 hours with no sign of cracking on the Unit 1 diesels.

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 (references 2, 3 and 11). An improved lube oil supply system was incorporated on Catawba diesels to furnish more lube oil flow to the turbochargers during startup.

SCOPE OF INSPECTION:

The bearings were visually and dimensionally inspected.

RESULTS OF INSPECTIONS:

The bearings were found severely worn. The cause of this wear was determined to be lube oil starvation. On installation of the engine, the lube oil supply tubing was damaged on the turbochargers. The tubing was replaced with tubing of equivalent O.D. but thicker walls. This resulted in a decrease in lube oil flow to the bearings which resulted in the bearing damage. Our records show that this problem was unique to diesel 2B.

SUMMARY:

The bearings on the right bank turbocharger were replaced. The left bank turbocharger was replaced entirely due to lack of spare parts. The lube oil tubing was replaced to original specifications.

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

PROBLEM:

Three small jacket water leaks have been experienced on Catawba diesel 1B (reference 2) resulting in water leaking into the fuel injector nozzle cavity. One leak of similar origin was seen on diesel 1A (reference 3). Failure analysis of one of the leaking heads has been completed (reference 4). The leak was due to cracks propagating from a corner where a partial penetration welded plug was installed in the fuel injector nozzle seating area. This welded plug was used to repair the injector bore during manufacture.

SCOPE OF INSPECTION

The inspections performed of the cylinder head included:

- o Visual examination of valve seats.

- o PT examination of valve seats in cylinder heads and the area between valve seats on the head.
- o UT examination of fire deck thickness at selected locations.
- o Eddy current inspections of heads to determine if they have a partial penetration welded in plug.
- o Visual inspection of heads to determine if they have a partial penetration welded in plug.

RESULTS OF INSPECTIONS:

All cylinder heads successfully passed all examinations.

SUMMARY:

The cylinder heads on diesel 2B were satisfactory.

3.2 Catawba Specific Problems

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

PROBLEM:

A fuel injection pump nozzle valve holder on Catawba diesel 1A cracked as a result of a material defect (reference 3).

SCOPE OF INSPECTIONS:

Visual inspection of the 2B valve holder bores using a boroscope was accomplished to determine if there were linear defects.

RESULTS OF INSPECTIONS:

All valve holders with the exception of two had no linear defects. One valve holder with indications was reamed, which removed the indications, the other valve holder was replaced as reaming did not remove the indication. The new unit passed all inspections.

ENGINEERING EVALUATION:

A failure analysis was performed on the 1A fuel injection pump nozzle valve holder (reference 20). 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

Catawba Unit 1 valve holders have withstood 10 million cycles of operation, the valve holder failure experience is considered an isolated material defect on these engines. Inspection of valve holders on other engines and reaming or replacement of holders with defects should assure that cracking does not occur.

SUMMARY:

It is concluded that the valve holder failure on diesel 1A was due to a material defect. The 2B diesel valve holders have been inspected to uncover such defects. The one valve holder (on diesel 2B) that had an indication was reamed and then found to be free of defects. The other valve holder was replaced as after reaming the defect was still evident. Hence all valve holders on the 2B engine are free of defects which would cause the problem experienced on diesel 1A.

3.2.2 Fuel Injection Pump Delivery Valve Assembly (Part No. F-099-170)

PROBLEM:

During the 1B extended operational test (reference 2) two fuel injection pump delivery valve assemblies leaked because of axial cracks. This type of failure does not exhaust fuel to the ambient but allows fuel to bypass the injectors and be returned to the fuel oil tank.

SCOPE OF INSPECTIONS:

The following inspections were accomplished:

- o MT examination in valve seat area.

RESULTS OF INSPECTIONS:

No rejectable linear indications were found during MT examination of the valve assemblies.

SUMMARY:

Diesel 2B valve assemblies have been found free of the type defect found in diesel 1B.

3.2.3 Turbocharger Prelube Oil Lines (Part No. 02-467A)

PROBLEM:

Two failures of the prelube oil lines occurred during the 1A extended operation test due to fatigue cracking at compression fittings (reference 3). The lines have been replaced using an improved procedure and using additional

clamps, vibration dampening devices, improved compression fittings and heavier wall stainless steel tubing on diesels 1A and 1B. As the Unit 1 diesels have passed their extended operation tests with no signs of leakage after the above modifications, no inspections of diesel 2B were accomplished. Diesel 2A and 2B lines have had additional clamps and vibration dampening devices installed to prevent vibration induced damage.

SCOPE OF INSPECTIONS:

Not applicable.

RESULTS OF INSPECTIONS:

Not applicable.

SUMMARY:

Since the 2B diesel has had additional clamps and vibration dampening devices installed no problems with vibration induced damage are expected.

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

PROBLEM:

A turbocharger air inlet adaptor cracked at a flange weld on diesel 1B (reference 2). A similar problem occurred on diesel 1A (reference 3). In addition, the internal air flow divider on diesel 1B (flow distributor) had a small crack at the junction to the case of the adaptor (reference 2). This problem was not seen on diesel 1A. An engineering evaluation indicates that the cracks are caused by excessive displacements at a location with limited flexibility.

A redesign has been implemented on both Unit 1 diesels that installs a flexible connection between the adaptor and turbocharger on the right bank to absorb displacements. In addition, on both Unit 1 diesels, strong backs have been welded to the case to eliminate the flexing which caused the air flow divider weld failure. This redesign will assure that in the future the adaptor will not crack.

Duke Power Company manufactured a new adaptor for diesel 2B with a strong back included. In the process of manufacture all welds were MT examined. The new adaptor with a flexible connection was installed on the right bank of diesel 2B. Hence additional inspections on diesel 2B were not accomplished.

SCOPE OF INSPECTIONS:

Not applicable.

RESULTS OF INSPECTIONS:

Not applicable.

SUMMARY:

With the new adapter and flexible connection installed on diesel 2B, it is concluded that problems initially seen on the Unit 1 diesels will not occur on diesel 2B.

3.2.5 Intercooler Jacket Flange (Part No. 136F-068)

PROBLEM:

A jacket water penetration into the water box on the intercooler seeped water during the extended operation test on diesel 1B (reference 2). Jacket water piping to this penetration was vibrating at the diesel fundamental frequency. The penetration was weld repaired. A rigid hanger was added to the external piping to change its characteristic frequency. The same rigid hanger was added to the Unit 2 diesels.

SCOPE OF INSPECTION:

Not applicable.

RESULTS OF INSPECTION:

Not applicable.

SUMMARY:

A rigid pipe hanger has been installed on both Unit 1 and Unit 2 diesels to change the natural frequency and limit displacements. This modification will eliminate pipe weld cracking at the penetration in to the water box of the intercooler.

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

PROBLEM:

Occasional failures of these capscrews has occurred due to fatigue (reference 20) 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.

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

PROBLEM:

A problem was detected in the post extended operation test inspections of diesel 1B (reference 2), and involves tight cracks running down the boss in the web between the bolt hole and the boss surface. A similar problem was detected on diesel 1A (see Figure 2-2B, reference 3). The cause of the problem is believed due to installation tolerances between bushings and the pedestal leading to excessive interference fits.

SCOPE OF INSPECTION:

- o Visual inspection of subcovers
- o The bosses on all of subcover assemblies were PT examined.

RESULTS OF INSPECTIONS:

No crack like indications were found on visual or PT inspections. One subcover appeared to have an incorrectly drilled hole for a bolt guide.

SUMMARY:

Several cracked bosses were found and the affected subcover assemblies have been replaced on Unit 1. These cracks have not caused a loss of operability of the engines. A failure analysis has been performed by FaAA under TDI Owners Group direction. This indicates that the cracks were due to installation or manufacturing errors and not due to service. Thus, replacement of the defective subcover castings resolves the problem. On diesel 2B no such cracks were found and thus these subcovers are considered acceptable for continued use. The incorrectly drilled hole was evaluated as having no effect on diesel operability.

3.2.8 Turbocharger Lube Oil Drain Line (Part No. 02-467A)

PROBLEM:

A temporary drain line on diesel 1A (reference 3) leaked during the extended operation test due to fatigue. It was replaced with an improved design as part of the diesel reassembly. Permanent lube oil drain lines have been installed on all Catawba diesels.

SCOPE OF INSPECTION:

Not applicable.

SUMMARY:

This problem has been resolved by installation of a permanent drain line on all Catawba diesels. The fact that this permanent drain line design did not leak during the 1B extended operation test provides assurance that the problem has been eliminated on all Catawba diesels.

3.2.9 Turbocharger Exhaust Gas Inlet Bolts (Part No. 02-380B)

PROBLEM:

One 1/2 inch stainless manifold to turbocharger adapter bolt was found broken during disassembly of diesel 1B (reference 2). This is similar to diesel 1A (reference 3) where four were found broken. The cause of the failure indicates that the bolts failed from creep rupture (reference 20).

SCOPE OF INSPECTION:

Not applicable.

RESULTS OF INSPECTION:

Not applicable.

SUMMARY:

On diesel 2B these bolts have been replaced with creep resistant SA 453, Grade 660, Condition A material. In addition, bolt installation procedures have been revised to insure that proper preloads are applied during this installation. Also, improved thread lubricant was used on reassembly to ease removal in the future.

3.2.10 Rocker Arm Adjusting Screw Swivel Pad (Part No. 02-390B)

PROBLEM:

One of the swivel pads was found cracked during operation on diesel 1B. This occurrence was reported in reference 2. Failure analysis (reference 20) 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. Another swivel pad was found cracked during reassembly of diesel 1B following the inspections. This pad is believed to have been cracked when the rocker arm was knocked over in storage.

SCOPE OF INSPECTIONS:

All swivel pads were visually inspected.

RESULTS OF INSPECTIONS:

Two swivel pads on diesel 2B were found to have small cracks. The cracks appear to have originated from die marks on the pads. Other pads were inspected and found to have these marks with no cracks associated with them. It is thought that the marks originated from upset metal on the die used to swage the pads.

SUMMARY:

The rocker arms with the cracked swivel pads were replaced with ones which were correctly swaged and free from cracking. Inspections of diesel 2A did not show the same problem. However, at the time of the 2A inspection it did not have the operating hours on it that 2B has. Diesel 2A now has about the same hours on it as 2B. Hence the swivel pads on 2A will be reinspected. In addition, the swivel pads will be reinspected after 6 months of operation on the 2B engine to ensure that cracks are not reoccurring. Finally, both engines 2A and 2B will be inspected at the first refueling as well.

3.2.11 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 11). During the extended operation test on diesel 1B (reference 2) one high pressure and one low pressure fuel line fitting leaked. The high pressure fitting was retorqued eliminating the leak. The low pressure fitting had teflon tape added to eliminate the leakage.

SCOPE OF INSPECTIONS:

The inspections of the fuel lines include a walk down inspection to verify that the piping is installed per the applicable design drawing and properly supported to suppress vibration.

RESULTS OF INSPECTIONS:

The inspection of the fuel lines was satisfactory.

SUMMARY:

During reassembly of the engine fuel lines, fittings were installed to Duke Power Company procedures to prevent improper torque values from being applied. In addition, walkdown inspections of the fuel lines have insured that the lines are properly attached, such that vibration problems are not expected.

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 2B diesel engine. The results of these inspections showed that the 2B diesel engine was in excellent condition, with only two additional problems in addition to the problems discussed in sections 3.1 and 3.2 above. The only additional problems noted were that a fuel injector nozzle stud had linear indications and one valve guide was found broken. These problems are discussed below.

3.3.1 Fuel Injector Nozzle Studs (Part No. 02-360A)

PROBLEM:

MT inspection revealed that one fuel injector nozzle stud had linear indications.

SCOPE OF INSPECTIONS:

All studs were visually and MT inspected.

RESULTS OF INSPECTIONS:

All studs passed visual examination. As mentioned above, one of the 32 studs MT examined had linear indications and was rejected.

SUMMARY:

The rejected stud was replaced by a spare stud which had passed both visual and MT examination.

3.3.2 Intake and Exhaust Valves (Part No. 02-360B)

PROBLEM:

One valve guide was found to be broken.

SCOPE OF INSPECTIONS:

The valve guides were visually inspected.

RESULTS OF INSPECTIONS:

One of the valve guides was found to be cracked in half in the cylinder head casting. The crack had proceeded circumferentially through the wall of the guide just below the seating surface of the guide. The valve guide is shrunk into the head with a mild interference fit. The upper section with the collar on it was captured by the valve spring and the lower section was retained by an interference fit in the head. The guide was functioning well although cracked and presented no safety problems.

SUMMARY:

Preliminary evaluations indicate that the failure could have resulted from a tolerance build or freeze damage. The cracked guide was removed from the head and replaced. Duke Power Co. is performing a failure analysis of this part.

3.4 Engineering Evaluation

In Section 5.0, Appendix B, an engineering evaluation of parts not inspected by traditional nondestructive techniques was performed. The engineering evaluation included reviews of operational and maintenance records to assure that no problems have been experienced.

The results of the engineering evaluation showed diesel 2B to be in excellent condition. Little nonscheduled maintenance had been performed on the engine mainly due to the small number of hours of service. Only two minor problems were discovered; several thermocouples were found defective and had to be replaced and one controlling relay was found defective and replaced. These failures were considered isolated and had no effect on engine operability in an emergency situation, and are therefore not considered significant.

References

1. Duke Power Co. letter dated April 30, 1985 to H. R. Denton, NRC, with attached document entitled "Catawba Unit 2 Inspection Matrix."
2. Duke Power Co. letter dated October 16, 1984 to H. R. Denton, NRC, enclosing "Catawba Nuclear Station, Diesel Engine 1B Component Revalidation Inspection."
3. Duke Power Co. letter dated June 29, 1984 to H. R. Denton, NRC, enclosing "Catawba Nuclear Station, Diesel Engine 1A Component Revalidation Inspection."
4. Failure Analysis Associates, "Metallurgical Analysis of Catawba Injection Port Leak", June 1984.
5. IE Information Notice No. 83-58, "Transamerica Delaval Diesel Generator Crankshaft Failure", NRC, August 30, 1983.
6. Bechtel Power Corporation, "Evaluation of Crankshaft Stresses for Duke Power Corporation, Catawba Nuclear Station", March 19, 1984.
7. Failure Analysis Associates, "Design Review of Connecting Rod Bearing Shells for Transamerica Delaval Enterprise Engines", March 12, 1984.
8. Catawba Diesels - "Owners Group DRQR Fuel Report - Summary of Recommendations", June 21, 1985.
9. (Deleted)
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11. 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.
12. Failure Analysis Associates, "Design Review of Engine Base and Bearing Caps for Transamerica Delaval Diesel Engine", April 1984.
13. Stone and Webster Engineering Corporation, "Emergency Diesel Generator Cylinder Head Stud Stress Analysis", March 1984.
14. Stone and Webster Engineering Corporation, "Supplement to Emergency Diesel Generator Auxiliary Module Control Wiring and Termination Qualification Review". June 1984.
15. 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.

16. Stone and Webster Engineering Corporation, "Emergency Diesel Generator, Fuel Oil Injection Tubing, Qualification Analysis", April 1984.
17. Stone and Webster Engineering Corporation, "Emergency Diesel Generator, Engine Driven Jacket Water Pump, Design Review", April 1984.
18. (Deleted)
19. Stone and Webster Engineering Corporation, "Emergency Diesel Generator, Auxiliary Module Control Wiring and Termination, Qualification Review", April 1984.
20. Duke Power Co., "Failure Analysis Report Catawba Nuclear Diesels 1A and 1B", June 26, 1984.
21. Stone and Webster Engineering Corporation, "Emergency Diesel Generator Air Start Valve Capscrew, Dimension and Stress Analysis", March 1984 and Supplement, April 1984.
22. Stone and Webster Engineering Corporation, "Emergency Diesel Generator Rocker Arm Capscrew Stress Analysis", dated March 1984, and Supplement dated April 1984.

Appendix A

Inspection Reports

Catawba Diesel 2B Inspection Report

Part Name:Jacket Water Standpipe Fittings and Gaskets

Part Number:00-700A

Class:B

Work Request No.:2176MNT

Attributes Verified

1. Visually inspect system per 11.2, ref. 1

References

1. MP/O/A/1000/53 Diesel Engine Jacket Water System, Piping, Standpipe and Manifold Special Inspection

Inspection Results

1. Visual inspections of the jacket water standpipe fittings and gaskets were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Jacket Water Standpipe Supports

Part Number: 00-700C

Class: B

Work Request No. 2176MNT

Attributes Verified

1. Visually inspect supports per 11.2, ref. 1.

References

1. MP/O/A/1000/53 Diesel Engine Jacket Water System, Piping, Standpipe and Manifold Special Inspection

Inspection Results

1. Visual inspections of the jacket water standpipe supports were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Jacket Water Standpipe Bolting Materials

Part Number: 00-700F

Class:B

Work Request No.2176MNT

Attributes Verified

1. Visually inspect bolting per 11.2, ref.1.

References

1. MP/O/A/1000/53 Diesel Engine Jacket Water System, Piping, Standpipe and Manifold Special Inspection

Inspection Results

1. Visual inspections of the jacket water standpipe bolting materials were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Main Bearing Bases

Part Number:02-305A

Class:A

Work Request No.2172MNT

Attributes Verified

1. Visually inspect mating surfaces per 11.5.3, ref. 1
(Bearings 4,6,8)

References

1. MP/O/A/1000/52 Diesel Engine Main Bearing Disassembly for
Special Inspection

Inspection Results

1. Visual inspections of the main bearing bases were
satisfactory.

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 2B Inspection Report

Part Name:Main Bearing Studs

Part Number:02-305C

Class:A

Work Request No.2172MNT

Attributes Verified

1. Verify stud elongation on reassembly per 11.7.10, ref. 1
(Bearings 4,6,8)

References

1. MF/O/A/1000/52 Diesel Engine Main Bearing Disassembly for
Special Inspection

Inspection Results

1. Stud elongations were satisfactory

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 2B Inspection Report

Part Name:Main Bearing Caps

Part Number:02-305D

Class:A

Work Request No.:2172MNT

Attributes Verified

1. Visually inspect mating surfaces per 11.5.3, ref. 1
(Bearings 4,6,8)

References

1. MP/O/A/1000/52 Diesel Engine Main Bearing Disassembly for
Special Inspection

Inspection Results

1. Visual inspections of the main bearing cap mating surfaces
were satisfactory.

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 2B Inspection Report

Part Name:Lube Oil Internal Headers

Part Number:02-307A

Class:A

Work Request No.2186MNT

Attributes Verified

1. Visually inspect headers per 11.3, ref. 1.

References

1. MP/O/A/1000/43 Diesel Engine Lube Oil System Piping and Sump
Special Inspection

Inspection Results

1. Visual inspections of the lube oil internal headers were
satisfactory.

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 2B Inspection Report

Part Name:Lube Oil Tubing and Fittings

Part Number:02-307B

Class:A

Work Request No.:2186MNT

Attributes Verified

1. Visually inspect internal lube oil system piping, tubing and fittings per 11.3, ref. 1
2. Visually inspect external lube oil system piping, tubing and fittings per 11.4.1 ref. 1

References

1. MP/O/A/1000/43 Diesel Engine Lube Oil System Piping and Sump
Special Inspection

Inspection Results

- 1&2 Visual inspections of the lube oil tubing and fittings were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Lube Oil Line Supports

Part Number:02-307D

Class:B

Work Request No.:2186MNT

Attributes Verified

1. Visually inspect supports per 11.3, ref. 1

References

1. MP/O/A/1000/43 Diesel Engine Lube Oil System Piping and Sump
Special Inspection

Inspection Results

1. Visual inspections of the lube oil line supports were
satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Crankshaft

Part Number:02-310A

Class:A

Work Request No.:2172MNT

Attributes Verified

1. Measure web deflection per 11.3.1, ref. 1 (All webs)
2. Visually inspect crankpins per 11.4.1, ref. 1 (All)
3. PT inspect oil holes in crankshaft per 11.6.1, ref. 1
(Journals 4,6,8)
4. ECT inspect oil holes in crankshaft per 11.6.2, ref. 1
(Journals 6,7,8)
5. Visually inspect crankshaft gear per 11.2.2, ref. 2

References

1. MP/O/A/1000/39 Diesel Engine Crankshaft and Turning Gear,
Gear, Crankshaft Bearings, Crankcase
Assembly, and Crankcase Covers Special
Inspection
2. MP/O/A/1000/40 Diesel Engine Idler Gears and Pump Drive
Gears Inspections and Adjustments

Inspection Results

1. Cold web deflections were satisfactory.
2. Visual inspections of the crankpins were satisfactory
3. PT inspection of the oil holes were satisfactory
4. ECT inspections of the oil holes were satisfactory.
5. Visual inspections of the crankshaft gear were satisfactory

Disposition of Inspection Findings

There were no significant findings. Hot web deflections could not be taken due to the #7 main bearing failure.

Catawba Diesel 2B Inspection Report

Part Name:Main Bearing Shells

Part Number:02-310B

Class:A

Work Request No.2172MNT

Attributes Verified

1. Visually inspect main bearing shells per 11.5.1, ref. 1. (Shells 4,6,8)
2. Measure thickness of the main bearing shells per 11.5.2, ref.1. (Shells 4,6,8)

References

1. MP/O/A/1000/52 Diesel Engine Main Bearing Disassembly for Special Inspection

Inspection Results

1. Visual inspections of the main bearing shells showed several instances of minor scratching, otherwise the bearings were satisfactory
2. Measurements of the thickness of the main bearing shells were satisfactory. The thickness of all shells was greater than .614 inches.

Disposition of Inspection Findings

1. Scratches on the main bearings were determined to be normal and the bearings were evaluated as satisfactory for reuse.

Catawba Diesel 2B Inspection Report

Part Name: Crankshaft Thrust Bearing Ring

Part Number: 02-310C

Class: A

Work Request No. 2172MNT

Attributes Verified

1. Measure thrust clearance per 11.3.1, ref. 1.

References

1. MP/O/A/1000/39 Diesel Engine Crankshaft and Turning Gear, Gear, Crankshaft Bearings, Crankcase Assembly, and Crankcase Covers Special Inspection

Inspection Results

1. Measurements of thrust clearance performed in the cold condition were satisfactory.

Disposition of Inspection Findings

There were no significant findings. Hot thrust bearing clearance could not be taken due to the #7 main bearing failure.

Catawba Diesel 2B Inspection Report

Part Name:Crankcase Assembly

Part Number:02-311A

Class:A

Work Request No.:2172MNT

Attributes Verified

1. Visually inspect cast surfaces of crankcase per 11.5.1, ref.1 (All surfaces)
2. Visually inspect crankcase arch wall per 11.5.2, ref.1 (All surfaces)
3. Verify crankcase material from foundry records per 11.5.4, ref. 1.

References

1. MP/O/A/1000/39 Diesel Engine Crankshaft and Turning Gear, Gear, Crankshaft Bearings, Crankcase Assembly, and Crankcase Covers Special Inspection

Inspection Results

1. Visual inspections of the cast surfaces were satisfactory.
2. Visual inspections of crankcase arch wall will be performed prior to plant operation.
3. The material was verified as being A-48 Gray Cast Iron

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Cylinder Block

Part Number:02-315A

Class:A

Work Request No.2171MNT

Attributes Verified

1. PT inspect cylinder block top per 11.2.1, ref. 1 (All blocks)
2. Measure liner landing area per 11.6.1, ref. 1 (Cyls 4,5-R/L)
3. PT inspect liner landing area per 11.6.2, ref. 1 (Cyls 4,5-R/L)
4. Replica inspect cylinder block per 11.7, ref. 1 (R/L Banks)

References

1. MP/O/A/1000/44 Diesel Engine Cylinder Block, Cylinder Liner and Jacket Water Manifold and Piping Special Inspection

Inspection Results

1. PT inspections of the cylinder block top were satisfactory.
2. Dimensions of the cylinder liner landing area were taken for information only - no acceptance standards were given. Liner and block landing area dimensions fell within .003 to .0055 in. proudness.
3. PT inspections of the liner landing area were satisfactory.
4. Replicas of the cylinder block demonstrated typical gray cast iron, class 40.

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 2B Inspection Report

Part Name:Cylinder Liner

Part Number:02-315C

Class:A

Work Request No.2171MNT

Attributes Verified

1. Visually inspect cylinder liners per 11.3.1, ref. 1 (All)
2. Measure bore of cylinder liner per 11.3.2, ref. 1 (1,4,5,8 R/L)
3. Measure distance liner protrudes per 11.3.3, ref. 1 (All)
4. Perform supplemental visual inspection of cylinder liners per 11.6.3, ref. 1 (4,5 R/L)
5. Perform supplemental dimensional inspections of cylinder liners per 11.6.4, ref. 1 (4,5 R/L)

References

1. MP/O/A/1000/44 Diesel Engine Cylinder Block, Cylinder Liner and Jacket Water Manifold and Piping Special Inspection

Inspection Results

1. Visual inspection of the cylinder liners were satisfactory.
2. Cylinder liner bores ranged from 16.995 to 16.999 inches.
3. Cylinder liner average protrusions were satisfactory.
4. Results of the supplemental visual inspections of the cylinder liner were satisfactory
5. Supplemental measurements of the cylinder liners were taken for information only.

Disposition of Inspection Findings

2. The liners were evaluated as satisfactory and acceptable for continued service.
5. There were no acceptance standards for these measurements, the data is for information only. See item 2, 02-315A.

Catawba Diesel 2B Inspection Report

Part Name: Cylinder Block Jacket Water Manifold

Part Number: 02-315D

Class: A

Work Request No. 2171MNT

Attributes Verified

1. Visually inspect the jacket water manifold per 11.5.1, ref. 1

References

1. MP/O/A/1000/44 Diesel Engine Cylinder Block, Cylinder Liner and Jacket Water Manifold and Piping Special Inspection

Inspection Results

1. Visual inspections of the jacket water manifold were satisfactory.

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 2B Inspection Report

Part Name:Cylinder Head Studs

Part Number:02-31SE

Class:8

Work Request No.:2170MNT, 2171MNT

Attributes Verified

1. Measure breakaway torque per 11.2.7, ref. 1. (3,4,5,6 L)
2. Verify proper installation per 11.6.3, ref. 1. (3,4,5,6 L)
3. Check free length per 11.6.4, ref. 1. (3,4,5,6L)
4. Visually inspect cylinder head studs per 11.4.2, ref. 2. (3,4,5,6 L)
5. Visually inspect for ID marks per 11.4.1, ref 2. (4,5 R/L)

References

1. MP/0/A/1000/35 Diesel Engine Cylinder Head Removal, Disassembly, Inspection and Reassembly
2. MP/0/A/1000/44 Diesel Engine Cylinder Block, Cylinder Liner and Jacket Water Manifold and Piping Special Inspection

Inspection Results

1. Breakaway torques were found to be 1057 to 1965 ft-lbs on the above sample.
2. All studs in the engine were removed and then reinstalled by inserting and backing out 1 turn.
3. The free lengths of all studs in the engine were verified as satisfactory (14-7/8 inches +1/4,-0)
4. Visual inspections of the cylinder head studs were satisfactory
5. Visual inspections showed appropriate ID markings.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Cylinder Head Nuts

Part Number:02-315F

Class:B

Work Request No.2170MNT, 2171MNT

Attributes Verified

1. Measure breakaway torque per 11.2.15, ref. 1 (All nuts)
2. Visually inspect nuts for ID markings per 11.4.3, ref. 2 (All nuts)
3. Visually inspect nuts for forging laps per 11.4.4, ref. 2 (25% sample)
4. Reassemble to TDI specifications per 11.6.10, ref. 1.

References

1. MP/O/A/1000/35 Diesel Engine Cylinder Head Removal, Disassembly, Inspection and Reassembly
2. MP/O/A/1000/44 Diesel Engine Cylinder Block, Cylinder Liner and Jacket Water Manifold and Piping Special Inspection

Inspection Results

1. Breakaway torques of the cylinder head nuts were 2390 to 3450 ft-lbs.
2. Visual inspections of ID numbers was satisfactory.
3. Visual inspections of the nuts for forging laps were satisfactory.
4. The nuts were reassembled and torqued to TDI specifications

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Cylinder Head Gaskets

Part Number:02-315G (02-360C)

Class:B

Work Request No.2170MNT

Attributes Verified

1. Visually inspect cover gaskets per 11.2.2, ref. 1 (All)
2. Verify correct gasket installation per 11.6.5, ref. 1 (All)

References

1. MP/O/A/1000/35 Diesel Engine Cylinder Head Removal,
Disassembly, Inspection and Reassembly

Inspection Results

1. Visual inspections of the cylinder head gaskets showed two instances of gaskets parting at seams.
2. Gaskets and seals were verified as properly installed

Disposition of Inspection Findings

1. All cylinder head cover gaskets were replaced on reassembly.
The defects found had no effect on diesel operability

Catawba Diesel 2B Inspection Report

Part Name:Jacket Water Manifold Assembly

Part Number:02-316A

Class:B

Work Request No.2176MNT

Attributes Verified

1. Visually inspect assembly per 11.3, ref. 1

References

1. MP/O/A/1000/53 Diesel Engine Jacket Water System, Piping, Standpipe and Manifold Special Inspection

Inspection Results

1. Visual inspections of the jacket water manifold assembly were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Jacket Water Inlet Manifold Coupling

Part Number:02-316B

Class:B

Work Request No.2176MNT

Attributes Verified

1. Visually inspect coupling per 11.3, ref.1.

References

1. MP/O/A/1000/53 Diesel Engine Jacket Water System, Piping, Standpipe and Manifold Special Inspection

Inspection Results

1. Visual inspections of the jacket water manifold couplings were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Jacket Water Discharge Manifold

Part Number:02-317A

Class:B

Work Request No.2176MNT,2171MNT

Attributes Verified

1. Visually inspect jacket water manifold per 11.5.1, ref. 1
2. Check Dresser coupling per 11.5.1, ref. 1
3. Visually inspect jacket water manifold per 11.4, ref. 2

References

1. MP/O/A/1000/44 Diesel Engine Cylinder Block, Cylinder Liner and Jacket Water Manifold and Piping Special Inspection
1. MP/O/A/1000/53 Diesel Engine Jacket Water System, Piping, Standpipe and Manifold Special Inspection

Inspection Results

1. Visual inspections of the jacket water manifold were satisfactory.
2. The Dresser coupling was marked D 21102-2ST66-B
3. Visual inspections of the manifold were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Jacket Water Discharge Manifold Coupling

Part Number:02-317B

Class:B

Work Request No.2176MNT

Attributes Verified

1. Visually inspect coupling per 11.5.1, ref. 1.

References

1. MP/O/A/1000/44 Diesel Engine Cylinder Block, Liner and Jacket Water Manifold Special Inspection

Inspection Results

1. Visual inspections of the jacket water manifold coupling were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Jacket Water Discharge Manifold Supports

Part Number:02-317C

Class:B

Work Request No.:2176MNT

Attributes Verified

1. Visually inspect supports per 11.4, ref. 1

References

1. MP/O/A/1000/53 Diesel Engine Jacket Water System, Piping, Standpipe and Manifold Special Inspection

Inspection Results

1. Visual inspections of the jacket water manifold supports were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Flywheel Bolting

Part Number: 02-330B

Class: A

Work Request No. 2190MNT

Attributes Verified

1. Verify correct torque is applied to flywheel bolts per 11.1, ref. 1 (All bolts)
2. Visually inspect flywheel for loose roll pins per 11.2.1, ref. 1 (All roll pins)

References

1. MP/O/A/1000/48 Diesel Engine Flywheel Bolting Special Inspection

Inspection Results

1. Correct torque was verified through construction documentation.
2. Visual inspections of the roll pins were satisfactory

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Front Gear Case Bolting

Part Number:02-335B

Class:C

Work Request No.:2173MNT

Attributes Verified

1. Visually inspect gear case covers for evidence of oil leaks per 11.1, ref. 1. (All covers)
2. Verify bolting is of appropriate material per 11.2, ref. 1 (All bolts)

References

1. MP/O/A/1000/41 Diesel Engine Gear Case Gaskets and Bolting
Special Inspection

Inspection Results

1. Visual inspections for evidence of leakage were satisfactory.
2. All capscrews were verified as class 5 or better quality.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Connecting Rods

Part Number:02-340A

Class:A

Work Request No.2171MNT

Attributes Verified

1. Measure torque of master rod bolts per 11.2.5, ref. 1 (All)
2. Check oil passages per 11.2.13, ref. 1 (All)
3. Measure torque of link rod bolts per 11.17.1, ref. 1 (All)
4. Measure link rod clearance per 11.18.6, ref. 1 (All)
5. Visually inspect connecting rods per 11.3.2, ref. 2 (All)
6. PT inspect rod box sides per 11.3.5, ref. 2 (All)
7. Visually inspect bolt washers per 11.4.1, ref. 2 (All)
8. MT inspect rod bolts per 11.4.2, ref. 2 (All)
9. Visually inspect bushings per 11.5.2, ref. 2 (All)
10. PT inspect con rod bushings per 11.5.3, ref. 2 (All)
11. Blue check serrations per 11.11.1, ref. 2 (All)
12. Measure con rod bushings per 11.3.3, ref. 2
(All Link Rods, Piston Pins 1L,5R,8L,8R)
13. Visually inspect link rod dowell per 11.3.4, ref. 2 (All)
14. Reassemble per TDI specifications per 11.15.10/11, ref 1.

References

1. MP/O/A/1000/36 Diesel Engine Piston Rod and Liner Removal, Disassembly, Inspection and Reassembly
2. MP/O/A/1000/38 Diesel Engine Piston, Rod, Bushing and Shell Special Inspection

Inspection Results

1. Torques of the master rod bolts ranged from 1010 to 2040 ft-lbs.
2. Inspections of the oil passages were satisfactory
3. Torques of the link rod bolts ranged from 760 to 1170 ft-lbs.
4. Measurements of link rod clearance were satisfactory
5. Visual inspections of the connecting rods showed minor scratches.
6. PT inspections of the rod box sides were satisfactory
7. Inspections of the rod washers and contact surfaces were satisfactory
8. MT inspections of the bolts were satisfactory
9. Visual inspections of the bushings showed minor scratches. One bushing (2L link rod) was heavily gouged
10. PT inspections of the bushings were satisfactory
11. All serrations showed > 80% contact-satisfactory
12. Dimensions of the con rod bushings were satisfactory

Connecting Rods, 02-340A- continued

13. Visual inspections of the con rod dowells were satisfactory
14. The connecting rods were reassembled per appropriate TDI specifications.

Disposition of Inspection Findings

5. The minor scratches that showed on visual inspection were evaluated as normal and it was determined that the parts are acceptable for continued service.
9. The 2L link rod bushing was replaced.

Catawba Diesel 2B Inspection Report

Part Name:Connecting Rod Bearings

Part Number:02-340B

Class:A

Work Request No.2171MNT

Attributes Verified

1. Visually inspect bearing shells per 11.5.2, ref. 1 (All)
2. PT inspect bearing shells per 11.5.3, ref. 1 (All)
3. RT inspect bearing shells per 11.5.4, ref. 1 (All)
4. Measure shell thickness per 11.5.5, ref. 1 (All)

References

1. MP/0/A/1000/38 Diesel Engine Piston, Rod, Bushing and Shell
Special Inspection

Inspection Results

1. Visual inspections of the bearing shells showed minor scratches.
2. PT inspections of the bearing shells showed no defects
3. RT inspections of the bearing shells showed one shell that could not be read to the acceptance standards.
4. Shell thicknesses were satisfactory

Disposition of Inspection Findings

1. The scratches that were discovered on visual inspections were determined to be normal and the bearing shells were evaluated as acceptable for reuse.
3. The shell was replaced even though it could not be determined to be unacceptable.

Catawba Diesel 2B Inspection Report

Part Name:Pistons

Part Number:02-341A

Class:A

Work Request No.2171MNT

Attributes Verified

1. Visually inspect fitup of crown to skirt per 11.6.1, ref. 1 (All pistons)
2. PT inspect piston skirt and crown per 11.6.2, 11.8.1, ref. 1 (All)
3. MT inspect piston skirts per 11.6.3, 11.8.3, ref. 1 (All)
4. Measure hardness of piston skirts per 11.8.4, ref. 1 (All)

References

1. MP/O/A/1000/3B Diesel Engine Piston, Rod, Bushing and Shell Special Inspection

Inspection Results

1. Visual inspections of the piston crown and skirt were satisfactory.
2. PT inspections of the piston skirts and crowns were satisfactory.
3. MT inspections of the piston skirts were satisfactory.
4. Hardness inspections showed uniform hardness in a range of 206 to 243 BHN

Disposition of Inspection Findings

4. The hardness data is affected by the surface roughness of the material measured. The hardness data is considered reasonable within the limits of accuracy of the measuring device.

Catawba Diesel 2B Inspection Report

Part Name:Piston Rings

Part Number:02-341B

Class:A

Work Request No.2171MNT

Attributes Verified

1. Inspect ring installation and measure per 11.11 ref. 1
(All rings)

References

1. MP/O/A/1000/36 Diesel Engine Piston, Rod, and Liner Removal,
Disassembly, Inspection and Reassembly

Inspection Results

1. New rings were installed in the engine to TDI specifications.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Piston Pins

Part Number:02-341C

Class:A

Work Request No.2171MNT

Attributes Verified

1. Visually inspect piston pin assembly per 11.7.2, ref. 1
Check rolled in Oil Plugs and inspect for distress. (All pins)

References

1. MP/O/A/1000/38 Diesel Engine Piston, Rod, Bushing and Shell
Special Inspection

Inspection Results

1. Visual inspections of the piston pins showed minor scratches; otherwise, the piston pins were satisfactory.

Disposition of Inspection Findings

1. The minor scratches that showed on visual inspection were determined to be normal and the piston pins were evaluated as acceptable for continued use.

Catawba Diesel 2B Inspection Report

Part Name: Intake Tappets

Part Number: 02-345A

Class: A

Work Request No.: 2173MNT

Attributes Verified

1. Visually inspect intake tappets per 11.6.1, ref. 1
(1L, 5L, 8L, 8R)

References

1. MP/O/A/1000/45 Diesel Engine Camshaft, Camshaft Gear and
Tappet Special Inspection

Inspection Results

1. Visual inspections of the intake tappets showed one tappet that was marked unsatisfactory because the tappet did not move freely outside of its normal range of travel. The tappet moved freely within its normal range of travel.

Disposition of Inspection Findings

1. This part was evaluated as satisfactory as it moved freely over its normal range of travel and is considered acceptable for continued use.

Catawba Diesel 2B Inspection Report

Part Name:Fuel Tappets

Part Number: 02-345B

Class:A

Work Request No.2173MNT

Attributes Verified

1. Visually inspect fuel tappets per 11.6.1, ref. 1.(1,5,8L, 8R)

References

1. MP/O/A/1000/45 Diesel Engine Camshaft, Camshaft Gear and Tappet Special Inspection

Inspection Results

1. Visual inspections of the fuel tappets were satisfactory.

Disposition of Inspection Findings

There were no significant findings

Catawba Diesel 2B Inspection Report

Part Name: Camshaft

Part Number: 02-350A

Class: A

Work Request No. 2173MNT

Attributes Verified

1. Visually inspect camshaft lobes per 11.3, ref. 1 (All)
2. Visually inspect camshaft locking clips per 11.4.3, ref. 1 (All)

References

1. MP/0/A/1000/45 Diesel Engine Camshaft, Camshaft Gear and Tappet Special Inspection

Inspection Results

1. Visual inspections of the camshaft lobes showed one lobe with minor pitting.
2. Visual inspections of the camshaft locking clips were satisfactory.

Disposition of Inspection Findings

The minor pitting seen on visual inspection was evaluated as a normal wear pattern. The camshaft was evaluated as satisfactory for continued use.

Catawba Diesel 2B Inspection Report

Part Name:Camshaft Bushings

Part Number:02-350B

Class:A

Work Request No.2173MNT

Attributes Verified

1. Visually inspect camshaft outboard support bushings per 11.4.2, ref. 1. (R/L)

References

1. MP/O/A/1000/45 Diesel Engine Camshaft, Camshaft Gear and Tappet Special Inspection

Inspection Results

1. Visual inspections of the camshaft bushings showed instances of minor scratches and gouges.

Disposition of Inspection Findings

1. The minor scratching and gouging reported on visual inspection were evaluated as normal wear patterns. The camshaft bushings were considered acceptable for continued service.

Catawba Diesel 2B Inspection Report

Part Name: Camshaft Gears

Part Number: 02-350C

Class: A

Work Request No. 2173MNT

Attributes Verified

1. Check web to gear torque per 11.4.4, ref. 1. (R/L)
2. Visually inspect cam gears per 11.5.4, ref. 1. (R/L)

References

1. MF/O/A/1000/45 Diesel Engine Camshaft, Camshaft Gear and Tappet Special Inspection

Inspection Results

1. The torque of the cam gear bolts was 80 (+10/-0) ft-lbs on reassembly.
2. Visual inspections of the cam gears were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Pump Drive Gear

Part Number:02-355A

Class:A

Work Request No.2173MNT

Attributes Verified

1. Visually inspect pump drive gear per 11.2.4, ref. 1.
2. Measure backlash per 11.3, ref. 1.

References

1. MP/O/A/1000/40 Diesel Engine Idler Gears and Pump Drive
Gears Inspections and Adjustments

Inspection Results

1. Visual inspections of the pump drive gear were satisfactory.
2. Backlash measurements were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Idler Gears

Part Number: 02-355B

Class: A

Work Request No. 2173MNT

Attributes Verified

1. Visually inspect idler gears per 11.2.3, ref. 1.
2. Measure backlash of the idler gears per 11.3.4, ref. 1.

References

1. MP/O/A/1000/40 Diesel Engine Idler Gears and Pump Drive
Gears Inspections and Adjustments

Inspection Results

1. Visual inspections of the idler gears were satisfactory.
2. Backlash measurements of the idler gears were satisfactory

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Air Start Valves

Part Number:02-359

Class:A

Work Request No.:2170MNT

Attributes Verified

1. Measure breakaway torque of capscrews per 11.2.13, ref. 1. (All)
2. Measure capscrew length per 11.3.2, ref. 2. (1,5,8L,8R)
3. Visually inspect seat areas of valves per 11.3.3, ref. 2. (All)
4. Visually inspect valve internal surfaces per 11.3.4, ref. 2. (All)

References

1. MP/0/A/1000/35 Diesel Engine Cylinder Head Removal, Disassembly, Inspection and Reassembly
2. MP/0/A/1000/37 Diesel Engine Cylinder Head and Associated Parts Special Inspection

Inspection Results

1. Breakaway torques ranges from 35-105 ft-lbs.
2. Capscrew lengths were verified as acceptable.
3. Visual inspections of the seat areas showed four valves that were unsatisfactory.
4. Visual inspections of the valve internal surfaces showed six valves that were unsatisfactory.

Disposition of Inspection Findings

1. Breakaway torques were considered in the range of 1A. These screws were installed by TDI. All screws have been reinstalled to correct torque values.
- 3&4. The results of these inspections were evaluated to be the result of normal wear for an engine that has seen service. These components were cleaned, reinstalled and evaluated as satisfactory for continued use.

Catawba Diesel 2B Inspection Report

Part Name:Cylinder Heads

Part Number:02-360A

Class:A

Work Request No.2170MNT

Attributes Verified (All steps inspect all 16 heads)

1. Visually inspect valve seats per 11.5.2, ref. 1.
2. PT inspect valve seats and fire deck per 11.5.3, ref. 1.
3. Measure thickness of fire deck using UT per 11.5.4, ref. 1.
4. Visually inspect heads for weld repairs per 11.5.5, ref. 1.
5. Visually inspect injection studs per 11.13.1, ref. 1.
6. MT inspect nozzle studs per 11.13.2, ref. 1.
7. ECT inspect nozzle cavities per ref. 2.

References

1. MP/O/A/1000/37 Diesel Engine Cylinder Head and Associated Parts Special Inspection
2. Special Engineering Evaluation "Eddy Currrent Inspection to Determine Catawba Diesel Cylinder Head Casting Weld Repairs" November, 1984

Inspection Results

1. Visual inspections of the valve seats were satisfactory.
2. PT inspections of the valve seats and fire deck were satisfactory.
3. UT thickness measurements of the fire deck showed the fire deck to be .50 - .52 inches thick.
4. All heads were free from partial penetration welded plugs.
5. All studs were found to be satisfactory.
6. One stud showed a linear indication on MT inspections which was on the shank.
7. All heads were satisfactory on ECT inspection.

Disposition of Inspection Findings

6. The stud with the linear indication was replaced.

Catawba Diesel 2B Inspection Report

Part Name: Intake and Exhaust Valves

Part Number: 02-360B

Class: B

Work Request No. 2170MNT

Attributes Verified

1. Check valve clearance per 11.5.4.2, ref. 1. (All)
2. Check valve seating per 11.5.4.3, ref. 1. (All)
3. Visually inspect seat area per 11.4.2, ref. 2. (All)
4. Visually inspect valve guides per 11.4.3, ref. 2. (All)
5. Visually inspect valve stems per 11.4.4, ref. 2. (All)
6. Visually inspect valve stem top per 11.4.5, ref. 2. (All)
7. Visually inspect friction weld per 11.4.6, ref. 2.
(1,5,8L/8R)
8. PT inspect valve stem-head radius per 11.4.9, ref. 2. (All)

References

1. MP/0/A/1000/35 Diesel Engine Cylinder Head Removal,
Disassembly, Inspection and Reassembly
2. MP/0/A/1000/37 Diesel Engine Cylinder Head and Associated
Parts Special Inspection

Inspection Results

1. Valve clearances were within normal limits.
2. All valve seating was checked and found satisfactory.
3. Visual inspections of the valve seat areas were satisfactory
4. Visual inspections of the valve guides showed valve guide 8L
to be broken.
5. Visual inspections of the valve stems showed one valve stem
to be unsatisfactory.
6. Visual inspections of the valve stem tops showed evidence of
normal wear.
7. Visual inspections of the friction welds were satisfactory.
8. PT inspections of the valve stem radii were satisfactory.

Disposition of Inspection Findings

4. The broken valve guide is being analyzed to determine the
cause of failure. Preliminary observations indicate that the
failure could have been the result of installation error.
The pieces of the guide were captured by the head casting at
all times and the guide functioned well although broken. The
guide was replaced.

Intake and Exhaust Valves, 02-3608, continued

5. One valve had a slight amount of displaced metal on the stem top. This valve was replaced.

Catawba Diesel 2B Inspection Report

Part Name:Valve Springs

Part Number:02-360D

Class:B

Work Request No.2170MNT

Attributes Verified

1. Check color code on valve springs per 11.4.7, ref. 1. (All)
2. Visually inspect the valve springs per 11.4.8, ref. 1.(All)

References

1. MP/O/A/1000/37 Diesel Engine Cylinder Head and Associated Parts Special Inspection

Inspection Results

1. The color code found on the valve springs was correct.
2. Visual inspections of the valve springs were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Subcovers

Part Number:02-362A

Class:B

Work Request No.2170MNT

Attributes Verified

1. Visually inspect subcovers per 11.6.2, ref. 1. (All)
2. PT inspect rocker arm pedestals per 11.6.3, ref. 1. (All)

References

1. MP/0/A/1000/37 Diesel Engine Cylinder Head and Associated Parts Special Inspection

Inspection Results

1. Visual inspections of the subcovers showed one subcover to have a possible manufacturing defect.
2. PT inspections of the rocker arm pedestals showed no defects.

Disposition of Inspection Findings

1. The defect found on visual inspection was an incorrectly drilled hole for a bolt guide. This was evaluated as having no effect on diesel operability and the part was determined to be acceptable for continued use.

Catawba Diesel 2B Inspection Report

Part Name: Fuel Injection Pump

Part Number: 02-365A

Class: B

Work Request No. 2170MNT

Attributes Verified

1. Visually inspect the ID of the valve holder using a borescope per 11.2.2, ref. 1. (All)
2. MT inspect the delivery valve assembly per 11.4.3, ref. 1. (All)

References

1. MP/O/A/1000/42 Diesel Engine Fuel Pump and Linkage Special Inspection

Inspection Results

1. Visual inspections of the ID of the valve holders were satisfactory with the exception of two holders.
2. MT inspections of the delivery valve assemblies were satisfactory.

Disposition of Inspection Findings

1. One valve holder was reamed out and the inspection was repeated with satisfactory results. The other valve holder was replaced.

Catawba Diesel 2B Inspection Report

Part Name:Fuel Injection Tubing

Part Number:02-365C

Class:B

Work Request No.2178MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.2, ref. 1.
2. ECT inspect tubing per 11.3, ref. 1. (All)

References

1. MP/O/A/1000/55 Diesel Engine Fuel Oil Piping System Special Inspection

Inspection Results

1. Visual inspections of the fuel injection tubing showed minor discrepancies with the as-designed drawings.
2. ECT inspections showed no indications.

Disposition of Inspection Findings

1. The discrepancies found on the visual inspections were determined to have no effect on engine performance. The tubing was reassembled and the determined to be satisfactory.

Catawba Diesel 2B Inspection Report

Part Name:Fuel Injection Tubing Supports

Part Number:02-365D

Class:B

Work Request No.:2178MNT

Attributes Verified

1. Visually inspect tubing supports to verify as-built condition per 11.2, ref. 1.

References

1. MP/O/A/1000/55 Diesel Engine Fuel Oil Piping System Special Inspection

Inspection Results

1. Visual inspections of the fuel injection tubing supports were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Fuel Pump Linkage

Part Number: 02-371A/B

Class:A

Work Request No.2170MNT

Attributes Verified

1. Visually inspect linkage per 11.1.2, ref. 1. (All)
2. Ensure that an adequate lubrication schedule is in place per 11.1.3, ref. 1.

References

1. MP/O/A/1000/42 Diesel Engine Fuel Pump and Linkage Special Inspection

Inspection Results

1. Visual inspections of the fuel pump linkage were satisfactory.
2. An adequate lubrication schedule was verified as in place.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 7B Inspection Report

Part Name: Intake Manifolds

Part Number: 02-375

Class: B

Work Request No. 2170MNT

Attributes Verified

1. Visually inspect surfaces and bolt holes per 11.2.2, ref. 1. (All)
2. Visually inspect gasket fitup and alignment on installation per 11.2.3, ref. 1. (All)
3. Verify correct installation per 11.6.14, ref. 2. (All)

References

1. MP/0/A/1000/46 Diesel Engine Intake and Exhaust Manifolds
Special Inspection
2. MP/0/A/1000/35 Diesel Engine Cylinder Head Removal,
Disassembly, Inspection and Reassembly.

Inspection Results

1. Visual inspections of the manifold surfaces and the bolt holes were satisfactory.
2. Visual inspections of gasket fitup were satisfactory.
3. The manifolds were installed to TDI specifications.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Exhaust Manifold

Part Number: 02-380A

Class: B

Work Request No. 2170MNT

Attributes Verified

1. Check alignment on disassembly per 11.2.11.1, ref. 1. (All)
2. Visually inspect flange welds per 11.3.4, ref. 2. (All)
3. Visually inspect system to verify as built condition per 11.2, ref. 3.
4. Verify proper reassembly per 11.6.13, ref. 1. (All)

References

1. MF/O/A/1000/35 Diesel Engine Cylinder Head Removal, Disassembly, Inspection and Reassembly
2. MF/O/A/1000/46 Diesel Engine Intake and Exhaust Manifolds Special Inspection
3. MF/O/A/1000/56 Diesel Engine Exhaust Manifold Special Inspection

Inspection Results

1. Alignment on disassembly was satisfactory.
2. Visual inspections of the flange welds were satisfactory.
3. Visual inspections of the as-built system were satisfactory.
4. The manifolds were installed to TDI specifications.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Exhaust Manifold Bolting

Part Number: 02-380B

Class: B

Work Request No.: 2170MNT

Attributes Verified (Accomplish 1,2, and 3 on one bolt from cyls
1L,5R and 8R)

1. Visually inspect bolts per 11.3.2, ref. 1.
2. Measure bolt length per 11.3.2, ref. 1.
3. Measure depth of bolt holes per 11.3.3, ref. 1.
4. Visually inspect bolts per 11.2, ref.2 (All)

References

1. MP/O/A/1000/46 Diesel Engine Intake and Exhaust Manifolds
Special Inspection
2. MP/O/A/1000/56 Diesel Engine Exhaust Manifold Special
Inspection

Inspection Results

1. Visual inspections of the exhaust manifold bolts were
satisfactory.
2. All bolts were 1.5 inches long - satisfactory.
3. Bolt hole depths were found to be satisfactory.
4. Visual inspections of the as built condition were
satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Crankcase Covers

Part Number: 02-386B

Class: C

Work Request No.: 2170MNT

Attributes Verified

1. Visually inspect bolt holes per 11.5.2, ref. 1. (All)
2. Reassemble covers per 11.16, ref. 2. (All)

References

1. MP/O/A/1000/39 Diesel Engine Crankshaft and Turning Gear, Gear, Crankshaft Bearings, Crankcase Assembly, and Crankcase Covers Special Inspection
2. MP/O/A/1000/36 Diesel Engine Piston, Rod and Liner Removal, Disassembly, Inspection and Reassembly

Inspection Results

1. Visual inspections of the crankcase cover bolt holes were satisfactory.
2. The covers were reinstalled to TDI specifications.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Intake/Intermediate Rocker Arms

Part Number: 02-390A

Class: B

Work Request No. 2170MNT

Attributes Verified (Accomplish on all Rocker Arms)

1. Visually inspect rocker arm shafts per 11.7.2, ref. 1.
2. Visually inspect rocker arm lips per 11.7.3, ref. 1.
3. Visually inspect sockets per 11.7.5, ref. 1.
4. Visually inspect swivel pads per 11.7.6, ref. 1.
5. Visually inspect drive studs per 11.7.8, ref. 1.

References

1. MP/O/A/1000/37 Diesel Engine Cylinder Head and Associated Parts Special Inspection

Inspection Results

1. Visual inspections of the rocker arms showed minor amounts of nicking and gouges.
2. Visual inspections of the rocker arm lips were satisfactory.
3. Visual inspections of the rocker arm sockets were satisfactory.
4. Visual inspections of the rocker arm swivel pads showed two pads with cracks.
5. Visual inspections of the rocker arm drive studs were satisfactory.

Disposition of Inspection Findings

1. The amount of nicking and gouges found on visual inspection of the rocker arms was determined to be normal and would have no effect on engine performance. These parts were evaluated as being acceptable for continued use.
4. The cracks found in the swivel pads were determined to be the result of improper swaging. The cracked pads were replaced with new pads.

Catawba Diesel 2B Inspection Report

Part Name: Exhaust Rocker Arms

Part Number: 02-390B

Class: B

Work Request No. 2170MNT

Attributes Verified (Accomplish on all Rocker Arms)

1. Visually inspect rocker arm shafts per 11.8.2, ref. 1.
2. Visually inspect rocker arm lips per 11.8.3, ref. 1.
3. Visually inspect sockets per 11.8.5, ref. 1.
4. Visually inspect swivel pads per 11.8.6, ref. 1.
5. Visually inspect drive studs per 11.8.8, ref. 1.

References

1. MP/O/A/1000/37 Diesel Engine Cylinder Head and Associated Parts Special Inspection

Inspection Results

1. Visual inspections of the exhaust rocker arms showed minor amounts of scratching.
2. Visual inspections of the exhaust rocker arm lips were satisfactory.
3. Visual inspections of the exhaust rocker arm sockets were satisfactory.
4. Visual inspections of the exhaust rocker arm swivel pads were satisfactory.
5. Visual inspections of the exhaust rocker arm drive studs were satisfactory.

Disposition of Inspection Findings

1. The amount of scratching found on visual inspection of the rocker arms was determined to be normal and would have no effect on engine performance. These parts were evaluated as being acceptable for continued use.

Catawba Diesel 2B Inspection Report

Part Name: Intake/Exhaust Pushrods

Part Number: 02-390C

Class: B

Work Request No. 2170MNT

Attributes Verified (Accomplish on all Pushrods)

1. Verify pushrods are of friction welded design per 11.9.2, ref. 1.
2. PT inspect friction weld per 11.9.3, ref. 1.
3. Visually inspect spherical surfaces per 11.9.4, ref. 1.

References

1. MP/O/A/1000/37 Diesel Engine Cylinder Head and Associated Parts Special Inspection

Inspection Results

1. The pushrods were verified as being of friction welded design.
2. PT inspections of the friction weld were satisfactory.
3. Visual inspections of the spherical surfaces were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Connector Pushrods

Part Number:02-390D

Class:B

Work Request No.:2170MNT

Attributes Verified (Accomplish on all Pushrods)

1. Verify pushrods are of friction welded design per 11.10.2, ref. 1.
2. PT inspect friction weld per 11.10.3, ref. 1.
3. Visually inspect spherical surfaces per 11.10.4, ref.1.

References

1. MP/O/A/1000/37 Diesel Engine Cylinder Head and Associated Parts Special Inspection

Inspection Results

1. The pushrods were verified as being of friction welded design.
2. PT inspections of the friction weld were satisfactory.
3. Visual inspections of the spherical surfaces were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Rocker Arm Bushings

Part Number: 02-390E

Class: B

Work Request No. 2170MNT

Attributes Verified

1. Visually inspect rocker arm bushings per 11.7.7, ref. 1.
(All)
2. Visually inspect exhaust rocker arm bushings per 11.8.7,
ref. 1. (All)

References

1. MP/O/A/1000/37 Diesel Engine Cylinder Head and Associated
Parts Special Inspection

Inspection Results

- 1,2 Visual inspections of the intake/intermediate and exhaust
rocker arms were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Rocker Arm Bolting

Part Number: 02-3906

Class: B

Work Request No. 2170MNT

Attributes Verified

1. MT inspect capscrew thread roots per 11.11.2, ref. 1. (All)
2. Visually inspect rocker arm capscrews per 11.11.5, ref. 1. (All)
3. Verify reassembly torque per 11.6.17, ref. 2. (All)

References

1. MP/O/A/1000/37 Diesel Engine Cylinder Head and Associated Parts Special Inspection
2. MP/O/A/1000/35 Diesel Engine Cylinder Head Removal, Disassembly, Inspection and Reassembly

Inspection Results

1. MT inspections of the rocker arm capscrew thread roots showed one defect in the capscrew shaft. All threads were satisfactory.
2. Visual inspections of the rocker arm capscrews were evaluated as satisfactory.
3. The capscrews were torqued to TDI specifications on reassembly.

Disposition of Inspection Findings

1. The capscrew with the MT defect in the shaft was replaced.

Catawba Diesel 2B Inspection Report

Part Name:Overspeed Trip and Accessory Drive

Part Number:02-410B

Class:A

Work Request No.2184MNT

Attributes Verified

1. Visually inspect drive gear per 11.3.2.1, ref. 1.
2. Visually inspect driven gear per 11.3.2.2, ref. 1.

References

1. MP/O/A/1000/47 Diesel Engine Governor and Overspeed Trip
Accessory Drives Disassembly, Inspection and
Reassembly

Inspection Results

1. Visual inspections of the drive gear were satisfactory.
2. Visual inspections of the driven gear were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Overspeed Trip Drive Coupling

Part Number:02-410C

Class:A

Work Request No.:2184MNT

Attributes Verified

1. Visually inspect coupling elastomer per 11.3.1.1, ref. 1.

References

1. MP/O/A/1000/47 Diesel Engine Governor and Overspeed Trip
Accessory Drives Disassembly, Inspection and
Reassembly

Inspection Results

1. Visual inspections of the coupling elastomer were
satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Speed Regulating Governor Drive

Part Number:02-411A

Class:A

Work Request No.2184MNT

Attributes Verified

1. Visually inspect large horizontal drive gear per 11.5.2.1, ref. 1.
2. Visually inspect small horizontal drive gear per 11.5.2.2, ref. 1.

References

1. MP/O/A/1000/47 Diesel Engine Governor and Overspeed Trip Accessory Drives Disassembly, Inspection and Reassembly

Inspection Results

1. Visual inspections of the large horizontal drive gear were satisfactory.
2. Visual inspections of the small horizontal drive gear were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Speed Regulating Governor Drive Coupling

Part Number:02-411B

Class:A

Work Request No.2184MNT

Attributes Verified

1. Visually inspect coupling per 11.5.2.3, ref. 1.
2. Verify coupling material is neoprene per 11.7.2, ref. 1.
3. Verify correct assembly of set screws and drive pins per 11.7.3, ref. 1.

References

1. MP/O/A/1000/47 Diesel Engine Governor and Overspeed Trip
Accessory Drives Disassembly, Inspection and
Reassembly

Inspection Results

1. Visual inspections of the governor drive coupling were satisfactory.
2. The coupling material was verified as neoprene.
3. The coupling set screws and drive pins were reassembled to proper procedural requirements.

Disposition of Inspection Findings

2. There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Speed Regulating Governor Linkage

Part Number: 02-413A

Class: A

Work Request No. 2184MNT

Attributes Verified

1. Check linkage action per 11.6.1, ref. 1.
2. Visually inspect cross shaft per 11.6.2, ref. 1.
3. Verify locktite installation per 11.6.4, ref. 1.

References

1. MP/O/A/1000/47 Diesel Engine Governor and Overspeed Trip
Accessory Drives Disassembly, Inspection and
Reassembly

Inspection Results

1. The linkage action was checked and found satisfactory.
2. Visual inspections of the cross shaft were satisfactory.
3. Locktite was installed to procedural requirements.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Fuel Pump Linkage and Shutdown Cylinder

Part Number:02-413B

Class:B

Work Request No.2184MNT

Attributes Verified

1. Check linkage action per 11.6.1, ref. 1.
2. Visually inspect cross shaft per 11.6.2, ref. 1.

References

1. MP/O/A/1000/47 Diesel Engine Governor and Overspeed Trip
Accessory Drives Disassembly, Inspection and
Reassembly

Inspection Results

1. The linkage action was checked and found to be satisfactory.
2. Visual inspections of the cross shaft were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Governor Booster Servomotor

Part Number:02-415B

Class:B

Work Request No.:2184MNT

Attributes Verified

1. Verify proper installation per 11.2.1, ref. 1.

References

1. MP/O/A/1000/47 Diesel Engine Governor and Overspeed Trip
Accessory Drives Disassembly, Inspection and
Reassembly

Inspection Results

1. The installation of the servomotor was verified as correct.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Governor Heat Exchanger

Part Number:02-415C

Class:A

Work Request No.2184MNT

Attributes Verified

1. Verify proper installation per 11.2.2, ref. 1.

References

1. MP/O/A/1000/47 Diesel Engine Governor and Overspeed Trip
Accessory Drives Disassembly, Inspection and
Reassembly

Inspection Results

1. The installation of the governor heat exchanger was verified
as satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Jacket Water Pump

Part Number: 02-423A

Class: A

Work Request No. 2183MNT

Attributes Verified

1. Visually inspect gear carrier per 11.2, ref. 1.
2. Visually inspect gear, coupling, and spline per 11.3.1, ref. 1.
3. Verify torque of impeller nut per 11.4, ref. 1.
4. Verify torque of spline nut per 11.5, ref. 1.
5. Check end play of external spline per 11.5.1, ref. 1.

References

1. MP/O/A/1000/59 Diesel Engine Jacket Water Pump Special Inspection

Inspection Results

1. The gear carrier assembly was inaccessible for inspection.
2. Visual inspections of the coupling and spline were satisfactory. Driven gear was inaccessible for inspection.
3. The torque of the impeller nut was found to be 80 ft-lbs.
4. The torque of the spline nut was found to be at least 120 ft-lbs.
5. The external spline was reassembled with the correct amount of end play.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Intercooler Piping Coupling

Part Number: 02-436B

Class: A

Work Request No. 2185MNT

Attributes Verified

1. Check Dresser coupling on piping per 11.5.4, ref. 1.

References

1. MP/O/A/1000/49 Diesel Engine Turbocharger and Intercooler
Special Inspection

Inspection Results

1. The Dresser coupling on the intercooler piping was inspected and found to be the correct type.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Turbocharger Cooling Water Piping and Fittings

Part Number: 02-437A

Class: B

Work Request No. 2176MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.5, ref. 1.

References

1. MP/O/A/1000/53 Diesel Engine Jacket Water System, Piping, Standpipe and Manifold Special Inspection

Inspection Results

1. Visual inspections of the turbocharger cooling water piping and fittings were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Turbocharger Cooling Water Piping Supports

Part Number: 02-437B

Class: A

Work Request No.: 2176MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.5, ref. 1.

References

1. MP/O/A/1000/53 Diesel Engine Jacket Water System, Piping, Standpipe and Manifold Special Inspection

Inspection Results

1. Visual inspections of the turbocharger cooling water piping supports were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Start Air Manifold Tubing

Part Number: 02-441A

Class:A

Work Request No.2175MNT

Attributes Verified

1. Visually inspect system to verify as built condition per.
11.2 ref. 1.

References

1. MP/O/A/1000/54 Diesel Engine Air Start Piping System Special
Inspection

Inspection Results

1. Visual inspections of the start air manifold tubing were
satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Start Air Manifold Pipe Supports

Part Number:02-441C

Class:A

Work Request No.2175MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.2 ref. 1.

References

1. MP/O/A/1000/54 Diesel Engine Air Start Piping System Special Inspection

Inspection Results

1. Visual inspections of the start air pipe supports were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Start Air Distributor Tubing

Part Number:02-442B

Class:A

Work Request No.2175MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.3 ref. 1.

References

1. MP/O/A/1000/54 Diesel Engine Air Start Piping System Special Inspection

Inspection Results

1. Visual inspections of the start air distributor tubing were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Fuel Injection Piping

Part Number:02-450B

Class:B

Work Request No.2178MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.2 ref. 1.

References

1. MP/0/A/1000/55 Diesel Engine Fuel Oil Piping System Special Inspection

Inspection Results

1. Visual inspections of the fuel injection piping showed minor discrepancies with as-designed drawings.

Disposition of Inspection Findings

1. The discrepancies found on the visual inspections were evaluated as having no effect on the performance of the diesel. The fuel injection system was reassembled and determined satisfactory for continued use.

Catawba Diesel 2B Inspection Report

Part Name:Fuel Oil Piping Supports

Part Number:02-450D

Class:A

Work Request No.2178MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.2 ref. 1.

References

1. MP/O/A/1000/55 Diesel Engine Fuel Oil Piping System Special Inspection

Inspection Results

1. Visual inspections of the fuel oil piping supports were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Fuel Oil Filter Mounting Hardware

Part Number:02-455C

Class:A

Work Request No.2173MNT

Attributes Verified

1. Verify correct torque is applied to bolt per 11.3.1, ref. 1.
2. Visually inspect system to verify as-built condition per 11.2, ref. 2.

References

1. MP/O/A/1000/42 Diesel Engine Fuel Pump and Linkage Special Inspection
2. MP/O/A/1000/55 Diesel Engine Fuel Oil Piping System Special Inspection

Inspection Results

1. The fuel oil filter mounting bolt torque was verified as 60 ft-lbs.
2. Visual inspections of the fuel oil filter mounting hardware were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:External Lube Oil Lines

Part Number:02-465A

Class:A

Work Request No.2186MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.4 ref. 1.

References

1. MP/O/A/1000/43 Diesel Engine Lube Oil System Piping and Sump Special Inspection

Inspection Results

1. Visual inspections of the external lube oil lines were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:External Lube Oil Line Supports

Part Number:02-465B

Class:A

Work Request No.2186MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.4 ref. 1..

References

1. MP/O/A/1000/43 Diesel Engine Lube Oil System Piping and Sump Special Inspection

Inspection Results

1. Visual inspections of the external lube oil line supports were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Turbocharger Lube Oil Piping

Part Number: 02-467A

Class: B

Work Request No. 2186MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.5 ref. 1.

References

1. MP/O/A/1000/43 Diesel Engine Lube Oil System Piping and Sump
Special Inspection

Inspection Results

1. Visual inspections of the turbocharger lube oil piping were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Turbocharger Lube Oil Piping Supports

Part Number: 02-467B

Class: B

Work Request No.: 2186MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.5 ref. 1.

References

1. MP/O/A/1000/43 Diesel Engine Lube Oil System Piping and Sump Special Inspection

Inspection Results

1. Visual inspections of the turbocharger lube oil piping supports were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Turbocharger Bracket

Part Number: 02-475A

Class: B

Work Request No.: 2185MNT

Attributes Verified

1. Visually inspect turbocharger bracket per 11.3.2, ref. 1.
(All brackets and bar supports)

References

1. MF/O/A/1000/49 Diesel Engine Turbocharger and Intercooler
Special Inspection

Inspection Results

1. Visual inspections of the turbocharger bracket were
satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Turbocharger Bracket Bolting

Part Number: 02-475D

Class: B

Work Request No. 2185MNT

Attributes Verified

1. Visually inspect bolted joint per 11.4.3, ref. 1. (R/L Banks)
2. Verify proper torque is applied to bolts per 11.4.4, ref. 1.
(Sample of 6 bolts)

References

1. MP/O/A/1000/49 Diesel Engine Turbocharger and Intercooler
Special Inspection

Inspection Results

1. Visual inspections of the joints were satisfactory.
2. The bolts were retorqued to the required values on reassembly.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Control Panel Tubing

Part Number:02-500M

Class:B

Work Request No.2177MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.3 ref. 1.

References

1. MP/O/A/1000/57 Diesel Engine Shutdown Tubing and Electrical Conduit Special Inspection

Inspection Results

1. Visual inspections of the control panel tubing were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Lube Oil Sump Tank

Part Number:02-540A

Class:B

Work Request No.2186MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.4 ref. 1.

References

1. MP/0/A/1000/43 Diesel Engine Lube Oil System Piping and Sump Special Inspection

Inspection Results

1. Visual inspections of the lube oil sump tank were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Lube Oil Sump Tank Bolting

Part Number:02-540B

Class:B

Work Request No.2186MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.4 ref. 1.

References

1. MP/O/A/1000/43 Diesel Engine Lube Oil System Piping and Sump Special Inspection

Inspection Results

1. Visual inspections of the lube oil sump tank bolting were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 28 Inspection Report

Part Name:Lube Oil Sump Tank Mounting Hardware

Part Number:02-540C

Class:B

Work Request No.2186MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.4 ref. 1.

References

1. MP/O/A/1000/43 Diesel Engine Lube Oil System Piping and Sump Special Inspection

Inspection Results

1. Visual inspections of the lube oil sump tank mounting hardware were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Engine/Auxillary Module Wiring Conduit

Part Number:02-688A

Class:A

Work Request No.2177MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.4 ref. 1.

References

1. MP/O/A/1000/57 Diesel Engine Shutdown Tubing and Electrical Conduit Special Inspection

Inspection Results

1. Visual inspections of the engine/aux wiring conduit showed satisfactory comparison with as-designed drawings.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name:Engine Shutdown Tubing

Part Number:02-695A

Class:A

Work Request No.2177MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.2 and 11.3, ref. 1.

References

1. MP/O/A/1000/57 Diesel Engine Shutdown Tubing and Electrical Conduit Special Inspection

Inspection Results

1. Visual inspections of the engine shutdown tubing showed minor discrepancies with as-designed drawings.

Disposition of Inspection Findings

1. The discrepancies found on visual inspections were evaluated as having no effect on diesel operability. The tubing will be reassembled to the correct configuration.

Catawba Diesel 2B Inspection Report

Part Name: Turbocharger Thrust Bearing Lube System

Part Number: 02-CFR

Class: C

Work Request No. 2186MNT

Attributes Verified

1. Visually inspect system to verify as built condition per 11.5 ref. 1.

References

1. MP/O/A/1000/43 Diesel Engine Lube Oil System Piping and Sump Special Inspection

Inspection Results

1. Visual inspections of the turbocharger thrust bearing lube system were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Intercooler

Part Number: F-068

Class: B

Work Request No. 2185MNT

Attributes Verified

1. Visually inspect intercooler per 11.5.2, ref. 1. (L/R)
2. PT or MT inspect intercooler adaptor flange weld per 11.5.3, ref. 1 (L/R)

References

1. MP/O/A/1000/49 Diesel Engine Turbocharger and Intercooler
Special Inspection

Inspection Results

1. Visual inspections of the intercooler were satisfactory.
2. MT examinations of the adaptor flange weld were satisfactory.

Disposition of Inspection Findings

There were no significant findings.

Catawba Diesel 2B Inspection Report

Part Name: Turbocharger

Part Number: MP/022/3

Class: A

Work Request No. 2185MNT

Attributes Verified (Perform inspections on all turbochargers
with > 50 hours service)

1. Visually inspect turbocharger assembly per 11.2.2, ref. 1.
2. Visually inspect journal bearings per 11.2.3, ref. 1.
3. Measure rotor float end clearance per 11.2.4, ref. 1.
4. Verify correct number of bolts in place on inlet casing per 11.2.5, ref. 1.
5. PT inspect stationary nozzle ring per 11.2.6, ref. 1.
6. Measure ID of journal bearings per 11.2.7, ref. 1.
7. Verify correct torque on casing bolts per 11.2.8, ref. 1.
8. Visually inspect exhaust gas inlet bolts per 11.6.1, ref. 1.

References

1. MF/0/A/1000/49 Diesel Engine Turbocharger and Intercooler
Special Inspection

Inspection Results

1. Visual inspections of the left bank turbocharger were unsatisfactory.
2. The turbocharger bearings were found severely worn.
3. The rotor float clearances were found satisfactory.
4. The inlet casing bolts were found satisfactory.
5. PT inspections were performed by the manufacturer. The documentation was reviewed and found satisfactory.
6. The bearing diameters were unsatisfactory due to severe wear.
7. The casing bolts were torqued to 60 ft-lbs on reassembly.
8. Visual inspections of the exhaust gas inlet bolts were satisfactory.

Disposition of Inspection Findings

The bearing wear found was determined to be the result of inadequate lubrication. The turbocharger had been run with inadequate oil flow due to the oil being supplied through piping with thicker than normal wall thickness. The bearings on the right bank turbocharger were replaced. The left bank turbocharger was replaced entirely due to lack of spare parts for repair. The thick wall piping was replaced with

5.0

Appendices

Appendix B
Engineering Evaluations

APPENDIX B

Introduction

The purpose of this appendix is to document the results of the engineering evaluations performed for selected parts of the Catawba 2B diesel. The parts were selected for this review if their quality was not being verified by detailed inspections. Information for the evaluation was obtained by reviews of maintenance records, discussions with diesel maintenance personnel and in some cases, visual observations. The maintenance and operating logs for diesel 2B were evaluated to ascertain if any problems had existed on the engine. The parts evaluated in this appendix are listed in Table B1 at the end of the appendix.

As diesel 2B had only about 200 hours of operation, very little maintenance has been performed on the engine. For this reason, only the parts with an operational problem or maintenance history will be discussed below. All other parts listed in Table B1 are considered to be satisfactory.

Detailed Review of Part Validation

Part No: 02-365B

Part Name: Fuel Injection Tips

Evaluation: The fuel injection tips were replaced with ones of a more efficient spray pattern. This modification was done to produce more uniform firing pattern on the piston and the tips that were removed were satisfactory.

Part No: 02-500J

Part Name: Control System Relays

Evaluation: One controlling relay was found defective. This defect had the effect of causing the engine speed to vary. The speed regulating governor was checked and found satisfactory. The defective relay was replaced and the speed control system has been satisfactory. This is considered an isolated failure.

Part No: 02-550

Part Name: Foundation Bolts and Anchors

Evaluation: A modification was made to strengthen the mounting surface for the generator pedestal bearing. A $\frac{1}{4}$ inch plate was installed on top of the pedestals. This modification prevents deformation of washers under bolt torque when in contact with the slotted mounting surface.

Part No: 02-630D

Part Name: Instrumentation Thermocouples

Evaluation: During initial engine operation, several thermocouples were noted to have readings that were inconsistent. These thermocouples were replaced with new ones. These failures are considered to be those associated with infant mortality of electrical devices.

Part No: CN-107

Part Name: Intake Air Silencers

Evaluation: During initial engine operation, it was discovered that one end cap was improperly welded. This has since been repaired and operating satisfactorily.

Part No: CN-111

Part Name: Lube Oil Heat Exchanger

Evaluation: This component was not supplied with a vent that would allow the heat exchanger to be fully filled with water. The heat exchanger was modified to include the vent and has performed well.

Table B-1

List of Parts Covered by Engineering Validation Review

<u>Part No.</u>	<u>Part Name</u>	<u>Class</u>
00-420	Lube Oil Pressure Regulating 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 and 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
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

Table B-1 (continued)

<u>Part No.</u>	<u>Part Name</u>	<u>Class</u>
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