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May 19, 1986

Director, Office of Nuclear Reactor Regulation
Attention. G. E. Lear, Director
PWR Project Directorate No. 1
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Gentlemen:

Subject: Docket No. 50-206
Inspection Report on Emergency Diesel Generator No. 1
San Onofre Nuclear Generating Station
Unit 1

References: (A) Letter, G. E. Lear (NRC) to K. P. Baskin (SCE), dated January 7, 1986, Status of the Long-Term Operability Review of Transamerica Delavel, Inc. (TDI) Diesel Engines

Enclosed for your review are the results of inspections performed on emergency diesel generator no. 1 at the San Onofre Nuclear Generating Station, Unit 1. These inspections were performed from November 1985 to February 1986 during the course of the Unit 1 refueling outage and were intended to comply with the recommendations of the TDI Diesel Generator Owners Group, as contained in the San Onofre Unit 1 Design Review and Quality Revalidation (DR/QR) Report dated February 1985.

This transmittal is to satisfy the NRC's request in Reference A for submittal of a complete report on the results of the engine inspections. A similar report for emergency diesel generator no. 2 will be transmitted to you by June 13, 1986.

If you have any questions, please call me.

Very truly yours,

Enclosure

cc: R. Dudley, NRC/NRR San Onofre Unit 1 Project Manager
F. R. Huey, NRC Senior Resident Inspector, Units 1, 2 and 3
J. B. Martin, NRC Region V, Regional Administrator
D. E. Broeils, Duke Power Co., TDI DG Owners Group

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INSPECTION REPORT
EMERGENCY DIESEL GENERATOR NO. 1
SAN ONOFRE NUCLEAR GENERATING STATION
UNIT NO. 1

INTRODUCTION:

SCE has performed a major inspection on the emergency diesel generator no. 1 at San Onofre Nuclear Generating Station, Unit 1. The inspection occurred from November 1985 to February 1986. This inspection was performed to comply with the recommendations of the TDI Diesel Generator Owners Group Design Review/Quality Revalidation (DR/QR) report. The DR/QR report was submitted to the NRC on September 3, 1985.

Major 16 Components/Phase I

Sixteen components were originally identified as the most significant affecting the safety function of the diesel generators. The following work was performed to meet all of the DR/QR report recommendations:

Air Start Capscrews

Dimensional, material and hardness checks were made with satisfactory results. Torque (cold and hot) was verified on reassembly. Service Information Memo (SIM) 329 was implemented and SIM 360 performed.

Auxiliary Module Wiring and Terminations

Wiring and terminations were replaced during a previous outage in accordance with TDI's SIM and 10 CFR 21 notification. No additional work was performed during the current inspection.

Connecting Rods

An NDE of all connecting rods was performed. No linear indications were found. All bushings and pins were dimensionally checked and are satisfactory.

A sample of four connecting rod assemblies was checked initially for material and hardness, as the result of which one nonconforming rod assembly was found. The remaining six rod assemblies and the spares were then checked for material and hardness with one more assembly found nonconforming. The nonconforming connecting rods were replaced with qualified 4140 material rods.

An eddy current test was performed on all rod box female threads with no defects found. NDE was performed on all connecting rod bolts.

Connecting Rod Bearing Shells

All connecting rod bearing shells were visually inspected. Two lower shells show gouges and metal displacement which are believed to have occurred during the disassembly. The replacement shells were examined with penetrant test (PT) and radiograph and are acceptable. All shell dimensions were checked satisfactorily.

Crankshaft

Main bearing journal holes #1 through #12 were PT inspected and no cracks were found. Crankshaft connecting rod pins were dimensionally checked and visually inspected satisfactorily. Main journals were visually inspected. Web hot and cold deflection measurements were performed satisfactorily.

All cross-drilling oil hole plugs were inspected in accordance with 10 CFR 21 notification dated 3/18/85. 16 gauge plugs were found and no deficiency noted.

Engine Base and Bearing Caps

NDE was performed on #6 main bearing saddle area and the bearing cap was visually inspected. The entire base was visually inspected. No indications were found.

Fuel Oil Injection Tubing

100% eddy current examination was performed by our consultant Failure Analysis Associates. A visual exterior inspection was also performed. The results were satisfactory and meet SCE commitment to the NRC in letter dated June 29, 1984.

Jacket Water Pump

NDE was performed on the shaft and gear. The lower casing wear ring has uneven wear surface and the shaft surface in the area of the seal is mushroomed. The pump was replaced with an in kind qualified spare from TDI.

Cylinder Liners

All cylinder liners were visually inspected and are satisfactory. Cylinder liners #1 left side (1L), #2 right side (2R), 5R, 7R and 8L have score marks. All marks are very shallow and do not affect function. All liner diameters except 6R are slightly less than the acceptance criteria of 17.000" to 17.080". The average undersize is 0.001", which provides for a slightly tighter fit. Cross hatch and ring wear are normal. There is no effect on function and the liners are acceptable.

Liners 3R, 4R, 5R, 6R, 3L, 4L, 5L and 6L were removed, inspected and then reinstalled. No deficiency noted.

Piston Skirts

75% of the pistons were disassembled and inspected (25% disassembled and inspected during a previous outage). The break away torque of the crown nuts could not be measured due to castle nut lock pin not being removable. 8L crown pilot diameter was out of specification and the crown was replaced. 4R skirt pilot diameter was also out of specification but was judged acceptable. Skirt spot face depths are insignificantly out of tolerance on 2R, 2L, 3L and 5R and are acceptable, based on SCE's engineering judgment.

Piston skirts outside diameter (OD) and pin clearance were measured and are satisfactory.

Linear indications were found in four AF modified skirt stud boss areas of 7L, 9R, 3L and 8R. Two skirts, 3L and 7L, have casting slag in the pin boss areas. The four flawed pistons were replaced with AE type assemblies.

The one AN type skirt that was inservice was removed and replaced with an AF modified piston assembly.

Cylinder Block

NDE was performed on the entire right block top and on liner landings of the right block with liners 3R, 4R, 5R and 6R removed to provide accessibility. NDE was also performed on the left block top between adjacent stud holes and the areas between studs and liners or studs and liner landings with liners 3L, 4L, 5L and 6L removed. No relevant indications were found. Liner landing dimensions were checked where accessible.

Cylinder Heads

In accordance with SCE's letter to NRC dated December 19, 1984, SCE changed out 25% of cylinder heads with reworked heads qualified to TDI's current standard for Group III heads (heads 2L, 3L, 4L, 5L and 6L). The following inspections on remaining heads (1R-10R, 1L, 7L-10L) were performed:

1. Visual
2. Liquid penetrant of valve seating surfaces
3. Ultrasonic to determine fire deck thickness. Head 3R was replaced and returned to TDI for rework.
4. Magnetic particle testing was performed on fire deck. Maintenance matrix recommendations were performed satisfactorily during post maintenance testing.

Cylinder Head Studs

Visually inspected head studs for signs of distress for cylinders 4R, 4L, 6R and 6L. Material analysis identification tests were performed on four studs 4R#1, 6R#1, 4L#1 and 6L#1. Hardness test was performed on 4R#5. All studs were found satisfactory for continued use.

Push Rods

Liquid penetrant examination on all pushrod ends was performed. Visual inspection for full insertion of forged head into tubes was performed. Two push rods which had linear indications were replaced with spares and two with minor indications were polished to remove the indications and reused. Previous work had replaced all ball head push rods with forged head push rods. Future purchases will include sample radiograph inspection or destructive examination.

Rocker Arm Capscrews

Performed magnetic particle test of the thread root area of all capscrews for linear indications. Also performed material comparator and hardness testing on four capscrews. All capscrews found to be satisfactory for continued service. A visual inspection on the drive studs was performed for signs of irregularity. Torquing was verified on reassembly.

Turbochargers

Performed turbocharger rotor end play inspection. All four turbochargers were found satisfactory.

The front-left turbocharger was fully disassembled for inspection. These inspections included:

1) visual inspection,
2) verification of proper number of bolts on the turbine inlet casing,
3) verification of proper torques, and
4) PT on stationary nozzle ring for signs of adverse wear and cracking.

SIM #300 is not applicable to San Onofre Unit 1 turbochargers. No deficiencies, indications or signs of wear were found.

SCE also performed boroscope examination on the rear-right turbocharger to identify the condition of the nozzle ring guide vanes. No missing or damaged vanes in areas accessible for inspection with the boroscope were noted.

Base line vibration data were taken on all four turbochargers.

Lube oil flow to turbochargers from drip lube system was measured and is being currently evaluated.

Balance of Reviewed Components/Phase II

The balance of the components reviewed by the Owners Group (Phase II) is tabulated on the following pages by major categories with summaries of the recommended actions and the work performed during the current outage.

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PHASE II REVIEW

Component	Owners Group Recommended Action	Summary of Work Performed
	TURBO, INTAKE, INTERCOOLER AND EXHAUST	
Turbocharger (MM 19/20)	Additional maintenance and inspection recommendations. Prelubrication procedures should be followed.	See Phase I.
Turbocharger Thrust Bearing Drip Lube System (Small Bore Scope Only) (02-CFR)	Addition/modification of supports. Refer to DR/QR report 02-CFR for details.	Modification not required.[1]
Intake Manifold and Piping (Large Bore Scope Only) (02-375)	Additional maintenance recommendations. Additional Quality inspections recommended.	Visually inspected air intake manifold elbow flange faces and increased bolt hole size to 1/8" oversize (5/8" ID). Inspection and modification completed satisfactorily.
Exhaust Manifold Piping (02-380A)	Flat bar which connects the shroud to the engine should be modified to allow for axial thermal-expansion. Addition of slip joints. Additional maintenance recommendations. Inspections of cap screws recommended. Replace 3/8-inch bolts that connect the water jacket shroud to the manifold assembly with 1/2-inch bolts.	Modifications not required.[1] Visually inspected. NDE of a sampling of pipe welds was performed. Results acceptable.
Exhaust Manifold: Gasket and Bolting (02-380B)	Additional Quality inspections recommended.	Verified torque on exhaust manifold bolting. Performed visual inspection of exhaust manifold to verify freedom from binding and flange fillet welds are free from cracks. All found satisfactory.
Turbocharger Bracket, Bolting and Gaskets (02-475A&D)	None	Inspected turbocharger brackets mounting bolts to verify torque and thread engagement. Some needed tightening and thread engagement was verified.
Air Butterfly Valve Assembly (02-475B)	Addition of grease fittings per TDI SIM 322. Additional maintenance requirements. Additional Quality Revalidation inspections recommended.	Disassembled and performed inspection on air strangulation valves. All satisfactory. SIM 322 was implemented previously.
Turbocharger Bracket-Air Intake Piping (02-475C)	Each crossover piping system should be supported by two flexible anchors only. Remove all U-bolts and strap supports.	None required.[1]
Turbocharger Bracket Pipe Supports (Large Bore Scope Only) (02-475E)	None	None required.
Flex Connections (02-805C)	None	None required.

1 Refer to SCE to NRC letter dated September 3, 1985, Enclosure III.

Component	Owners Group Recommended Action	Summary of Work Performed
Intake Air Silencer (02-805D)	None	Inspected interior of each silencer to ensure both ends of centerline "bullet" are welded on. Inspected for end cap using mirrors in accordance with 10 CFR 21 dated 11/10/85. All end caps welded.
Intercooler (41-127A)	Additional maintenance recommendations.	Inspected condition of tubes and shell for scaling, sediment or corrosion and cleaned as required. Right and left rear intercoolers had leaks and were repaired.
Intercooler Piping and Piping Couplings, Gaskets and Bolting (041-127B&C)	Addition/modification of supports. Refer to DR/QR report 041-127B&C for details.	None required.[1]
	LUBE OIL	
Lube Oil Full Pressure Strainer (SE-014)	Inspect and clean the strainer element at any significant increase in differential pressure and at each refueling outage. Check differential pressure during each engine operation.	Cleaned and inspected strainer for holes or physical damage. Stopped oil leak from valve cap.
Lube Oil Pressure Regulating Valve (00-420)	Disassemble and clean the valve annually or at each refueling outage. To ensure proper clearance, the dimensions of the valve internal parts should be checked.	Disassembled, cleaned and inspected two valves.
Lube Oil Fittings - Internal Headers (Large Bore Scope Only) (02-307A-LB)	None	None required.
Lube Oil Fittings - Internal: Headers (02-307A-SB)	Modify supports. Refer to DR/QR report 02-307D for details.	Refer to item 02-307D.
Lube Oil Fittings Internal Tube and Fittings (Small Bore Scope Only) (02-307B)	Check tubing for dents or crimps. Perform gear train spray check.	Checked tubing for dents and crimps. Performed gear train spray check.
Lube Oil Fittings Internal - Supports (Small Bore Scope Only) (02-307D)	Replacement of all 1/4-inch U-bolts with 3/8-inch U-bolts on the auxiliary internal lube oil header. Installation of suitable locking devices on nuts.	None required.[1]
Engine Driven Lube Oil Pump (02-420)	None	Dissassembled and inspected with satisfactory results.
Lube Oil Lines External: Tubing, Fittings and Couplings (Large Bore Scope Only) (02-465A-LB)	Addition of support to provide a stiffer load path and to relieve seismic stresses on the external header. Recommendation for a minimum installation gap between the pipe ends of 0.171 inch.	None required.[1]

1 Refer to SCE to NRC letter dated September 3, 1985, Enclosure III.

Component	Owners Group Recommended Action	Summary of Work Performed
Lube Oil Lines - External Tubings, Fittings, Couplings (O2-465A-SB)	Modify supports. Refer to DR/QR report O2-465B for details.	None required.[1]
Lube Oil Lines - External Supports (Large Bore Scope Only) (O2-465B-LB)	None	None required.
Lube Oil Lines External: Supports (Small Bore Scope Only) (O2-465B-SB)	Modify supports, U-bolts and locking devices. Refer to DR/QR report O2-465B for details.	None required.[1]
Turbocharger - Lube Oil Fitting - Pipe, Tubing and Flexible Coupling (Large Bore Scope Only) (O2-467A-LB)	Perform a comparison of the as-built configuration with the assembly details.	None required.[1]
Turbocharger Lube Oil Fitting: Pipe, Tubing, Fittings and Flexible Coupling (Small Bore Scope Only) (O2-467A-SB)	Addition/modification of supports. Refer to DR/QR report O2-467B for details.	None required.[1]
Turbocharger - Lube Oil Fitting and Supports (Large Bore Scope Only) (O2-467B-LB)	None	None required.
Turbocharger - Lube Oil Fittings: Supports (Small Bore Scope Only) (O2-467B-SB)	Addition/modification of supports. Modification of U-bolts. Installation of locking devices. Refer to DR/QR report O2-467B for details.	None required.[1]
Lube Oil Sump Tank with Strainer Assembly and Mounting Hardware (O2-540A&C)	Visual inspection of the tank seam and assembly welds recommended. Recommendation to measure engine, tank and pipe displacement at next refueling outage. Verify proper bolt torque.	Torqued sump base bolts. L.O. System Inspection: 1. Sump a. Interior for rust, corrosion and weld seam integrity b. Suction strainer c. Heater element for coking and deposits and insulation resistance d. Sump cover gaskets Verified lube oil sump tank mounting bolt torque.
Lube Oil Sump Tank Misc. Fittings, Gaskets, Bolting Material, Valves (Small Bore Scope Only) (O2-540B)	None	None required.
Lube Oil System Auxiliary Lube Oil Pump (O2-545)	None	None required.

1 Refer to SCE to NRC letter dated September 3, 1985, Enclosure III.

Component	Owners Group Recommended Action	Summary of Work Performed
Auxiliary Sub Base and Oil and Water Piping Lube Oil: Pipe/Fittings (Small Bore Scope Only) (02-717F)	Addition/modification of supports. Refer to DR/QR report 02-717F for details.	Modification not required.[1] Keep warm pump suction strainer inspected and cleaned.
Auxiliary Sub Base and Oil and Water Piping: Lube Oil Valves (02-717G)	Additional maintenance requirements.	Tested relief valve 100 and tested and installed new relief valve 101 between L.O. pumps and sump.
Auxiliary Sub Base and Oil and Water Piping: Lube Oil: Gaskets & Bolting (02-717H)	The auxiliary piping should be walked down daily to verify the leak tightness of the lube oil piping flanges.	Performed routinely.
Intake Air Filter (02-805B)	Additional maintenance requirements.	Inspected distribution plates and changed oil.
Miscellaneous Equipment - Heater, Lube Oil Sump Tank (02-820A)	Additional maintenance recommendations.	Visually inspected lube oil sump tank level switch floats. Cables appear OK. Floats have cracks and one chip missing. Inspected, tested, reworked TE-224 lube oil temperature sensor lead. Visually inspected lube oil sump tank level switch floats. Displacers for LSL-114 had cracks in them and one chip approx. 1" across and 1/8" deep. Replaced with qualified in kind spare.
Lube Oil Heat Exchanger (02-820B)	Additional maintenance recommendations.	Disassembled, cleaned and inspected L.O. heat exchanger.
Full Flow Lube Oil Filter (02-820C)	Additional maintenance requirements	Changed filter and corrected cover leakage.
Prelube Oil Pump (02-820D)	Additional maintenance recommendation.	Overhauled.
Oil Prelube Filter (02-820E)	Additional maintenance recommendations.	Replaced filters.
	ENGINE BASE AND BEARING CAPS	
Base and Bearing Caps - Base Assembly, Main Bearing Studs and Nuts and Main Bearing Caps (02-305A,C,D)	Additional maintenance recommendations. Additional Quality inspections recommended.	See Phase I.
	CRANKSHAFT AND BEARINGS	
Crankshaft (02-310A)		See Phase I.
Main Bearings (02-310B)	Additional Quality inspections recommended.	Measured all main bearing shells thicknesses and new #10 and #12 lower halves. PT performed on all main bearing shells. Indications were noted in two bearing halves and were associated with disassembly.

1 Refer to SCE to NRC letter dated September 3, 1985, Enclosure III.

Component	Owners Group Recommended Action	Summary of Work Performed
Crankshaft and Bearings: Thrust Bearing Ring (02-310C)	Additional maintenance recommendations.	Performed thrust check and visually inspected thrust bearing ring.
Crankcase: Crankcase Assembly (02-311A)	Additional Quality inspections recommended.	Visually inspected crankcase and no problems noted.
Crankcase: Crankcase Mounting Hardware (02-311D)	None	None required.
Crankcase: Crankcase Gaskets and Mounting Hardware (02-386B)	Additional Quality inspections recommended.	Inspected bolt holes on crankcase covers for cracks. One bolt hole on crankcase for cylinder covers on cylinders 3L, 7L and 8R had threads pulling out. Deficiencies corrected.
Crankcase Relief Valve and Vacuum Fan (02-385A)	Additional maintenance recommended.	Disassembled and inspected crankcase vent fans and measured insulation resistance. Cleaned flame arrestor portion of relief valve.
	CYLINDER BLOCK, LINERS AND WATER MANIFOLD	
Cylinder Block (02-315A)	Verify cylinder liner bore and mating block dimensions. Additional Quality inspections recommended. Additional maintenance inspections recommended.	See Phase I
Cylinder Block Liners and Water Manifold - Cylinder Liners (02-315C)	Additional maintenance recommendations. Additional Quality inspections recommended.	See Phase I
Jacket Water Manifold Piping (Large Bore Scope Only) (02-315D)	Perform a non-destructive examination of subject piping component to ensure the integrity of pipe welds. Inspect inaccessible piping to ensure adequate seismic restraint.	Performed NDE of large bore jacket water piping weld.
Cylinder Block Liners and Water Manifold: Studs (02-315E)	Modify head stud installation procedure to lower the stresses in the cylinder block stud boss area. Additional Quality inspections recommended.	See Phase I
Cylinder Block Liner and Water Manifold - Cylinder Head Nuts (02-315F)	Additional Quality Revalidation inspections recommended.	Performed a visual examination for forging laps and recorded all identification markings on cylinder head nuts. No problems noted. Verified torque on reassembly.
Cylinder Block - Liners and Water Manifold: Seals and Gaskets (02-315G)	Verify installation of proper cylinder liner seals (TDI P/N JF-019-000) in diesel generators.	The eight cylinder liners removed were reinstalled using TDI P/N JF-019-000.
Cylinder Block Covers: Gaskets and Bolts (02-385B)	Verify that the proper torque is applied and the specified material is installed. Additional Quality inspections recommended.	Visually inspected cylinder block cover gaskets for signs of elastometric compound breakdown and cracking. No problem noted and all new gaskets were used. Verified torque on reassembly.

1 Refer to SCE to NRC letter dated September 3, 1985, Enclosure III.

Component	Owners Group Recommended Action	Summary of Work Performed
	AIRSTART AND BARRING DEVICE	
Starting Air Distributor: Distributor Assembly (OO-442A)	Additional Quality Revalidation inspections recommended. Additional maintenance recommendations.	Verified installation of starting air distributor follower lobes. No problems noted. Visually inspected the poppet valves spool ends and timing.
Starting Air Distributor - Tubing, Fittings and Gaskets (OO-442B)	All Air Distributor Tubing is addressed under component numbers O2-441A&C.	See component numbers O2-441A&C.
Air Start Valves (O2-359)	Implementation of SIMs 329 and 360. Additional maintenance recommendations. Additional Quality inspections recommended.	Air start valves inspected. Cylinder #7 valve seat/disk found unsatisfactory, #4R failed to close. Replaced both valves. See Phase I for capscrews.
Starting Air Manifold: Piping, Tubing and Fittings (Large Bore Scope Only) (O2-441A-LB)	Addition/modification of supports. Refer to DR/QR report O2-441A-LB for details.	None required.[1] However, modified the air start line strainer supports (4 in number) to improve the diesel's margin of safety and make the air start system pipe supports identical to those of diesel generator No. 2.
Starting Air Manifold - Piping, Tubing and Fittings (Small Bore Scope Only) (O2-441A-SB)	Modify supports. Refer to DR/QR report O2-441C for details.	None required.[1]
Starting Air Manifold: Valves, Strainers, Filters (O2-441B)	Additional maintenance requirements.	Replaced filter elements. Cleaned, inspected and refurbished block valves.
Starting Air Manifold Support (Large Bore Scope Only) (O2-441C-LB)	None	None required.
Starting Air Manifold - Supports (Small Bore Scope Only) (O2-441C-SB)	Addition of two-directional supports to the tubing running from the distributor to the horizontal tubing runs on top of the engine. Addition of a two-directional lateral support to each 1/2-inch tube entering and exiting the air filter.	None required.[1]
Barring Device - Pneumatic Regulator Valve/ Shutoff Valve (O2-525B)	None	None required.
Barring Device - Pneumatic: Mounting Bracket/Supports (O2-525D)	None	None required.
Starting Air Tank (O2-835E)	Additional maintenance recommendations.	Inspected tanks. Cleaned flow traps, calibrated pressure switches. Tanks were State recertified.
Air Start Tank Relief Valves (O2-835G)	None	None required.

1 Refer to SCE to NRC letter dated September 3, 1985, Enclosure III.

Component	Owners Group Recommended Action	Summary of Work Performed
Skid Base - Starting Air Equipment (02-835A,F&H)	None	Replaced leaking inlet check valve. Air compressor crankcase oil sampled, drained, flushed and refilled. Verified spring and change setpoint per FCN S1109-M. Inspected and cleaned compressors. Replaced belts. No problems noted. Inspected and serviced moisture traps in starting air system. All drain traps were cleaned and are in satisfactory condition.
	CONNECTING RODS	
Connecting Rods: Connecting Rods and Bushings (02-340A)	Additional inspections recommended.	See Phase I
Connecting Rod: Bearing Shells (02-340B)	Additional maintenance requirements. Additional Quality Revalidation inspections recommended.	See Phase I
	PISTONS	
Piston (02-341A)	Additional inspections of the stud boss attachment area recommended. Additional Quality inspections recommended.	See Phase I
Pistons: Rings (02-341B)	Additional maintenance and Quality Revalidation inspection recommendations.	Disassembled pistons and inspected rings. No service failed rings were found.
Piston: Piston Pin (02-341C)	Replacement of spiral ring retainers with Waldes SNAP ring retainers (P/N GE-003-067). Additional Quality inspections recommended. Additional maintenance recommendations.	All piston pin dimensions were checked and found satisfactory. Pin to bushing clearance was calculated and 8 pin clearances were undersized but acceptable as is. Performed material comparator test, material hardness test, dimensional check and magnetic particle exam on one spare piston pin and one inservice pin. All satisfactory. Chrome finish and end plugs inspected. Two end plugs were rerolled.
	CAMSHAFT AND VALVE TRAIN	
Tappets and Guides: Intake and Exhaust Tappet Assembly (02-345A)	Additional maintenance recommendations. Additional Quality inspection recommended.	Tappet roller to tappet roller pin clearance was greater than specified - accepted as is per TDI. Tappet rollers were visually inspected. Freedom of rotation was checked and found satisfactory.
Tappets and Guides: Fuel Tappet Assembly (02-345B)	Additional maintenance recommendations. Additional Quality inspections recommended.	Work performed similar to 02-345A.
Tappets and Guides: Fuel Pump Base Assembly (02-345C)	None	None required.
Camshaft: Camshaft Assembly (02-350A)	Additional maintenance and Quality Revalidation inspection recommendations.	Visually inspected for premature wear.
Camshaft: Camshaft Bearings (02-350B)	None	Completed cam and thrust bearing inspection satisfactorily.

1 Refer to SCE to NRC letter dated September 3, 1985, Enclosure III.

Component	Owners Group Recommended Action	Summary of Work Performed
Camshaft-Supports, Bolting and Gears; Idler Gear Assembly - Crank to Pump Gear; Idler Gear (02-350C, 02-355A&B)	Additional maintenance recommendations. Additional Quality inspections recommended.	Cam gear nut torqued. Performed material comparator/ hardness test on cam gears. Verified cam to cam gear bolt torque. Completed satisfactorily. Performed visual inspection with satisfactory results.
Subcover (02-362A)	Additional inspections and Quality Revalidation inspections recommended.	Four subcovers (assembly web area) were visually inspected. Performed NDE on all subcovers on the machined surfaces of the rocker shaft assembly bolt bosses. Replaced subcover 6R due to linear indications.
Rocker Shaft Assemblies: Intake/Intermediate & Exhaust (02-390A&B)	Additional Quality Revalidation inspections recommended.	Performed dimensional check of rocker arm shafts and bushings and inspected bushings. Performed inspections of rocker shaft assemblies. Rocker arm intake pushrod cups in subcovers 4R and 7L had chips in them. Rocker arm intake pushrod cup in subcover 1L had a crack. Replaced 1L intake pushrod cup and replaced 4R and 7L rocker arms with qualified in kind spares. Performed material comparator test of intake and exhaust rocker arm shaft for 6R.
Main and connector pushrods (02-390C&D)	Additional Quality Revalidation inspections recommended.	See Phase I
Rocker Arm and Pushrods: Bushings (02-390E)	Additional maintenance requirements.	See 02-390A&B
Rocker Arms and Pushrods: Lifters (02-390F)	Additional Quality Revalidation inspections recommended.	All lifters were inspected and verified to be in the correct up position. Checked valve lash. Reinstalled and adjusted lifters.
Rocker Arms and Pushrods - Miscellaneous Bolts and Drive Studs (02-390G)	Additional maintenance recommendations. Additional Quality inspections recommended.	See Phase I.
	IDLER GEAR ASSEMBLY AND FRONT GEAR CASE	
Front Gearcase Bolting (02-335B)	Additional inspections of bolts. Addition of positive locking features (bent tab or lockwire). Additional Quality inspections recommended.	Verified proper installation and torque of internal gearcase bolting.
	FLYWHEEL	
Flywheel (02-330A)	None	None required.
Flywheel Bolting (02-330B)	Recommended that the assembly procedures include an effort to keep the flange faces of the flywheel, crankshaft and generator shaft free of antisieze compound. TDI bolt torque requirements should be documented.	Flywheel bolting torque was verified.

1 Refer to SCE to NRC letter dated September 3, 1985, Enclosure III.

Component	Owners Group Recommended Action	Summary of Work Performed
	ENGINE INSTRUMENTATION AND WIRING	
Pyrometer Conduit Assembly: Thermocouples (02-630D)	Additional maintenance recommendations.	Verified thermocouples indicated ambient temperature when engine was cold. Repairs were made on conduit and two thermocouple elements replaced. Conduit east end of engine had seal flex pulled loose from engine mounted rigid conduit.
Engine and Auxiliary Module Wiring Material and Fittings: Pyrometer Conduit Assembly - Conduit, Fittings and Supports (02-688A, 02-630A, B, C)	Upgrade conduit supports. Addition of supports for Category I rigid and flexible conduits.	See 02-630D. Conduit supports will be reviewed.
Engine and Auxiliary Module Wiring Material: Wiring and Terminations (02-688B)	Implementation of TDI SIM No. 361 on Engine No. 1 should be confirmed.	See Phase I.
Engine and Auxiliary Module Wiring Material - Boxes and Terminals (02-688C)	None	None required.
On Engine Alarm Sensors (02-690)	None	None required.
Off Engine Alarm Sensors (02-691A)	None	None required.
	OVERSPEED TRIP AND GOVERNOR	
Overspeed Trip: Governor (02-410A)	Additional maintenance requirements and Quality Revalidation inspections recommendations.	Trip setpoint was verified. Set screws were marked with torque-seal.
Overspeed Trip: Governor and Accessory Drive Assembly (02-410B)	Evaluation of crankshaft torsional response and its effect on the governor and accessory drive assembly is required. Additional Quality Revalidation inspections recommended.	Inspected and performed NDE on overspeed trip governor and accessory drive. Accessory drive gear is AISI 4140 rather than AISI 4340. Accepted as is.
Overspeed Trip: Couplings (Flexible and Spider) (02-410C)	Additional Quality inspections recommended. Additional maintenance recommendations.	New spider was installed. New coupling was installed previously.
Vent Valve: Overspeed Trip (02-410D)	Valve "O" ring should be changed every 5 years.	Cleaned, inspected and replaced "O" ring.
Governor Drive: Governor and Tachometer Drive Gear and Shaft (02-411A)	Additional Quality inspections recommended.	Inspected and performed NDE on governor drive gear and shaft. Also inspected for key to keyway clearance. Exam results accepted as is.

1 Refer to SCE to NRC letter dated September 3, 1985, Enclosure III.

Component	Owners Group Recommended Action	Summary of Work Performed
Governor Drive: Couplings, Pins and Keys (02-411B)	Additional maintenance recommendations. Additional Quality inspections recommended.	Verified set screws and lock pins are locked in place. Verified coupling grid color code. Also see 02-411A. Fabricated new coupling shaft, spacer pin and redoweled mounting bracket and plate to restore governor drive assembly clearance and alignment per TDI drawing.
Governor Linkage (02-413A)	Additional maintenance recommendations. Additional Quality inspections recommended.	Greased rod end fittings. Inspected linkage assembly. Installed positive locking hardware.
Fuel Pump Linkage: Automatic Shutdown Cylinder (02-413B)	Additional maintenance recommendations.	Checked automatic shutdown cylinder for extension and return. Checked tailrod vent for leakage.
Governor Assembly: Woodward Governor (02-415A)	Additional maintenance recommendations. Additional quality inspections recommended.	Operating procedure reviewed to verify compliance with manufacturers recommendations and required testing. Changed governor oil. Replaced governor assembly during a previous outage. Verified control knob settings.
Governor Assembly Booster Servomotor (02-415B)	Additional Quality inspections recommended.	Verified correct installation of governor servomotor following replacement with a qualified spare.
	ENGINE SHUTDOWN AND EQUIPMENT	
Engine Shutdown Equipment - Tubing/Fittings & Supports (Small Bore Scope Only) (02-695A)	Addition of two and three direction supports. Reinforcement or redesignment of interface bulkhead between engine and off engine tubing to increase vertical load capacity. Refer to DR/QR report 02-695A for details.	None required.[1]
Engine Shutdown Equipment - Valves, Regulators, Orifices (02-695B)	Additional maintenance requirements.	Replaced pressure regulator.
Engine Shutdown Trip Switches (02-695C)	Additional maintenance requirements.	Verified switch setpoints.
	JACKET WATER	
Jacket Water Manifold - Manifold Assembly with Hardware, Coupling and Gaskets (Large Bore Scope Only) (02-316A&B)	Perform a non-destructive examination of subject piping component to ensure the integrity of pipe welds. Inspect inaccessible piping to ensure adequate seismic restraint.	See 02-315D.
Water Discharge Manifold: Jacket Water Discharge Manifold, Couplings and Seals (Large Bore Scope Only) (02-317A&B)	Additional maintenance requirement.	Inspection performed routinely.

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Component	Owners Group Recommended Action	Summary of Work Performed
Water Discharge Manifold: Supports (Large Bore Scope Only) (02-317C)	None	None required.
Jacket Water Pump (02-425A)	Modify torque values for nuts on impeller and shaft. At the drive gear end of the pump shaft, a second hole should be drilled in the threaded end, 90 deg from the existing one to minimize nut rotation required to insert the locking cotter pin. Additional Quality inspections recommended.	See Phase I.
Jacket Water Fittings - Pipe and Fittings (Small Bore Scope Only) (02-435A)	Additional maintenance requirement.	Inspection performed routinely.
Turbo Water Piping - Pipe and Fittings (02-437A-SB) (Small Bore Scope Only)	Replacement of 1/4-inch diameter U-bolts with 3/8-inch diameter U-bolts on turbo water inlet supports for Engine 2, generator end. Addition of two-direction supports on the 1/4-inch tubing from the jacket water outlet headers to the combustion air coolers on both engines.	Modification not required.[1] Inspection performed routinely.
Turbo Water Piping - Pipe & Fittings (Large Bore Scope Only) (02-437A-LB)	Addition of a rigid anchor on the 2 1/2-inch diameter header at the location of the intersection with the two 1 1/2-inch diameter branches.	Modification not required.[1] Inspection performed routinely.
Thermostatic Valves (02-515)	Replacement of the power elements at 3 to 5 year intervals. Additional inspections recommended.	Replaced jacket water thermostatic valve. Verified exhaust ports are centerline horizontal on both valves. Replaced thermopower elements on lube oil valve. Visually inspected for leaks.
Jacket Water Standpipe Pipe, Fittings, Gaskets (02-700A)	None.	Jacket water drain valve had bent stem and was replaced.
Jacket Water Standpipe and Miscellaneous Bolting Material (02-700F)	Additional inspections recommended.	Visually inspected.
Auxiliary Sub Base, Oil and Water Jacket Water Valves (02-717B)	Monthly inspections for leakage at packing.	Visually inspected.
Auxiliary Sub Base and Oil and Water Piping - Jacket Water: Gaskets and Bolting (02-717D)	None	None required.

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Component	Owners Group Recommended Action	Summary of Work Performed
Auxiliary Sub Base and Oil andWater Piping – Jacket Water: Supports (Small Bore Scope Only) (02-717E)	Addition/modification of supports, U-bolts and locking devices. Refer to DR/QR report 02-717E for details.	None required.[1]
Miscellaneous Equipment – Heater, Jacket Water Standpipe (02-810A)	Additional maintenance recommendations	Jacket water heater was replaced. New heater was meggered and controller calibrated.
Jacket Water Heat Exchanger (02-810B)	None	None required.
Jacket Water Standby Heater Pump (02-810C)	None	Jacket water keep-warm pump was inspected.
	CYLINDER HEADS AND VALVES	
Cylinder Heads (02-360A)	Additional maintenance recommendations. Additional Quality inspections recommended.	See Phase I
Cylinder Head Valves: Intake and Exhaust Valves (02-360B)	Additional inspections and Quality Revalidation inspections recommended.	Inspected intake and exhaust valves and valve to guide clearance. NDE performed on valves with all found satisfactory. Replaced broken exhaust valve guide on cylinder head 4R. Visually inspected subcover for valve guide blowby. Valve inspections: – Visual inspection to verify adequate valve seating (all) – Visual inspection of valve for scuffing, pitting and erosion (all) – Liquid penetrant test on blended radius of stem head for cracking (all) – Valve and valve ring material determination (spectrotest) (16 valves) Cylinder head valve 1L failed blue check and was lapped until satisfactory.
Cylinder Head and Valves: Bolting and Gaskets (02-360C)	Replacement of affected seals with those called out in SIM 315. Additional Quality inspections recommended.	All seals meet SIM 315. Visually inspected for signs of distress.
Cylinder Head and Valves: Spring (02-360D)	Visually inspect and document the color code of the valve springs.	Inspected for broken or cracked valve springs and verified color code.
	FUEL OIL INJECTION	
Fuel Oil Drip Tank Assembly (00-621A)	None	None required.
Fuel Oil Day Tank (00-621C)	None	Replaced leaking pressure control valve.

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Component	Owners Group Recommended Action	Summary of Work Performed
Fuel Injection Pump (02-365A)	Additional maintenance recommendations.	Calibration/operational testing performed on all pumps by offsite contractor. Capscrew broken on fuel oil injection pump 9L. Replaced 9L pump. Fuel injection pump 9R had 2 drops/min leak. Removed and reinstalled 9R pump to correct leak. Visually checked pressure bleed screws for erosion.
Fuel Injection Nozzle Assembly (02-365B)	Additional maintenance recommendations.	Inspected and cleaned tips. Checked nozzle pop pressure. Checked spray pattern. Checked assembly for leakage. Replaced nozzle spray tips on cylinders 5R and 7L. Disassembled, cleaned and retested on 6L and 8L.
Fuel Injection Equipment Tube Assembly (02-365C)	Additional maintenance recommendations. Additional Quality inspections recommended.	See Phase I
Fuel Injection Equipment Supports (Small Bore Scope Only) (02-365D)	Perform a visual inspection of the support elastomer to check for signs of deterioration or degradation.	Visual inspection was performed and all support elastomers replaced due to deterioration and degradation.
Fuel Pump Control Shaft, Linkage Assembly and Bearings (02-371A&B)	Additional maintenance recommendations. Additional quality inspections recommended.	Inspected fuel pump linkage and bearings for freedom of movement. Greased swivel link on fuel pump assemblies. Routinely inspect and lube oil cups.
Engine Driven Fuel Oil Booster Pump (02-445)	Additional quality inspections recommended.	Visually inspected pump gears for pitting and galling. Found raised metal on edge of gear teeth and scoring on pump case. Old pump replaced.
Fuel Oil Header - Piping and Tubing (Small Bore Scope Only) (02-450B)	Replacement of fabricated cross on the fuel oil supply crossover header on the governor end of Engine 1 with appropriate wrought fittings (socket welding or butt welding tee and reducers).	Inspected fuel oil valves, piping and components. Modification not required.[1]
Fuel Oil Headers - Fuel Oil Tubing Supports (Small Bore Scope Only) (02-450D)	Modify supports and U-bolts. Install suitable locking devices on nuts. Refer to DR/QR report 02-450D for details.	None required.[1]
Fuel Oil Filters and Strainers: Filters (02-455A)	Additional maintenance recommendations.	Replaced filters. Verified bowl bolt torquing. Vented on refill.
Fuel Oil Filters and Strainers: Strainers (02-455B)	Additional maintenance recommendations.	Cleaned and inspected. Verified bowl bolt torquing. Vented and refilled.
Fuel Oil Filters and Strainers: Mounting Hardware (02-455C)	None	None required.

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Component	Owners Group Recommended Action	Summary of Work Performed
Auxiliary Sub Base and Oil and Water Piping Fuel Oil: Piping and Fittings (Small Bore Scope Only) (02-717J)	Addition/modification of supports, U-bolts and locking devices. Refer to DR/QR report 02-717J for details.	None required.[1]
Auxiliary Sub Base and Oil and Water Piping: Fuel Oil Valves (02-717K)	Additional maintenance requirements. Additional Quality inspections recommended.	Inspected installation position of fuel oil relief valves. Disassembled and inspected F.O. discharge check valve. RV 110 tee connection had a flange leak and gasket was replaced.
Auxiliary Sub Base and Oil and Water Piping - Fuel Oil: Gaskets and Bolting (02-717L)	The auxiliary piping should be walked down daily to verify the leak tightness of the fuel oil piping flanges.	Inspection routinely performed.
	GENERATOR	
Generator: Generator (SO-101)	Additional maintenance recommended.	Checked operation of brushes and slip rings. Cleaned and inspected all accessible parts of the generator. Meggered rotor and stator. Verified operation of space heaters. Measured vibration and checked against base line data.
Generator: Generator Controls (SO-102)	None	None required.
Generator - Shaft and Bearing (SO-103)	Additional maintenance recommended.	Checked ring oilers for proper operation and verified oil level. Drained, flushed and refilled bearing housing. Measured bearing housing insulation resistance. Disassembled and inspected bearing and checked clearances.
	CONTROL PANEL ASSEMBLY	
Control Panel Assembly - Cabinet/System (02-500A)	Additional maintenance recommendations.	Replaced regulator. Inspected and replaced control panel air filter bowl. Inspected interior of cabinet for cleanliness and cleaned as required. Visually checked wiring for insulation degradation. Visually checked instrument tubing for leaks. Functionally checked cabinet heater and calibration of thermostat. Tested pneumatic S/D board logic.
Control Panel Assembly - Circuit Breakers and Contact Blocks (02-500C)	Additional maintenance recommendations.	Inspected interior of cabinet for cleanliness and cleaned as required. Visually checked wiring for insulation degradation. Visually checked instrument tubing for leaks. Functionally checked cabinet heater and calibration of thermostat. Tested pneumatic S/D board logic. Replaced "O" rings, gaskets and filter in pressure regulator. Checked all terminals and cleaned and tightened as required. Visually checked wiring insulation for degradation. Trip checked circuit breakers.

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Component	Owners Group Recommended Action	Summary of Work Performed
Control Panel Assembly - Accumulator (02-500F)	None	None required.
Control Panel Assembly - Valves (02-500G)	Additional maintenance requirements.	System cleanliness maintained by filters and driers. Inspection not warranted.
Control Panel Assembly - Pressure Switches (02-500H)	None	None required.
Control Panel Assembly - Control Relays (02-500J)	Additional maintenance recommendations.	Serviced and tested relays in panels and checked associated alarms. Inspected, cleaned and adjusted as needed.
Control Panel Assembly - Solenoid Valves (02-500K)	None	None required.
Control Panel Components - Piping, Tubing, Fittings (02-500M)	None	None required.
Control Panel Assembly - Terminal Boards/Switches, Wiring (02-500N)	Additional maintenance recommendations.	Cleaned terminal boards and switch contacts. Visually checked wire insulation and terminals for tightness and degradation. Inspected for arcing and overheating.
	ENGINE AND AUXILIARY SUB BASE AND FOUNDATION BOLTS	
Foundation Bolts (02-550)	To ensure continued reliability, the foundation bolts for both engines should be torqued to 600 ft/lbs at the next refueling outage. Additional maintenance recommended.	Torqued generator foundation bolts to 600 ft/lbs. Visually inspected foundation for breaks in the bond between the sole plates and grout.
Auxiliary Sub Base and Oil and Water Piping: Auxiliary Sub Base (02-717A)	None	None required.

IAA:6702F

1 Refer to SCE to NRC letter dated September 3, 1985, Enclosure III.