TDI DIESEL GENERATOR

DESIGN REVIEW

AND

QUALITY REVALIDATION

REPORT

prepared for

TEXAS UTILITIES GENERATING COMPANY
COMANCHE PEAK STEAM ELECTRIC STATION - UNIT 1

by

TDI DIESEL GENERATOR OWNERS GROUP

REVISION 1

January, 1985

Reviewed by: RJ Deese

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2.6 FINAL DOCUMENTATION

The DR/QR program has been completed for Texas Utilities. A summary of the results of this effort are contained in Section 3.0.

Appendix I contains component DR/QR Summary Reports which provide a detailed summary of the review and analysis performed on each component including references to supporting documentation and the recommendations and conclusions resulting from this effort.

Appendix II contains a comprehensive set of maintenance and surveillance recommendations for each component. These recommendations were derived from existing vendor recommendations and the individual component DR/QR Summary reports. The purpose of this Appendix is to provide the utility a basis for its maintenance and surveillance program which will maintain the qualification of its diesel generators for the life of the plant.

This entire report constitutes final documentation of the completion of the DR/QR Program on the Comanche Peak TDI diesel generators. 1

3.1 Summary Resolution of Sixteen Generic Components (Phase I)

The results of the Phase I program have been submitted to the NRC in a series of reports and supplements (Refs. 2 through 34) which covered the 16 generic components. The results of these reviews are summarized below.

Component	Acceptability	Recommended Action
Turbocharger (MP-022/3)	Unlimited Life	Additional testing and maintenance requirements. Revision of operating procedures.
Base and Bearing Caps (03-305A, 03-305C, 03-305D)	Unlimited Life	Additional maintenance and inspection requirements.
Crankshaft (03-310A)	Unlimited Life (provided the engines are run at no greater than a 3130 kW load.)	None
Cylinder Block and Liner (03-315A, 03-315C)	Unlimited Life	Additional maintenance and inspection requirements.
Cylinder Head Studs (03-315E)	Unlimited Life	None
Connecting Rods: Connecting Rods and Bushings (03-340A)	Unlimited Life	Additional inspection requirements.
Connecting Rod Bearing Shells (03-340B)	Unlimited Life	Additional maintenance requirements. Additional inspections recommended.
Pistons (03-341A)	Unlimited Life	AN piston skirts should be replaced with AE piston skirt.
Air Start Valve (03-359)	Unlimited Life	Additional maintenance requirements. Verification of dimensions recommended.
Cylinder Heads (03-360A)	Unlimited Life	Additional maintenance requirements.
Fuel Injection Equipment: Tube Assembly (03-365C)	Unlimited Life	Additional testing and maintenance requirements. Procurement specification requirement.

Component	Acceptability	Recommended Action
Main and Connector Pushrods (03-390C, 03-390D)	Unlimited Life	Additional procurement requirement. Additional inspections recommended. Random destructive testing recommended.
Rocker Arm Capscrews (03-390F)	Unlimited Life	Additional maintenance requirements.
Jacket Water Pump (03-425A)	Unlimited Life	Additional maintenance requirements.
Wiring and Terminations (03-688B)	Unlimited Life	None

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3.2 Summary Resolution of Phase II Components

Component	Acceptability	Recommended Action
TURBO, INTAKE, INTERCOOLER & EXHAUST		
Intercooler (F-068)	Unlimited Life	Additional maintenance requirements.
Turbocharger (MP-022/023)	Unlimited Life	See section 3.1
Turbocharger Thrust Bearing Drip Lube System (02-CFR)	Modifications	Addition of supports.
Air Intake Manifold (02-375)	Modifications	Installation of missing U-bolt nuts. Additional installation requirements.
Exhaust Manifold Piping (02-380A)	Modifications	Replace slip joints with slip on flanges. Additional maintenance requirements.
Exhaust Manifold Bolting and Gaskets (02-380B)	Unlimited Life	None
Intercooler Piping - Pipe (02-436A)	Unlimited Life	None
Intercooler Piping - Gaskets, Bolting (02-436B)	Unlimited Life	None
Turbocharger Bracket Bolting and Gaskets (02-475A&C)	Unlimited Life (pending confirmation of acceptable engine vibration levels)	Additional inspections of the bracket to engine and bracket to turbo base screws recommended. 1
Air Butterfly Valve (02-475B)	Modifications	Addition of grease fittings to valve shaft. Additional maintenance requirements.

Component	Acceptability	Recommended Action
Intake Air Silencer (02-805A)	Unlimited Life	None
Intake Air Filters (02-805B)	Unlimited Life	Additional maintenance requirements.
Flex Connections (02-805D)	Unlimited Life	None
LUBE OIL		
Lube Oil Pressure Regulating Valve (00-420)	Unlimited Life	Additional maintenance requirements.
Lube Oil Fittings - Internal - Headers (02-307A)	Modifications	Modification of several supports.
Lube Oil Fittings - Internal - Tube and Fittings (02-307B)	Unlimited Life	None
Lube Oil Fitting - Internal - Supports (02-307D)	Modifications	Modification of several supports.
Engine Driven Lube Oil Pump (02-420)	Unlimited Life	None
Lube Oil Lines External - Tubing, Fittings, Couplings (02-465A)	Modifications	Addition of supports. Additional installation requirement.
Lube Oil Lines External - Supports (02-465B)	Modifications	Modification of a support.

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Component	Acceptability	Recommended Action
Auxiliary Sub-Base and Oil and Water Piping Lube Oil: Supports and Mounting Hardware (02-717I)	Modifications	Addition, replacement and modification of supports.
Lube Oil Sump Tank Heater (02-820A)	Unlimited Life	None
Miscellaneous Equipment - Auxiliary Lube Oil Pump (02-820B)	Unlimited Life	None
Prelube Oil Pump (02-820C)	Unlimited Life	Additional inspections recommended
Lube Oil Keep-warm Strainer (02-820D)	Unlimited Life	Additional maintenance requirements.
Oil Prelube Filter (02-820E)	Unlimited Life	Additional maintenance requirements.
Full Flow Lube Oil Filters (02-820F)	Unlimited Life	Additional maintenance requirements.
Lube Oil Heat Exchanger (02-820G)	Unlimited Life	Additional maintenance requirements.
Lube Oil Full Pressure Strainer (02-820H)	Unlimited Life	Additional maintenance requirements.
ENGINE BASE & BEARING CAPS		
Base and Bearing Caps - Base Assembly (02-305A)	Unlimited Life	See section 3.1

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Component	Acceptability	Recommended Action
Connector Pushrods (02-390D)	Unlimited Life	See Section 3.1
Rocker Arms and Pushrods: Bushings (02-390E)	Unlimited Life	Additional maintenance requirements.
Rocker Arms and Pushrods - Lifters (02-390F)	Unlimited Life	At each refueling outage, replace worn lifters. 1
Rocker Arms and Pushrods - Bolts, Drive Studs (02-390G)	Unlimited Life	See Section 3.1
IDLER GEAR ASSEMBLY & FRONT GEAR CASE		
Front Gearcase - Gasket and Bolting (02-335B)	Unlimited Life	None
Idler Gear Assembly - Crank to Pump Gear (02-355A)	Unlimited Life	None
Idler Gear Assembly (02-355B)	Unlimited Life	Implement nut locking procedure and additional maintenance requirements.
CYLINDER HEADS & VALVES		
Cylinder Heads (02-360A)	Unlimited Life	See Section 3.1
Intake & Exhaust Valves (02-360B)	Unlimited Life	Additional maintenance requirements.
Cylinder Head and Valves - Bolting and Gaskets (02-360C)	Unlimited Life	None
Cylinder Head Valves: Springs and Retainers (02-360D)	Unlimited Life	None

HOW TO USE THIS REPORT

Tabs in this report identify the following categories:

Turbo, Intake, Intercooler & Exhaust
Lube Oil
Engine Base & Bearing Caps
Crankshaft & Bearings
Cylinder Block, Liners & Water Manifold
Air Start & Barring Device
Connecting Rods
Pistons
Camshaft & Valve Train
Idler Gear Assembly & Front Gear Case
Flywheel
Engine Instrumentation & Wiring
Overspeed Trip & Governor
Engine Shutdown & Equipment
Jacket Water
Cylinder Heads & Valves
Fuel Oil Injection
Generator
Control Panel Assembly
Engine & Auxiliary Sub-Base & Foundation Bolts

These categories have been defined to allow the reader to review a complete diesel generator subsystem in a convenient manner.

Within each category tabs identify Comanche Peak specific component numbers.

A given component report can be found by:

a) If the component number is known - use the alpha - numeric index which identifies the volume number and category in which the component report is located.

b) If only the component name is known - Section 3.2 may be used as a cross-reference to find the volume number where the component report may be found.

Some reports address more than one component. A tab is provided for each component. However, some components are combined under one report. Slip sheets are provided where required to reference back to the appropriate tab. Some components required more than one report. These are identified by the abbreviation LB-Large Bore, and SB-Small Bore on the component number tabs. 1

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Component Number	Component Description	Category	Vol. No.
CP-101A	Generator: Generator	Generator	8
CP-101B	Generator: Shaft and Bearings	Generator	8
CP-102	Generator Controls	Generator	8
F-068	Intercooler	Turbo, Intake, Intrclr. & Exhaust	2
MP022/3	Turbocharger	Turbo, Intake, Intrclr. & Exhaust	2
00-420	Lube Oil Pressure Regulating Valve	Lube Oil	2
00-442A	Starting Air Distributor: Distributor Assembly	Air Start & Barring Device	4
00-442B	Starting Air Distributor: Tubing, Fittings, Gaskets	Air Start & Barring Device	4
00-621A	Fuel Oil Drop Tank	Fuel Oil Injection	8
02-CFR	Turbocharger Thrust Bearing Lubricant System	Turbo, Intake, Intrclr. & Exhaust	2
02-305A	Base and Bearing Caps: Base Assembly	Engine Base & Bearing Caps	3
02-305C	Base and Bearing Caps: Main Bearing Studs & Nuts	Engine Base & Bearing Caps	3
02-305D	Base and Bearing Caps: Main Bearing Caps	Engine Base & Bearing Caps	3
02-307A	Lube Oil Fittings: Internal - Headers	Lube Oil	2
02-307B	Lube Oil Fittings: Internal - Tube & Fittings	Lube Oil	2

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Component Number	Component Description	Category	Vol. No.
02-316B	Jacket Water Inlet Manifold: Coupling and Gaskets	Jacket Water	7
02-316C	Jacket Water Inlet Manifold: Vent Line to Discharge Manifold	Jacket Water	7
02-317A	Water Discharge Manifold: Jacket Water Discharge Manifold, Coupling and Seals	Jacket Water	7
02-317B	Water Dicharge Manifold: Coupling & Seals	Jacket Water	7
02-317C	Water Discharge Manifold: Supports	Jacket Water	7
02-330A	Flywheel: Flywheel	Flywheel	6
02-330B	Flywheel Bolting	Flywheel	6
02-335B	Front Gear Case- Gasket and Bolting	Idler Gear Assembly & Front Gear Case	5
02-340A	Connecting Rods: Connecting Rods & Bushings	Connecting Rods	4
02-340B	Connecting Rods: Bearing Shells	Connecting Rods	4
02-341A	Pistons: Pistons	Pistons	5
02-341B	Pistons: Rings	Pistons	5
02-341C	Piston: Pin Assembly	Pistons	5
02-345A	Intake/Exhaust and Fuel Tappet Assembly	Camshaft & Valve Train	5
02-345B	Tappets and Guides: Fuel Tappet Assembly	Camshaft & Valve Train	5
02-345C	Tappets and Guides: Fuel Pump Base Assembly	Camshaft & Valve Train	5

The evaluation of the exhaust water jacket was performed in accordance with the philosophy, and intent of the ASME Code, Section III "Nuclear Power Plant Components"; Subsection ND for Class 3 Components.

Quality Revalidation Checklist results were reviewed for acceptability.

The TDI Emergency Diesel Generator Component Tracking System was reviewed for the Comanche Peak site, nuclear, and non-nuclear industry experience.

IV RESULTS AND CONCLUSIONS

The maximum deadweight stress for the subject component is 2,260 psi. The piping load controlled seismic stresses were acceptable, never exceeding 7,060 psi. Thermal expansion stresses were somewhat higher, with stresses always less than 16,500 psi and the stresses caused by axial discontinuity at the in-line slip joints were less than 4,320 psi.

All piping stresses are acceptable.

Consistent with intent and philosophy of the ASME Code, the adoption of an inspection program which provides a means for identifying the possible degradation of the exhaust manifold piping components, particularly the welded joints is recommended (Ref.3).

Because of the flexibility of the slip joints, especially with respect to seismic considerations, modifications are recommended for the present configuration. Four of the twelve slip joints for this component require removal and replacement with 150 lb. slip-on flanges. The remaining eight slip joints were found to be acceptable and will perform their intended design function at Comanche Peak.

The exhaust water jacket was evaluated for normal operating loads, earthquake (OBE and SSE), thermal effect, and the effects of all applicable load combinations described in Reference 1. The intent and philosophy of ASME Code Section III, Subsection ND for Class 3 components was used as the acceptace criteria. Based on this review it is concluded that the exhaust water jacket is acceptable for its intended design function at Comanche Peak. In the event of a SSE, it is recommended that the cap screws which hold the water jacket to the exhaust manifold assembly support be inspected at some time subsequent to the SSE event and replaced if the inspection warrants, but the equipment will continue to operate safely after a SSE event.

The following maintenance recommendation is required to be performed on the exhaust manifold:

- Perform a visual inspection and a Magnetic Particle test for a sampling of the circumferential pipe welds and corresponding heat affected zones.

This is to be performed during the first refueling outage and alternate outages thereafter. However, diesel operation should not exceed 200 hours between inspections.

All pipe loads on the engine block and turbocharger have been tabulated and issued for evaluation.

The information provided on the following TERs has been reviewed and is consistent with the final conclusions of this report: 10-115 and 10-134.

Quality Revalidation Checklist results identified in Appendix B have been reviewed and considered in the performance of this design review and the results are consistent with the final conclusion of this report.

Based on the above review, it is concluded that the subject piping components, with the recommended modifications and inspection (Ref.4) are adequate for their intended design function at Comanche Peak.

V REFERENCES

1. "Supporting Calculations for the Evaluation of Comanche Peak Diesel Generator Large Diameter Piping and Supports, " Impell Report No. 02-0630-1230, Rev. 0, August 1984.

2. "Design Criteria for Diesel Generator Large Diameter Piping," Impell Report No. 02-0630-1231, Rev. 0, August 1984, This is included in Appendix III of the final DR/QR report.

3. Memorandum form G. Shears (Impell) to J. Kammeyer (SWEC), "Inspection program for Exhaust Manifold, " August 13, 1984.

4. Memorandum from R. Markovich/G. Shears (Impell) to J. Kammeyer (SWEC), " Required Modifications for Validations of Impell's Design Review for Impell Report No. 02-0630-1215, Rev. A," dated August 13, 1984.

the background and provides the technique for evaluating the subject piping components and supports. This criteria is presented in its entirety in Reference 2.

Quality Revalidation Checklist results were reviewed for acceptability.

The TDI Emergency Diesel Generator Component Tracking System was reviewed for the Comanche Peak site, nuclear, and non-nuclear industry experience.

The Dresser couplings were evaluated by comparing the coupling against the manufacturer's selection and service requirements. These included the design service conditions, relative end displacements -- both translational and rotational -- of the joined pipe, and shelf and service life.

IV RESULTS AND CONCLUSIONS

The maximum deadweight stress for the intercooler piping is 2,200 psi. The piping load-controlled seismic stresses were acceptable, never exceeding 9,500 psi. Thermal expansion stresses were lower, with stresses less than 800 psi, and the stresses caused by the axial discontinuity at the in-line Dresser couplings were less than 2200 psi.

All piping stresses were within the design allowables specified by the ASME Section III Code.

The total movements at two of the Dresser couplings (Style 38, 7 inches long) are within the manufacturer's allowables, Reference 3. The movements due to thermal, deadweight, and pressure on the intercooler inlet pipe coupling are within the manufacturers allowables. However, the increment due to seismic loading exceeds allowables by less than 20 percent. Since the seismic loading is occasional, this is acceptable.

TERs 10-60 and 10-108 have been reviewed. These TERs indicate that the Dresser couplings are Style 450 and not Style 38, as listed in the Comanche Peak TDI Parts Manual. However, per Reference 5, the Dresser Manufacturing Co. does not manufacture a Style 450 coupling. An Impell field walkdown has confirmed that a Style 38 is installed and is acceptable. | 1

The information provided on the following TERs has been reviewed and is consistent with the final conclusions of this report: 10-115 and 10-134.

There are no service life constraints (Ref. 4) because these couplings have no significant history of failure. Shelf life (Ref. 4) is unlimited as long as the gaskets remained packed and protected from the elements: light, water, etc. The coupling is adequate with respect to manufacturer's service condition limits.

All pipe loads on the intercooler were tabulated and issued for evaluation.

Quality Revalidation Inspection results identified in Appendix B have been reviewed and considered in the performance of this design review and the results are consistent with the final conclusion of this report except for information on TERs 10-060 and 10-108 which was superseded by Impell's field walkdown.

Based on the above review, it is concluded that the subject piping components are adequate for the intended design function at Comanche Peak.

V REFERENCES

1. "Supporting Calculations for the Evaluation of Comanche Peak Diesel Generator Large Diameter Piping and Supports," Impell Report No. 02-0630-1230, Rev. 0, August 1984.

2. "Design Criteria for Diesel Generator Large Diameter Piping for Comanche Peak," Impell Report No. 02-0630-1231, Rev. 0, August 1984. This is included in Appendix III of the final DR/QR report.

3. Dresser Pipe Couplings, Pipe Fittings, and Pipe Repair Products Catalog, No. 63.

4. Telephone Conservation A. Palumbo and M. Riley, of Dresser Manufacturing Co., June 5, 1984.

5. Telephone Conversation A. Palumbo and B. Steck, of Dresser Manufacturing Co., July 25, 1984. | 1

IV RESULTS AND CONCLUSIONS

The SDRC seismic analysis report adequately modeled the turbocharger bracket; however, loads were only based upon seismic inertia loads and dead weight. Analyses of the Shoreham bracket (Ref. 2) indicated that pipe thermal loads and engine vibration loads may be the most significant loads experienced by the bracket and bolts. By comparison to the Shoreham bracket which was stress analysed, it can be concluded that the bracket is designed to have a high stiffness and would not be a weak point. Stresses in the Shoreham bracket were found to be insignificant. The Comanche Peak bracket is similar in that it is of substantial cross section and uses full penetration welds for major structural connections.

The SDRC analysis reported stresses for 1 inch diameter bracket bolts, while 3/4 inch bolts are specified in the parts listing. In TER 10-122 it was determined that 3/4 inch bolts were used.

The 3/4 inch bolts have been analyzed and found to have adequate strength (Ref. 3). However, the review of the turbocharger bracket and bolting finds that in the worst case load condition, vibration and manifold nozzle loads could potentially produce bolt loads in excess of preloads. Therefore the bracket to engine and bracket to turbo base screws (P.N. GB-001-143 and GB-001-120) are recommended to be inspected on a regular basis as discussed below:

Eacn month for the first three months of commercial operation these screws should be inspected to assure that no screw loosened due to engine operating loads. If during these inspection none of the screws are found loosened or damaged, from then on inspections are to be conducted on a yearly basis (or during plant shutdown). But if at any time during inspection any screw is found loosened or damaged, it must then be replaced (if damaged) and all screws retorqued as follows; 125 ft-lbs for the bracket to engine screws and 75 ft-lbs for the bracket to turbo base screws. 1

To avoid damage to the bracket to engine, and/or bracket to turbo base screws, the proper torques as deliniated above should be utilized for each respective bracket bolting application.

The information provided on the following TERs has been reviewed and is consistent with the final conclusions of this report: 10-035, 10-110, and 10-122. The bolts as currently installed have been torqued correctly, are of the correct material, have adequate thread engagement, and have been installed properly.

Quality Revalidation Inspection results identified in Appendix B have been reviewed and considered in the performance of this design review and the results are consistent with the final conclusion of this report.

Based on the above review, the turbocharger bracket and bolting have been found adequate for their intended service at Comanche Peak pending confirmation of acceptable engine vibration levels.

V REFERENCES

1. SDRC Seismic Report No. 7663 on DSRV-16-4 Diesel Gen. Units.

2. Stone & Webster Calculation No. 11600.02 NM(B) -437-CZC-039, "Design Review of the Turbocharger Bracket and Bolting." (Shoreham)

3. Stone & Webster Calculation No. 11600.60-NM(B)-001-CZC-039, "Design Review of the Turbocharger Bracket and Bolting." (Comanche Peak) | 1

EXPERIENCE	REFERENCE DOCUMENTS	COMANCHE PEAK STATUS
NON-NUCLEAR		
Breakage of holddown capscrews of turbocharger due to high stress in manifold-turbo-jumper pipe area.	City of Homestead Florida Letter from J. Smith (Homestead) to G. Trussell (TDI) 05/14/77.	Nozzle loads for Comanche Peak have been reviewed and were found acceptable.
Due to high vibration, many bracket-to-engine mounting bolts failed. Bolts were replaced	Rafha Electricity Co. and Suburbs, Saudi Arabia dated 07/12/81 (File #T-57).	The means to resolve vibration concerns are provided in the DR report. See text for further details.

COMPONENT QUALITY REVALIDATION CHECKLIST

COMPONENT Lube Oil Lines External - Supports

UTILITY Texas Utilities Generating Co., Comanche Peak Station

GPL NO. 02-465B

REV. NO. 2

SNPS GPL NO. 03-465B

TASK DESCRIPTIONS

D.G. CP1-MEDGEE-01

1. Assemble and review existing documentation.
2. Verify the proper installation of the supports by a line walkdown.
3. Perform a material comparator test on the supports required by TER# 10-115.

D.G. CP1-MEDGEE-02

Same as D.G. CP1-MEDGEE-01

ATTRIBUTES TO BE VERIFIED

D.G. CP1-MEDGEE-01

1. Quality status of Component Document Package
2. All supports are installed in accordance with the issued as-built isometric drawings.
3. Material of supports required by TER# 10-115.

D.G. CP1-MEDGEE-02

Same as D.G. CP1-MEDGEE-01

ACCEPTANCE CRITERIA

D.G. CP1-MEDGEE-01

1. Satisfactory Document Package
2. Review of detailed information by the Design Group
3. Review of inspection report by Design Group

D.G. CP1-MEDGEE-02

Same as D.G. CP1-MEDGEE-01

REFERENCES

D.G. CP1-MEDGEE-01

1. QCI-FSI-F11.1-020
2. Procedure DG-7
3. TER# 10-115

D.G. CP1-MEDGEE-02

Same as D.G. CP1-MEDGEE-01

DOCUMENTATION REQUIRED

D.G. CP1-MEDGEE-01

1. Document Summary Sheet
2. Quality verified as-built isometric drawing for supports.
3. Inspection Report

D.G. CP1-MEDGEE-02

Same as D.G. CP1-MEDGEE-01

GROUP CHAIRPERSON _____ PROGRAM MANAGER _____

COMPONENT REVIEW

D.G. CP1-MEDGEE-01

1. No EDGCTS site experience documents are in evidence.

2. The Design Group will be responsible for closing out the as-built drawings as per Procedure DG-7. The as-built drawings will be Quality verified by the appropriate site Quality organization.

3. A material comparator test was performed on a lube oil support as required by TER# 10-115. Results were reported by TER# 10-134.

D.G. CP1-MEDGEE-02

Same as D.G. CP1-MEDGEE-01

RESULTS AND CONCLUSION

D.G. CP1-MEDGEE-01

The Quality Revalidation effort with respect to this component, as outlined above, is complete. The results have been forwarded to the Design Review Group for their evaluation and conclusions in support of the final report.

D.G. CP1-MEDGEE-02

Same as D.G. CP1-MEDGEE-01

GROUP CHAIRPERSON Victor A Sorieta PROGRAM MANAGER

HOW TO USE THIS REPORT

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Turbo, Intake, Intercooler & Exhaust
Lube Oil
Engine Base & Bearing Caps
Crankshaft & Bearings
Cylinder Block, Liners & Water Manifold
Air Start & Barring Device
Connecting Rods
Pistons
Camshaft & Valve Train
Idler Gear Assembly & Front Gear Case
Flywheel
Engine Instrumentation & Wiring
Overspeed Trip & Governor
Engine Shutdown & Equipment
Jacket Water
Cylinder Heads & Valves
Fuel Oil Injection
Generator
Control Panel Assembly
Engine & Auxiliary Sub-Base & Foundation Bolts

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background and provides technique for evaluating the subject piping and supports. This criteria is presented in its entirety in Reference 2.

Quality Revalidation Checklist results were reviewed for acceptability.

The TDI Emergency Diesel Generator Component Tracking System was reviewed for the Comanche Peak site, nuclear and non-nuclear industry experience.

IV RESULTS AND CONCLUSIONS

The maximum deadweight stress for the subject component is 3,885 psi. The piping load controlled seismic stresses were acceptable, never exceeding 11,680 psi. Thermal expansion stresses were higher, with stresses always less than 22,550 psi. and the stresses caused by the axial discontinuity at the in-line Dresser couplings were less than 9,130 psi. All piping stresses were within the design allowables specified by the ASME Section III Code.

With respect to the Dresser couplings, Impell evaluated the couplings against the manufacturer's selection and service requirements. These include the design service conditions, relative end displacements from both translation and rotation of the joined pipes, and shelf and service life.

It is recommended that two of the five Dresser couplings for this component be modified. To take credit for the mutual stiffening effects of the joined pipes, extra nuts are required on the tie-rod assemblies surrounding the two 6 inch Dresser Couplings. Also, a 1 inch diameter rod is recommended to accommodate the compression loading. 1

In addition, it is recommended that a 6 inch Style 38, 6 7/8 inch long Dresser coupling be added on the piping between the lube oil sump tank and the engine pump inlet to mitigate the thermal expansion loading and stresses on these nozzles.

There are no service life constraints (Ref. 4) because this style coupling has no significant history of failure. Shelf life (Ref. 4) is unlimited as long as the gaskets remained packaged and protected from the elements: light, water, etc. The coupling is adequate with respect to manufacturer's service condition limits.

In order to provide adequate load transfer capability, the 3 inch x 2½ inch - 150# reducing flanges at supports LO-PSA-10204 and LO-PSA-10205 have specific requirements for bolt torquing; specified in Appendix IV of the DeLaval Instruction Manual Vol. 1 for Model DSRV-16-4.

All pipe loads on the engine were tabulated and issued for evaluation.

Mechanical Design

This pump's design has been used by the IMO Division of TDI for many years. The following summarizes the major pump design parameters and the operating requirements (Ref. 1 and 2):

Parameter	Design	Operating
Design Pressure	500 psig	25 psig
Speed	4400 rpm	1800 rpm
Brake Horsepower	57 hp	15 hp
Suction Pressure	75 psig	1 psig

No stresses were calculated since the operating conditions are so far below the design conditions and the AC induction motor imposes no unusual torque fluctuations on the pump.

The coupling is a Falk Model 40T10 with a maximum speed rating of 4500 rpm vs. an operating speed of 1800 rpm; the horsepower rating is 1.90 hp per 100 rpm. At 1750 rpm this 33.25 hp vs. the 15 hp operating; this is a safety factor of 9.5. The coupling is satisfactory.

The mechanical design is satisfactory.

Material Suitability

The pressure boundary parts are carbon steel. The internal wetted parts are cast iron and carbon steel. The mechanical seal is a John Crane Type 9 with 18-8 stainless steel metal parts and Teflon secondary seals. All are satisfactory for lubricating oil service.

Vendor Qualification

The Comanche Peak pumps are not, nor are they required to be, N-stamped components. However, the IMO Division of TDI has been a supplier of ASME Section III N-stamp pumps for well over 10 years.

B. Conclusions

The applied piping loads on the prelube oil pump inlet and outlet nozzles are above the manufacturer's allowables. There has, however, been no experience of pump leakage due to these loads at Comanche Peak or other V-16 engines using the same model prelube pump. It is recommended therefore that as part of daily engine walkdown, the pump be inspected for signs of leakage and corrective modifications (addition of flexible piping connections) be implemented as required. 1

Quality Revalidation Inspection results identified in Appendix B have been reviewed and considered in the performance of this design review and the results are consistent with the final conclusions of this report.

There are no TERs associated with this component.

Based on the above, it is concluded that the lube oil keepwarm pump is acceptable for its intended design function at Comanche Peak.

V References

1. IMO Pump Division "Process, Transfer and Burner Pump Data Book," PT-80.

2. IMO Pump Division, "IMO Lube Oil and Seal Oil Pump Data Book," LS-80.

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A modal superposition analysis of the crankshaft was performed. The pressure loading was obtained from the dynamic test at Shoreham Nuclear Power Plant (Ref. 2). This analysis calculates the nominal shear stresses at each crank pin and main journal location. The TDI Holzer calculations were reviewed by comparing the results with results obtained from the torsiograph test and the modal superposition analysis (Ref. 1).

The stress levels in the main journal oil holes were compared with the endurance limit.

IV RESULTS AND CONCLUSIONS

The TDI Holzer calculations were found to be in agreement with modal superposition analysis. The torsiograph test has not been conducted to date. A comparison of the TDI Holzer calculations with the torsiograph test results will need to be performed upon completion of the test.

The modal superposition analysis determined the maximum amplitude of nominal stress to be 5326 psi between cylinder numbers 5 and 6 for a load at 7000 kW. This value is slightly lower than the value of 5367 psi, which was determined for the DSRV-16-4 crankshafts at Grand Gulf Nuclear Power Station. The difference is due to the slightly lower inertia at the flywheel and generator at Comanche Peak. The nominal stresses were found to satisfy the requirements of DEMA, and are less than 5000 psi for a single order and less than 7000 psi for combined orders.

The material certification reports for the crankshafts at Comanche Peak indicate that the tensile strengths for the crankshaft material in engines Serial No. 76001 and Serial No. 76002 are within the original design specifications (Ref. 3). The material for engine Serial No. 76003 has a tensile strength of 79.5 ksi or 3.5 ksi below the original design specifications (Refs. 3 and 4). The factor of safety against fatigue failure in the main journal oil holes was found to be 1.3 based on a minimum ultimate tensile strength of 83 ksi for engine Serial No. 76002.

Eddy Current tests were performed on selected main journal oil holes on engine 76001 and 76002. At various locations, background readings were recorded that exceed the allowable threshold limit. The affected oil holes were polished out and reinspected by Eddy Current methods. As a result of the reinspection, no relevant indications were noted. 1

Non-nuclear experience (M/V Pride ' Texas) disclosed cracking of oilway plugs which resulted from improper installation of the thinner plug material used in those crankshaft oilway plugs. Reference 5 identifies the interval from March 1980 to June 1982 when the thinner gage material was used in the plugs for easier installation. Reference 6 confirms that the Comanche Peak engines were delivered before the change to thinner plug material occurred. No problems have been encountered with the plugs made from the thicker material. Therefore, the oilway plugs at Comanche Peak are acceptable.

The information provided on the following TERs has been reviewed and is consistent with the final conclusions of this report, TER #10-002, TER #10-069 and TER #10-137, 1

Quality Revalidation Inspection results identified in Appendix B have been reviewed and considered in the performance of this design review and the results are consistent with the final conclusion of this report.

Based on the above review, it is concluded that the crankshafts in engine Serial Nos. 76001 and 76002 are acceptable for their intended function at Comanche Peak, provided the torsiograph test is completed satisfactorily.

V REFERENCES

1. Yang, Roland, "Torsional and Lateral Critical Speed Analysis: Engine Numbers 76001/04 Delaval Enterprise Engine Model DSRV-16-4 7000 kW, 9737 BHP at 450 RPM," Transamerica Delaval Inc., Engine and Compressor Division, Oakland, California, October 5, 1976.

2. "Evaluation of Emergency Diesel Generator Crankshafts at Shoreham and Grand Gulf Nuclear Power Stations," Report No. FaAA-84-3-16, Failure Analysis Associates, Palo Alto, California, May 22, 1984.

3. Material Certification Reports, Numbers 0-06751, 0-07042, 0-07019 and 0-12850, National Forge Company, Quality Control Department, Irvine, Warren County, Pennsylvania.

4. National Forge Company, Quality Control, Request for Waiver, Request Number E-2767, 2/8/79.

5. Letter from C.S. Matthews (TDI) to C. Seaman (LILCO), dated 7/12/84 on Crankshaft Oil Hole Plug P/N R3149.

6. IOC M. Lange (TUGCO) to W. Littman (FaAA), dated 8/15/84.

HOW TO USE THIS REPORT

Tabs in this report identify the following categories:

Turbo, Intake, Intercooler & Exhaust
Lube Oil
Engine Base & Bearing Caps
Crankshaft & Bearings
Cylinder Block, Liners & Water Manifold
Air Start & Barring Device
Connecting Rods
Pistons
Camshaft & Valve Train
Idler Gear Assembly & Front Gear Case
Flywheel
Engine Instrumentation & Wiring
Overspeed Trip & Governor
Engine Shutdown & Equipment
Jacket Water
Cylinder Heads & Valves
Fuel Oil Injection
Generator
Control Panel Assembly
Engine & Auxiliary Sub-Base & Foundation Bolts

These categories have been defined to allow the reader to review a complete diesel generator subsystem in a convenient manner.

Within each category tabs identify Comanche Peak specific component numbers.

A given component report can be found by:

a) If the component number is known - use the alpha - numeric index which identifies the volume number and category in which the component report is located.

b) If only the component name is known - Section 3.2 may be used as a cross-reference to find the volume number where the component report may be found.

Some reports address more than one component. A tab is provided for each component. However, some components are combined under one report. Slip sheets are provided where required to reference back to the appropriate tab. Some components required more than one report. These are identified by the abbreviation LB-Large Bore, and SB-Small Bore on the component number tabs. 1

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HOW TO USE THIS REPORT

Tabs in this report identify the following categories:

Turbo, Intake, Intercooler & Exhaust
Lube Oil
Engine Base & Bearing Caps
Crankshaft & Bearings
Cylinder Block, Liners & Water Manifold
Air Start & Barring Device
Connecting Rods
Pistons
Camshaft & Valve Train
Idler Gear Assembly & Front Gear Case
Flywheel
Engine Instrumentation & Wiring
Overspeed Trip & Governor
Engine Shutdown & Equipment
Jacket Water
Cylinder Heads & Valves
Fuel Oil Injection
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TDI OWNERS GROUP

for

COMANCHE PEAK STEAM ELECTRIC STATION - UNIT 1

CYLINDER BLOCK
COMPONENT PART NO. 02-315A

I INTRODUCTION

The TDI Emergency Diesel Generator Owners Group Program for the Comanche Peak Steam Electric Station requires Design and Quality Revalidation reviews of cylinder blocks to determine the adequacy of their design for the intended use at Comanche Peak. The blocks are manufactured by TDI and are supplied under their part numbers 02-315-03-AE. The cylinder block forms the framework of the liquid cooled engine and provides passage for coolant and support for the cylinder liners and cylinder heads.

II OBJECTIVE

The objective of this review was to evaluate the adequacy of the cylinder block for intended service at Comanche Peak Steam Electric Station; specifically to perform:

- A review of liquid penetrant, and 100 hour inspections of Comanche Peak RV-16 engines.
- Evaluate steady state stresses, alternating stresses, and stiffness in key portions of this component.
- Evaluate critical flaw sizes for cylinder block landing and counterbore diameter.
- A review of Comanche Peak Site, nuclear, and non-nuclear industry experience.
- A review of Quality Revalidation Checklist results for acceptability.

III METHODOLOGY

The TDI Emergency Diesel Generator Component Tracking System results were reviewed for the Comanche Peak, nuclear, and non-nuclear industry experiences with the cylinder block.

The structural adequacy of the cylinder block for the intended service was evaluated by strain gauge testing combined with two and three-dimensional analytical models of the block top and liner. The ability of the cylinder blocks to perform adequately during emergency service was established based on: 1) comparison of block microstructure between Comanche Peak cylinder blocks with Shoreham EDG 103 cylinder block, and 2) comparison of cumulative damage incurred during testing of Shoreham EDG 103 from March 11, 1984 through April 14, 1984, with the predicted cumulative damage during a LOOP/LOCA event (Refs. 1 and 2).

All Quality Revalidation documents were analyzed for pertinent data (Ref. 2).

IV RESULTS AND CONCLUSIONS

A generic investigation of the structural adequacy of the TDI R-4 and RV-4 series diesel engine cylinder blocks for emergency standby service in nuclear power plants is summarized in Reference 1. The investigation considers the cause, extent, and consequences of cylinder block cracking, and the inspections required to assure sufficient margin of safety during continued operation under test and postulated accident conditions. | 1

Diesel generators DG CP1-MEDGEE-01 and DG CP1-MEDGEE-02 have been inspected for block cracks. Cracks were indicated by liquid penetrant inspection of DG CP1-MEDGEE-01 in cylinders 4 and 5 right bank and 6 left bank. Additional inspection with eddy current confirmed the presence of indications in the right bank but did not substantiate indications in the left bank. The cracks in the right bank extend adjacent to the cylinder head stud boss from just below the bottom of the block top diagonally upwards across the cylinder liner landing and then up through the upper cylinder liner counterbore towards the surface of the block top. The cracks lie in the vicinity of the between cylinder studs on the exhaust side of the engine. Acetate replicas for metallurgical evaluation of the cracks in the right bank were made. Results of this evaluation show the cracks to be casting induced. | 1

In engine DG CP1-MEDGEE-02 several linear indications were found in the lower pilot diameter in cylinders 4 and 5 right bank. The length of these indications are 3/8-inch or less and the depth appears to be less than 0.050-inch as measured by ultrasonic examination. The indications are located near the longitudinal centerline of the engine.

For the purpose of further analysis and determining inspection criteria, these cracks in the right banks of both engines are considered to be treated conservatively as ligament cracks. | 1

In addition, other acetate replicas have been made of each block top in a thick-section region to evaluate the microstructure and to determine whether Widmanstaetten graphite was present. Widmanstaetten graphite is a degenerate microstructure that reduces fatigue resistance. All four block tops at Comanche Peak were found to be free of Widmanstaetten graphite.

Therefore, for the purpose of the cumulative damage computations, the cylinder blocks are considered to have typical material properties for gray cast iron, Class 40.

The power output for these engines is 7000 kW at 100 percent load. Maximum output required for LOOP/LOCA is 7000 kW. The duration of a LOOP/LOCA used in this analysis is 168 hours.

Evaluation of steady state stresses, alternating stresses and stiffness in key portions of the cylinder block was accomplished as part of the strain gauge testing and the results were included in the cumulative damage and crack growth analysis. The cumulative damage algorithm is explained in Reference 1. 1

Strain gauge testing of the original Shoreham EDG 103 block, inspection data from before and after testing, and material testing were used to predict adequate life for cylinder blocks. The apparent rate of propagation of cracks between studs holes in the original EDG 103 block at Shoreham, when compared with the Comanche Peak LOOP/LOCA requirements, indicates that blocks with ligament cracks (i.e., the right cylinder bank of DG CP1-MEDGEE-01 and 02) are predicted to withstand with sufficient margin a LOOP/LOCA event provided that inspection shows no detectable 1
stud-to-stud cracks between cylinder heads and no detectable stud-to-edge cracks adjacent to the number 1 and 8 cylinder heads at the ends of the engines whenever the engines are returned to emergency standby service 1
after any period of operation in excess of 50 percent load.

Application of the cumulative damage algorithm (Figure 5-1 of Reference 1) shows that the left cylinder banks (those without cracks at the last inspection) for engines DG CP1-MEDGEE-01 and 02 can perform for 437 hours at 100 percent load (or operation resulting in equivalent damage), without inspection, with sufficient margin for a LOOP/LOCA event (Reference 2).

Engine operation in excess of the time periods listed above without inspection could be justified if the fatigue damage index since the last inspection has not exceeded the allowable fatigue damage index before the last inspection. In the future, after additional engine operation without inspection has been accumulated, additional engine operation may be performed after removal of the cylinder heads and inspection of the block top for detectable ligament, stud-to-stud or stud-to-end cracks. If none are found, then additional engine operation without inspection may be performed until the future fatigue damage index equals the allowable fatigue damage index accrued to the last inspection. This process may be repeated indefinitely throughout the life of the engine. 1

Optionally, in the future, after additional engine operation without inspection has been accumulated and the fatigue damage index for future operations exceeds the allowable fatigue damage index, continued engine operation without removal of cylinder heads and inspection of the block top will allow sufficient margin to withstand a LOOP/LOCA event provided periodic eddy current inspections are performed. The periodic eddy current inspections are described in Figure 5-1 of Reference 1.

The information provided on the following TERs has been reviewed and is consistent with the final conclusions of this report: 10-012, 10-013, 10-066.

Quality Revalidation Inspection results identified in Appendix B have been reviewed and considered in the performance of this design review and the results are consistent with the final conclusions of this report.

Based on the above review and implementation of the recommended inspections, it is concluded that the cylinder blocks are acceptable for their intended use at Comanche Peak Steam Electric Station.

V REFERENCES

1. "Design Review of TDI-R4 and RV-4 Series Emergency Diesel Generator Cylinder Blocks," FaAA-84-9-11. |1

2. FaAA Support Package Number SP-84-9-11(b).

The manufacturing process used to create the interference fit between the roller pin and bushing is acceptable based on analysis and service history. The pin material is yielded by the hydraulic press and shortens enough to capture the bushing while remaining secure in the tappet. If the pin-bushing interference was not adequately achieved during manufacture, the pin would fail soon after initial start-up. Overall industry experience, shop testing and field endurance testing show that the manufacturing process is acceptable

As part of the routine maintenance for this component, at the refueling outage, the tappet assemblies should be inspected with the TDI inspection and maintenance record form 345-1-1. 1

The information provided on the following TERs has been reviewed and is consistent with the final conclusions of this report: TERs 10-044, 10-062, 10-085.

Quality Revalidation Checklist results identified in Appendix B have been reviewed and considered with the performance of this design review. The results are consistent with the final conclusions in this report.

Based on the above review, it is concluded that the intake, exhaust and fuel tappet assemblies are acceptable for their intended use at Comanche Peak.

V REFERENCES

1. FaAA memorandum, J. Zimmerman (FaAA) to J. Kammeyer (TDI) Owners Group, Program Manager) SUBJECT: Intake, Exhaust and Fuel Tappet Reivew. 8/17/84.

2. TDI Memo from M. Lowrey (TDI) to J. Zimmerman, (FaAA) 5/29/84.

3. Telecon; J. Carbonaro (SWEC) to M. Lowrey (TDI) Subject: Approximate Number of Existing Tappet Assemblies, 8/20/84.

Static and linear dynamic models of the gear system (Ref. 1) were used to determine the steady state and transient loads which must be transmitted through the gear interfaces. These loads were then used in calculations to evaluate resistance of the gears to pitting and bending in conformance with AGMA standards (Ref. 2). The adequacy of the support structure, outboard support bushing, and the bolts which connect the hub to the gear was also investigated. A journal orbit analysis of the bushing was completed.

IV RESULTS AND CONCLUSIONS

The results of the linear dynamic analysis and AGMA evaluation of the gear are presented below in tabular form for pitting and bending resistance. Backlash was considered through the choice of the AGMA applications and dynamic factors.

	CAMSHAFT GEAR FACTOR OF SAFETY
Pitting Stresses	1.56
Bending Stresses	1.91

The calculated factors of safety indicate that this gear is acceptable for its intended use. However, due to the pitting that has been observed on the Shoreham gears, it is recommended that:

1

The surveillance maintenance/inspection procedures be modified to inspect the cam gear at every refueling outage.

The four bolts which connect the cam hub to the cam gear are adequate (factor of safety of 3.1) with respect to the preload generated by the initial 70±20 ft-lbf torque (Ref. 3). They do not, however, provide a clamping force which is sufficient to prevent slipping between the gear and hub. It is recommended that either:

The number of No. 9167 bolts, torqued at 70±20 ft-lbf, be increased from 4 to 6. This is more consistent with the 6 bolts which connect the idler gear and hub, particularly in view with the fact that the torque imbalance on the cam gear (4 bolts) is larger than on the idler gear (6 bolts). The resulting factor of safety with respect to slipping is 1.31.

OR

The initial torque in the No. 9167 bolts which connect the cam gear to the cam hub be increased to 80(-0,+10) ft-lbf providing a unit factor of safety with respect to slipping and a factor of safety of 3.1 with respect to the preload in the bolt.

The first solution is preferred in that it results in factors of safety larger than one for both slipping and bolt preload.

The suitability of solid lifters was established by comparing valve train forces with the zero lash imposed by hydraulic lifters and the specified lash of solid lifters (Ref. 4).

The conversion from hydraulic lifters to solid lifters is analyzed from the viewpoint of the suitability of the existing hydraulic lifters for service. That is, if hydraulic lifters are found suitable, the conversion is deemed unnecessary (Ref. 4).

The manufacturer of the hydraulic lifters (Eaton Corporation) was contacted to determine what application specification might apply to this component.

Quality Revalidation Inspection results were analyzed to determine whether or not they confirm the other findings of this report.

IV. RESULTS AND CONCLUSIONS

Other similar TDI engines have experienced collapsed lifters. The problem only occurred at the time of the first start following an extended period of inactivity and is diagnosed as resulting from the oil within the lifter draining out in response to gravitational forces. In fact, at the time this problem arose, the hydraulic lifters were wrongly specified by TDI to be installed upside down. A modification has been made at the instruction of TDI (Ref. 1) to reinstall the lifters right side up; and indeed, the collapsed lifter problem has not reoccurred.

The operational forces imposed upon the valve train using solid lifters are essentially indentical to those found with hydraulic lifters (Ref. 3). No reliability improvement is forecast by converting from one to the other.

The hydraulic lifter arrangement has proven its reliability at Comanche Peak by successfully operating through extended engine testing. This history of demonstrated reliability proves that the conversion to a solid lifter system is unnecessary and hence, the suitability of solid lifters is irrelevant to Comanche Peak.

Inspection results do indicate a high wear rate of the hydraulic lifters. Although this wear is undesirable, operating experience at C.P. links no failures to it. Therefore, it is concluded that the degree of wear seen thus far is benign and it is recommended that worn lifters be replaced with new lifters at each refueling outage. 1

	Crank To Pump Gear Factor Of Safety
Pitting Stresses	1.14
Bending Stresses	2.89

Due to the low factor of safety with respect to pitting, as well as the pitting observed at Shoreham, it is recommended that the crank to pump gear be inspected during each refueling outage. The inspection should be directed at potential pitting and any abnormal indications or progressive pitting should be reported for an engineering evaluation.

The capscrews which connect the "crank to pump gear" to the crankshaft are adequate with a factor of safety of 4.6 with respect to the tensile preload in the bolt under the prescribed torque of 70 ft-lbs (Ref. 3).

Quality Revalidation Checklist results have been reviewed and considered in the performance of this design review, and the results are consistent with the final conclusion of this report.

The information provided on the following TER's has been reviewed and is consistent with the final conclusions of this report: 10-045, 10-083.

Based on the above review, it is concluded that the idler gear assembly - crank to pump gear and capscrew are acceptable for their intended service at Comanche Peak.

V REFERENCES

1. "Gear Train Analysis," FaAA 84-6-69(b).

2. AGMA Standard Publication 218.01, "Rating the Pitting Resistance and Bending Strength of Spur and Helical Gear Teeth."

3. TDI Instruction Manual, Appendix IV, p. 8-5-A.

TDI OWNERS GROUP

for

COMANCHE PEAK STEAM ELECTRIC STATION - UNIT 1

IDLER GEAR ASSEMBLY
COMPONENT PART NO. 02-355B

I INTRODUCTION

The TDI Emergency Diesel Generator Owners Group Program for the Comanche Peak Steam Electric Station requires Design and Quality Revalidation reviews of the idler gear assembly. This assembly consists of:

Part Name	TDI Part No.	Manufacturer	
Idler hub	02-355-03-AC	TDI	1
Idler gear	02-355-01-0E	TDI	
Bolt idler gear to hub	9167	TDI	
Washer Flat 5/8 std	GA-001-027	Various vendors	1
Nut 5/8 slotted	GB-061-006	Various vendors	
Cotter pin 1/8 x 1 & 3/4	GC-002-024	Various vendors	
Idler gear hub bushing	03-355-01-0B	TDI	

The primary function of the idler gear assembly is to transmit torque from the crankshaft to the camshaft. The idler gear bushings interface between the idler hub and the supports.

II OBJECTIVE

The objective of this design review was to evaluate the ability of the idler gear assembly to provide adequate service life, specifically to perform:

- An evaluation of the structural integrity of the gear interfaces and the bolts under steady state and dynamic loads.
- An evaluation of the bushing to provide adequate support for the idler gear assembly during normal operation.
- A review of Comanche Peak site, nuclear, and non-nuclear industry experience.

HOW TO USE THIS REPORT

Tabs in this report identify the following categories:

Turbo, Intake, Intercooler & Exhaust
Lube Oil
Engine Base & Bearing Caps
Crankshaft & Bearings
Cylinder Block, Liners & Water Manifold
Air Start & Barring Device
Connecting Rods
Pistons
Camshaft & Valve Train
Idler Gear Assembly & Front Gear Case
Flywheel
Engine Instrumentation & Wiring
Overspeed Trip & Governor
Engine Shutdown & Equipment
Jacket Water
Cylinder Heads & Valves
Fuel Oil Injection
Generator
Control Panel Assembly
Engine & Auxiliary Sub-Base & Foundation Bolts

These categories have been defined to allow the reader to review a complete diesel generator subsystem in a convenient manner.

Within each category tabs identify Comanche Peak specific component numbers.

A given component report can be found by:

a) If the component number is known - use the alpha - numeric index which identifies the volume number and category in which the component report is located.

b) If only the component name is known - Section 3.2 may be used as a cross-reference to find the volume number where the component report may be found.

Some reports address more than one component. A tab is provided for each component. However, some components are combined under one report. Slip sheets are provided where required to reference back to the appropriate tab. Some components required more than one report. These are identified by the abbreviation LB-Large Bore, and SB-Small Bore on the component number tabs. 1

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adjustment affects the reset speed as well. An additional screw setting is basically used to hold the speed adjusting lever (within the governor) in a fixed position, in conjunction with the trip speed adjusting screw.

The TDI Instruction Manual has a section on adjustment of the overspeed trip which essentially duplicates the material from the Woodward manual. These adjustment procedures are acceptable.

While the Woodward manual does not specify the trip speed, the TDI instructions specify a setting 15 percent above normal (corresponding to a governor speed of 3381 rpm), which agrees with the diesel generator purchased material specification for the overspeed trip (Rev. 4).

Since it is a bistable device, the overspeed trip is less susceptible to torsional vibrations from an operational point of view, in comparison with a continuous acting device like the governor. There may be concern over the material integrity of the governor's parts, especially since the manufacturer has no specification for an allowable level of vibration. However, neither the industry and Comanche Peak experiences nor that of the manufacturer indicate that there is any problem with the overspeed trip failing due to torsional vibrations.

Industry experience indicates that a potential problem exists with incorrect settings causing trips when they are not warranted. Since the adjustments are screw settings, there is no easy way to visually check the governor's trip speed. Thus, the trip speed setting should be tested as part of the normal surveillance testing.

Based on the overspeed trip's history and the manufacturer's suggested practices, the following recommendations are made to improve the system's reliability (Ref. 5):

- Modify the surveillance testing procedures to include verification that the overspeed trip is correctly set to an overspeed trip setting of 518 +/- 1% at every refueling outage, ensuring that both the electric governor and the mechanical backup governor are properly returned to their normal settings following the overspeed test. The test is to be performed with no load on the engine by increasing the normal governor's speed setting(s) until a trip occurs. After several inspection periods, the history of the required adjustments should be reviewed to evaluate and possibly modify the testing interval. 1

HOW TO USE THIS REPORT

Tabs in this report identify the following categories:

Turbo, Intake, Intercooler & Exhaust
Lube Oil
Engine Base & Bearing Caps
Crankshaft & Bearings
Cylinder Block, Liners & Water Manifold
Air Start & Barring Device
Connecting Rods
Pistons
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Engine Shutdown & Equipment
Jacket Water
Cylinder Heads & Valves
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INDEX(continued)

Component Number	Component Description	Category	Vol. No.
CP-101A	Generator: Generator	Generator	8
CP-101B	Generator: Shaft and Bearings	Generator	8
CP-102	Generator Controls	Generator	8
F-068	Intercooler	Turbo, Intake, Intrclr. & Exhaust	2
MP022/3	Turbocharger	Turbo, Intake, Intrclr. & Exhaust	2
00-420	Lube Oil Pressure Regulating Valve	Lube Oil	2
00-442A	Starting Air Distributor: Distributor Assembly	Air Start & Barring Device	4
00-442B	Starting Air Distributor: Tubing, Fittings, Gaskets	Air Start & Barring Device	4
00-621A	Fuel Oil Drop Tank	Fuel Oil Injection	8
02-CFR	Turbocharger Thrust Bearing Lubricant System	Turbo, Intake, Intrclr. & Exhaust	2
02-305A	Base and Bearing Caps: Base Assembly	Engine Base & Bearing Caps	3
02-305C	Base and Bearing Caps: Main Bearing Studs & Nuts	Engine Base & Bearing Caps	3
02-305D	Base and Bearing Caps: Main Bearing Caps	Engine Base & Bearing Caps	3
02-307A	Lube Oil Fittings: Internal - Headers	Lube Oil	2
02-307B	Lube Oil Fittings: Internal - Tube & Fittings	Lube Oil	2

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INDEX(continued)

Component Number	Component Description	Category	Vol. No.
02-316B	Jacket Water Inlet Manifold: Coupling and Gaskets	Jacket Water	7
02-316C	Jacket Water Inlet Manifold: Vent Line to Discharge Manifold	Jacket Water	7
02-317A	Water Discharge Manifold: Jacket Water Discharge Manifold, Coupling and Seals	Jacket Water	7
02-317B	Water Dicharge Manifold: Coupling & Seals	Jacket Water	7
02-317C	Water Discharge Manifold: Supports	Jacket Water	7
02-330A	Flywheel: Flywheel	Flywheel	6
02-330B	Flywheel Bolting	Flywheel	6
02-335B	Front Gear Case- Gasket and Bolting	Idler Gear Assembly & Front Gear Case	5
02-340A	Connecting Rods: Connecting Rods & Bushings	Connecting Rods	4
02-340B	Connecting Rods: Bearing Shells	Connecting Rods	4
02-341A	Pistons: Pistons	Pistons	5
02-341B	Pistons: Rings	Pistons	5
02-341C	Piston: Pin Assembly	Pistons	5
02-345A	Intake/Exhaust and Fuel Tappet Assembly	Camshaft & Valve Train	5
02-345B	Tappets and Guides: Fuel Tappet Assembly	Camshaft & Valve Train	5
02-345C	Tappets and Guides: Fuel Pump Base Assembly	Camshaft & Valve Train	5

IV RESULTS AND CONCLUSIONS

In order to mitigate pipe support and in-line equipment loadings, pipe support JW-PSVER-10265 should be modified. It is a single directional support, providing restraint against downward movement only. In order to validate the analysis of the associated pipe, restraint against upward movement is required. This suggested modification is provided in Reference 3.

All pipe support loads were tabulated and issued for evaluation.

Quality Revalidation Inspection results identified in Appendix B have been reviewed and considered in the performance of this design review and the results are consistent with the final conclusion of this report.

The information provided on the following TERs has been reviewed and is consistent with the final conclusions of this report: 10-115 and 10-134.

With respect to the Design Review Attribute regarding support evaluation with the piping stress analysis, this is not applicable since the supports are evaluated in this report.

Based on the above review, it is concluded that the subject piping support, modified as noted above, is adequate for its intended design function at Comanche Peak.

V REFERENCES

1. "Supporting Calculations for the Evaluation of Comanche Peak Diesel Generator Large Diameter Piping and Supports," Impell Report No. 02-0630-1230, Rev. 0, August 1984.

2. "Design Criteria for Diesel Generator Large Diameter Piping for Comanche Peak," Impell Report No. 02-0630-1231, Rev. 0, August 1984. This is included in Appendix III of the final DR/QR report.

3. Memorandum from R. Markovich/G. Shears (Impell) to J. Kammeyer (SWEC) "Required Modification for Validation of Impell's Design Review for Impell Report No. 02-0630-1217, Rev. A" dated August 1, 1984. | 1

The TDI Emergency Diesel Generator Component Tracking System was reviewed for the Comanche Peak site, nuclear, and non-nuclear industry experience.

IV RESULTS AND CONCLUSIONS

The maximum deadweight stress for the subject component is 2,675 psi. The piping load controlled seismic stresses were acceptable, never exceeding 14,600 psi. Thermal expansion stresses were lower, with stresses always less than 7,300 psi and the stresses caused by the axial discontinuity at the in-line Dresser couplings were less than 2,375 psi.

All piping stresses were within the design allowables specified by the ASME Section III Code.

With respect to the design review attributes regarding the Dresser couplings, Impell evaluated the couplings against the manufacturer's selection and service requirements. These include the design service conditions, relative end displacement, both rotational and translational, of the joined pipes, and shelf and service life.

The movements at five of the ten Dresser couplings in the subject component exceed the manufacturer's end movement requirements (Ref. 3). This requires modifications to be made to these five couplings. Because of excessive relative pipe end movements at three of these couplings, even when additional supports were postulated, these three couplings must be removed and replaced with flanges. Also, in order to mitigate the excessive movements at the Dresser coupling located above the jacket water inlet manifold, it is recommended that a support be added. In additions, extra nuts are required on the tie-rod assemblies of the other two couplings. Further details on these modificaitons are provided in Reference 4. 1

Specifically the following modifications are recommended:

- Remove 3 Dresser couplings and replace with flanges.

  - Remove the 8 inch coupling on the jacket water cooler piping and replace with an 8 inch-150# S.O. flange.

  - Remove the 6 inch coupling on the jacket water cooler piping and replace with a 6 inch-150# S.O. flange.

  - Remove the 6 inch coupling at the jacket water auxiliary pump discharge and replace with a 6 inch-150# S. O. flange.

- Double-nut the tie-rod assemblies, surrounding two of the Dresser couplings, to prevent excessive relative inward axial movement of the adjoining piping spool pieces. Also, a 1-inch diameter rod is recommended to accommodate the compression loading. These two couplings are: 1

  - the 6 inch coupling joining the jacket water skid piping, and the intercooler inlet piping

- the 8 inch coupling south of the 8 inch three-way thermostatic valve

In order to provide adequate load transfer capability, the 6"-150# S.O. flange at support JW-PSA-10251 has specific requirements for bolt torquing as specified in Appendix IV of the Delaval Instruction Manual Vol. I for Model DSRV-16-4. It is recommended that these bolts be torqued per the requirements (Ref. 4). 1

There are no service life constraints (Ref. 5) because these style couplings have no significant history of failure. Shelf life (Ref. 5) is unlimited as long as the gaskets remain packaged and protected from the elements: light, water, etc. The coupling is adequate with respect to manufacturer's service condition limits. 1

To ensure adequate restraint of the piping system, modifications of some supports are recommended. Details on support modifications are summarized in Impell Report No. 02-0630-1227, Rev. A, August 1984, for Component No. 02-717E and described in more detail in Reference 1.

All pipe loads on the pump, coolers and intercooler were tabulated and issued for evaluation.

Quality Revalidation Inspection results identified in Appendix B have been reviewed and considered in the performance of this design review and the results are consistent with the final conclusion of this report.

Based on the above review, it is concluded that the subject piping components with the recommended modifications, are adequate for their intended design function at Comanche Peak.

V REFERENCES

1. "Supporting Calculations for the Evaluation of Comanche Peak Diesel Generator Large Diameter Piping and Supports," Impell Report No. 02-0630-1230, Rev. 0, August 1984.

2. "Design Criteria for Diesel Generator Large Diameter Piping for Comanche Peak," Impell Report No. 02-0630-1231, Rev. 0, August 1984. This is included in Appendix III of the final DR/QR Report.

3. Dresser Pipe Couplings, Pipe Fittings, and Pipe Repair Products Catalog No. 63.

4. Memorandum from R. Markovich/G. Shears (Impell) to J. Kammeyer (SWEC), "Required Modificaitons for Validation of Impell's Design Review for Impell Report No. 02-0630-1226, Rev. A," dated August 6, 1984.

5. Telephone conversation between A. Palumbo and M. Riley, of Dresser Manufacturing Company, June 5, 1984.

HOW TO USE THIS REPORT

Tabs in this report identify the following categories:

Turbo, Intake, Intercooler & Exhaust
Lube Oil
Engine Base & Bearing Caps
Crankshaft & Bearings
Cylinder Block, Liners & Water Manifold
Air Start & Barring Device
Connecting Rods
Pistons
Camshaft & Valve Train
Idler Gear Assembly & Front Gear Case
Flywheel
Engine Instrumentation & Wiring
Overspeed Trip & Governor
Engine Shutdown & Equipment
Jacket Water
Cylinder Heads & Valves
Fuel Oil Injection
Generator
Control Panel Assembly
Engine & Auxiliary Sub-Base & Foundation Bolts

These categories have been defined to allow the reader to review a complete diesel generator subsystem in a convenient manner.

Within each category tabs identify Comanche Peak specific component numbers.

A given component report can be found by:

a) If the component number is known - use the alpha - numeric index which identifies the volume number and category in which the component report is located.

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Some reports address more than one component. A tab is provided for each component. However, some components are combined under one report. Slip sheets are provided where required to reference back to the appropriate tab. Some components required more than one report. These are identified by the abbreviation LB-Large Bore, and SB-Small Bore on the component number tabs. 1

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One significant failure occurred in 1984 at the Catawba Nuclear Plant (Duke Power). A delivery valve holder, which experiences full discharge pressure, fractured. Duke Power had the part examined at the Babcock & Wilcox Alliance Research Center. It concluded that the fracture initiated at a casting defect in the part and was not a design deficiency.

Performance

Each pump is shop-tested and calibrated at 225 rpm and the equivalent operating pressure of 12,800 psig at three rack setting (Ref. 2).

At Comanche Peak and other nuclear power plants, the engines have run at full load and speed for sufficient time to prove the sufficiency of properly assembled and adjusted pumps to deliver the required fuel.

There is also no reported history of failure of the Bendix pumps to supply sufficient fuel to their engines.

Material Suitability

The materials of the pressure boundary and high stress members of the pump are various grades of steel, heat treated as required for service. The pump housing is an automotive grade cast iron which is suitable for its non-pressure boundary duty. There is no history at Comanche Peak or other nuclear power plants of a material problem on this pump except for the one instance at the Catawba Nuclear Plant mentioned above, which resulted from a casting defect. The pump materials are suitable for corrosion resistance to No. 2 fuel oil.

Vendor Qualifications

The Electrical Components Division of Bendix is a supplier of fuel injection pumps and nozzles to the nuclear industry on engines manufactured by TDI, Cooper Industries, Worthington, and Nordberg.

B. Conclusion

End reactions on small bore components (2 in. and smaller) are considered acceptable since the relative strength of small bore is much greater than that of the attached small bore piping/tubing components.

There are no TERs associated with this component.

To augment the maintenance procedures, it is recommended that the utility inspect this component for leaks during the routine engine walk-around and that one pump be disassembled, inspected and tested during alternate refueling outages. Based on the results, a decision can be made regarding the remainder of the pumps.

Based on the above, it is concluded that the pump is acceptable for its intended design function at Comanche Peak.

II. VOLTAGE REGULATOR BOARDS

A. Adjustment Potentiometers

1. Coat one side of the adjustment screw for each of the five adjustment potentiometers on the printed circuit board of the voltage regulator with Glyptol lacquer. After each monthly test, inspect the potentiometers to ensure that no motion of the adjustment screws has occurred.

2. If adjustments are needed, remove the Glyptol and reapply when the adjustment procedure is complete.

B. Printed Circuit Board

1. After each monthly test, inspect the components mounted on the printed circuit board. Check for cleanliness and proper mounting of components. Report any abnormal conditions to engineering for evaluation.

2. Any integrated circuits which are in the TO-5 (metal can) package should be replaced with those of the Mini DIP (Dual Inline Package) package.

C. Spare Parts

1. It is recommended that an adequate supply of spare parts be maintained.

III. FIELD FLASHING RELAY

A. Relay Rating

1. Replace FF relay (a DC contactor, class P10 Cat. No. 102D12 made by Gould Distribution and Control Division, Ref. 5) by an equivalent Gould DC contactor rated as follows: Coil voltage 90-140 V, contact voltage 140 V DC contact 90A DC. It may be necessary to install a voltage reduction circuit to permit the use of a contactor with a conventional coil voltage range.

B. Enclosure

1. The relay should be of the enclosed type to prevent particles of dirt from being deposited on the contacts. 1

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IV. REFERENCES

1. 1983 Omega Temperature Measurement Handbook, Omega Engineering, Inc. p. Q05.

2. Portec Static Exciter Voltage Regulator Model 72 11800 10 Instruction Manual.

3. GE Semiconductor Data Handbook 3rd Edition, p. 255-256.

4. Gerber Electronics Catalog p. 585 - General Cement Production Bulletin.

5. Portec Dwg. D7211801710.

HOW TO USE THIS REPORT

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Turbo, Intake, Intercooler & Exhaust
Lube Oil
Engine Base & Bearing Caps
Crankshaft & Bearings
Cylinder Block, Liners & Water Manifold
Air Start & Barring Device
Connecting Rods
Pistons
Camshaft & Valve Train
Idler Gear Assembly & Front Gear Case
Flywheel
Engine Instrumentation & Wiring
Overspeed Trip & Governor
Engine Shutdown & Equipment
Jacket Water
Cylinder Heads & Valves
Fuel Oil Injection
Generator
Control Panel Assembly
Engine & Auxiliary Sub-Base & Foundation Bolts

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Component Number	Component Description	Category	Vol. No.
02-540B	Lube Oil Sump Tank: Misc. Fittings, Gaskets, Pipe & Bolting Material, Valve	Lube Oil	3
02-540C	Lube Oil Sump Tank: Mounting Hardware	Lube Oil	3
02-550	Foundation Bolts: Anchors, Bolts, Misc. Hardware	Engine & Aux. Sub Base & Foundation Bolts	9
02-630A	Pyrometer Conduit Assembly: Conduit	Engine Instrumentation & Wiring	6
02-630B	Pyrometer Conduit Assembly: Conduit Fittings	Engine Instrumentation & Wiring	6
02-630C	Pyrometer Conduit Assembly: Support	Engine Instrumentation & Wiring	6
02-630D	Pyrometer Conduit Assembly: Thermocouples	Engine Instumentation & Wiring	6
02-688A	Engine & Aux Module Wiring Material: Conduit & Fittings; Pyrometer conduit assembly - conduit, Fittings, Supports	Engine Instrumentation & Wiring	6
02-688B	Engine & Aux. Module Wiring Material: Wiring & Terminations	Engine Instrumentation & Wiring	6
02-688C	Engine & Aux. Module Wiring Material: Boxes & Terminals	Engine Instumentation & Wiring	6
02-689	Off Engine Alarm Sensors: Wiring	Engine Instrumentation & Wiring	6
02-690	On Engine Alarm Sensors	Engine Instrumentation & Wiring	6

COMANCHE PEAK MAINTENANCE MATRIX

Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
F-068	Intercoolers	1. Evaluate heat exchanger performance by checking engine operating parameters.	X					
		2. Clean/inspect shell and tube sides.		X				Refr: DR/QR Report #F-068. (Items 2, 3, 4)
		3. Visually inspect for external leaks.	X					Refr: 7/26/84 IOC from J. Cadogan to M. McGerigle. Refr: 08/14/84 letter to C. Ray from M. Lowrey.
		4. Verify intake manifold drain connection is open and clean daily.						To be performed daily.
MP-022/23	Turbocharger	1. Measure vibration and check with base line data.		X				To be accomplished during 24 hour test run.
		2. Clean impeller and diffuser.		X				
		3. Measure rotor end play (axial clearance) to identify trends of increasing clearance, i.e; thrust bearing degradation.		X				Review thrust bearing axial clearances after inspection to determine if a trend exists. Any trend toward increasing axial clearance could signify thrust bearing degradation. Refr: DR/QR Report #MP-022/23.
		4. Perform visual and blue check inspections of the thrust bearing.				X		NOTE: Thrust bearing inspection should also be performed prior to 40 non-prelubed (automatic) fast starts. Refr: DR/QR Report #MP-022/23.
		5. Disassemble inspect and refurbish.				X		For Items 1-6; Refr: IOC dated 3/23/84 from M. Wehmeyer to R. Kadlec.

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COMANCHE PEAK MAINTENANCE MATRIX

Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
		6. Perform a spectro-chemical engine oil analysis to assist the bearing monitoring program. To further expand/clarify chemical analysis, ferrographic analysis may be utilized. Particular attention shall be paid to copper level and particulate size, which could signify thrust bearing degradation.		X				To be performed during the last monthly test run prior to oil change. NOTE: Sample to be drawn up stream of lube oil filter. Refr: DR/QR Report MP-022/3.
CP-101A	Emergency Generator	1. Check operation of brushes and slip rings.	X					Refr: IOC 3/30/84 M. Wehmeyer to D. Mercaldi (Items 1-5).
		2. Clean/inspect all accessible parts of the generator.		X				
		3. Megger rotor and stator.		X				
		4. Verify operation of space heaters.	X					
		5. Measure vibration and check against base line data.		X				
CP-101B	Emergency Generator Pedestal Bearing	1. Check ring oilers for proper operation and verify oil level.	X					To be accomplished during every test run of the engine. Refr: 2/30/84 IOC from M. Wehmeyer to N. Cooperrider.
		2. Drain flush refill bearing housing.		X				
		3. Measure bearing housing insulation resistance.		X				
		4. Disassemble and inspect bearing and check clearances.				X		
CP-102	Emergency Generator Control Panel	1. Inspect panel for cleanliness and clean as required.		X				Items 1-5; Refr: 3/30/84 IOC from M. Wehmeyer to D. Mercaldi.

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
		2. Check terminal boards for loose wiring.		X				
		3. Visually check condition of wire insulation for degradation.		X				
		4. Clean and inspect relay contacts.		X				
		5. Check meter calibrations.		X				
		6. Bridge rectifier assembly.						Refr: DR/QR Report #CP-102, Attach. 1.
		a. Inspect the temperature sensitive label placed on the most visible face of the hexagonal body of the diodes. The label shall be inspected before and after each running of the engine.	X					If the label permanently blackens, the maximum temperature of the diode has been exceeded requiring an electrical inspection of the diode and an inspection of the mounting threads of the heat sink and diode. Replace the diode and the heat sink as needed and assure that proper mounting tightness of 300 in-lbs and proper thread condition is maintained.
		b. Inspect glyptol applied to the side of the lugs and mounting bolt for the lugs which attach to the bottom of the diode and SCR heatsinks for signs of relative motion.						To be performed after each monthly test run. Retighten any loose connections, remove old glyptol and reapply if connections are retightened.
		7. Adustment potentiometers - inspect glyptol applied to the the side of the adjustment screws for each of the five adjustment	X					To be performed after each monthly test run. If adjustments are needed, remove glyptol and reapply when the

COMANCHE PEAK MAINTENANCE MATRIX

Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
		potentiometers on the printed circuit board of the voltage regulator for signs of relative motion.						adjustment procedure is complete.
		8. Printed circuit boards - check for cleanliness and proper mounting of components.	X					To be performed after each monthly test run. - Report any abnormal conditions to engineering for evaluation.
00-420	Lube Oil Pressure Regulating Valve	1. Disassemble and clean.		X				If valve sticks repeatedly, more frequent cleaning may be necessary. If valve plugging becomes a problem, the dimensions of the valves internal parts should be checked to ensure proper clearance.
		2. During initial startup after a major reassembly of Lube Oil piping, the L.O. regulating valve should be disassembled and cleaned until abnormal L.O. pressure excursions subside.						Refr: DR/QR Report #00-420.
00-442A	Starting Air Distributor Assembly	1. Visually inspect the poppet valve spool ends and timing cam of the starting air distributor.		X				Evaluate the degree of wear to determine whether existing condition would have an adverse effect on timing and the specified ability to start the engine.
		2. Ensure that the starting air manifold vent is open and on obstructed.	X					Refr: DR/QR Report 00-442A (STAD), Items 1 & 2.

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COMANCHE PEAK MAINTENANCE MATRIX

Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
02-305A	Base Assembly	1. Perform a visual inspection of the base. The inspection should include the areas adjacent to the nut pockets of each bearing saddle and be conducted after a thorough wipe down of the surfaces, using good lighting.		X				Note: Any cracks detected must be investigated further before the engine is allowed to return to service. The mating surfaces of the base and cap shall be throughly cleaned with solvent before any reassembly. Refr: DR/QR Report #02-305A.
02-305C	Main Bearing Caps - Studs and Nuts	1. Upon removal of bearing caps, clean mating surfaces with a solvent prior to reassembly of the caps to the base.						Refr: DR/QR Report #02-305C
02-307B	Lube Oil Tubing and Fittings - Internal	1. Check tubing for dents or crimps.		X				Items 1, 2; Refr: TDI Instruction Manual, Vol. I, Maintenance Schedule.
		2. Perform gear-train spray check.		X				
02-310A	Crankshaft	1. Measure crankshaft web deflection.		X				Complete TDI Inspection and Maintenance Record Form No. 310-1-1, TDI Instruction Manual, Volume I, Section 6. Refr: TDI Instruction Manual, Vol. I, Maintenance Schedule.
		2. Measure diameter of crank journals.			X			Complete TDI Inspection and Maintenance Record Form No. 310-3-1, TDI Instruction Manual, Volume I, Section 6.

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COMANCHE PEAK MAINTENANCE MATRIX

Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
02-310B	Main Bearings Shells	1. Inspect and measure main bearing shell thickness. Inspection shall evaluate bearing wear and evidence of harmful crankshaft misalignment. If results show evidence of misalignment, TDI recommendations for crankshaft realignment should be implemented.			X			The first inspection should be performed at the first fuel outage and at alternate outages thereafter. Complete TDI Inspection and Maintenance Record Form No. 310-2-1, TDI Instruction Manual, Volume I, Section 6 - one sheet for each main bearing. Use Volume I, Appendix III for clearance values. Refr: TDI Instruction Manual, Vol. I, Maintenance Schedule. Ref: DR/QR Report #02-310B.
02-310C	Thrust Bearing Ring	1. Measure thrust bearing ring clearance via "bump check" method to be performed in conjunction with crankshaft web deflection measurements. The following information should be recorded: ° Date of inspection ° Hours of engine operation ° Hours of engine operation since last bearing replacement (Last bearing replaced: ____ forward ____ back) ° Bearing clearance		X				Complete applicable of sections TDI Inspection and Maintenance Record Form No. 310-1-1 TDI Instruction Manual, Volume I, Section 6. NOTE: If the clearance is greater than the maximum allowed in the TDI Instruction Manual, then at least one bearing must be replaced. Bearings should also be replaced if they are cracked or gouged. Refr: DR/QR Report #02-310C. Refr: 8/13/84 memo from G. McCarthy to D. Pasquale.
		2. Visually inspect thrust bearing ring for signs of wear or degradation.			X			To be performed simultaneously with main bearing shell inspection.

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COMANCHE PEAK MAINTENANCE MATRIX

Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
02-311A	Crankcase Assembly	1. Perform a visual inspection of the vertical portion of the crankcase arch wall to the nut pocket area for indications of cracking.		X				The first inspection after 185 hours of at or near full load operation may be used to justify the discontinuation of such inspection. Refr: DR/QR Report # 02-311A.
02-315A	Cylinder Block	1. Perform a visual inspection of the cylinder block. Perform an eddy current inspection of block tops for stud-to-stud cracks between cylinder heads and for cracks between the block edge and studs at the block ends.						This inspection must be performed prior to returning the engine to emergency STANDBY service after any period of operation exceeding 50% load. Refr: 08/24/84 Memo from C. Vogler to D. Pasquale.
02-315C	Cylinder Liners	1. Perform a visual inspection of liners for potential progressive wear.						Boroscopic inspection is acceptable if heads are not removed. Complete TDI Inspection and Maintenance Record form No. 315-1-1, TDI Instruction Manual, Volume I, Section 6. Refr: DR/QR Report #02-341B.
02-317A&B	Water Discharge Manifold - Jacket Water Discharge Piping, couplings and seals	1. Visually inspect for leaks. Note: In the event of a leak developing in the existing Dresser Style 65 couplings, these couplings should be replaced with Dresser Style 90 couplings equipped with Viton gaskets.	X					This recommendation is made on the basis that the maximum suggested operating temperature of 150°F for the Style 65 coupling may be exceeded. The maximum suggested operating temperature of the Style 90 is 212°F. Ref: Letter dated 12/13/84 from C. L. Ray to J. George. Ref: DR/QR Report #02-317A&B

COMANCHE PEAK MAINTENANCE MATRIX

Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
02-340A/B	Connecting Rods, Bushings and Bearing Shells	1. Inspect and measure conn. rod bearing shells to verify lube oil maintenance, which affects wear rate. The visual and dimensional inspection of the bearing shells should be conducted at the fuel outage which precedes 500 hours of operation by at least the sum of hours of operation in a LOOP/LOCA event plus the expected hours of operation between outages.						To be performed in conjuction with piston pin inspection. Complete TDI Inspection and Maintenance Record Form No. 340-1-1, TDI Instruction Manual, Volume I, Section C, Appendix III for clearance values. Refr: DR/QR Report #02-340B (Item 1)
		2. Inspect and measure the connecting rods.				X		Complete TDI Inspection Maintenance Record Form No. 340-2-1, 2, TDI Instruction Manual, Volume I, Section 6.
		3. Perform an x-ray examination on all replacement bearing shells to acceptance criteria developed by Owners Group Technical Staff.						This is to be performed prior to installation of any replacement bearing shells. Refr: DR/QR Report #02-340B.
		4. Measure the clearance between the link pin and link rod. This clearance should be zero, ie; no measurable clearance when the specified bolt torque of 1050 ft-lbs is applied. This examination may be performed with the engine assembled after a major engine disassembly.				X		Ref: DR/QR Report #02-340A
		5. At the first 5 yr overhaul visually inspect the rack teeth surfaces for signs of fretting and prior to reassembly inspect mating surfaces to verify that the minimum manufacturers recommended percent contact surface is available.				X		Refr: DR/QR Report #02-340A (Items 4, 5).

COMANCHE PEAK MAINTENANCE MATRIX

Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
02-341A	Pistons	1. Inspect and measure skirt and piston pin.				X		Complete TDI Inspection and Maintenance Report Form No. 341-1-1, TDI Instruction Manual, Volume I, Section 6. Use Volume 1, Section 8, Appendix III for clearance values. To be performed in conjunction with piston pin inspection.
02-341B	Piston Rings	1. Inspect and measure piston replacement rings.						Complete TDI Inspection and Maintenance Record Form No. 341-2-1, TDI Instruction Manual, Volume I, Section 6. Use Volume I, Section 8, Appendix III for clearance values. To be performed in conjunction with piston pin inspection.
		2. Visually inspect liners for wear. NOTE: Ring replacement and cylinder liner honing should be performed in accordance with TDI maintenance procedures.		X				Complete TDI Inspection and Maintenance Record Form No. 315-1-1, TDI Instruction Manual, Volume I, Section 6. Use Volume I, Section 8, Appendix III for clearance values. Refr: DR/QR Report #02-341B (Items 2, 3, 4).
		3. 135° fuel oil spray tips may be used if inspection results indicate a need for additional action to improve lubrication and reduce coke buildup.		X				Refr: 07/31/84 Memo from L. Swanger to D. Pasquale.
		4. When replacing engine oil use H.D. oil that meets or exceeds series 3 standards, the base stock should be more resistant to thermal degradation and coke formation. The additive package		X				NOTE: Do not mix L.O. brands or types. When changing L.O. replace the entire L.O. charge. Refr: 08/14/84 letter to C. Ray from M. Lowrey.

COMANCHE PEAK MAINTENANCE MATRIX

Component Number	Component Identification		PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
			should provide high detergent dispersant properties with high alkalinity and a high level of antiwear additive such as zinc dithiophosphate. Total Base Number (TBN) should be 12 to 15 for use with #2 fuel oil and a sulfated ash content of 1.5% to 2.0% is preferred. An engine oil with such properties, Mobilguard 412 or equivalent product, may be used to ensure improved lubrication.						
02-341C	Piston Pin Assembly	1.	Visually inspect for chrome plate damage. Replace pins which show chipped or blistered chrome. NOTE: All new or replacement pins should be L.P. or M.P. inspected before installation in Owners Group engines.				X		Also to be performed whenever pistons are removed and disassembled to an extent that such inspection is possible. Refr: DR/QR Report #02-341C (Items 1, 2), For details on acceptance criteria, Refr: 08/22/84 memo from W. Littmann to D. Pasquale and DR/QR Report #02-341C.
		2.	Inspect end plugs and reroll or replace any that are loose.				X		Note: This inspection is to be performed whenever the engine is sufficantly dismantled to allow this inspection. Ref: DR/QR Report #02-341C.
02-345A	Intake and Exhaust Tappet Assembly	1.	Inspect intake and exhaust and tappet assembly condition.		X				Complete TDI Inspection and Maintenance Report Form No. 345-1-1, TDI Instruction Manual, Volume I, Section 6. Refr: TDI Instruction Manual, Vol. 1, Maintenance Schedule Refr: TDI Letter dated 2/16/84 from D. Schmitz to J. Kammeyer, Ref. IOC 9/14/84 from J. Carbonaro to D. Pasquale.

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COMANCHE PEAK MAINTENANCE MATRIX

Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
		2. Verify that cam rollers are free to rotate and that there is no measurable clearnace between the cam rollers and the roller pins.		X				Complete TDI inspection and maintenance Record Form No. 345-1-1 TDI Instruction Manual, Vol. I, Section 6. Refr: DR/QR Report #02-345A.
02-345B	Fuel Tappet Assembly	1. Inspect fuel assembly condition.		X				Complete TDI Inspection and Maintenance Report Form No. 345-1-1, TDI Instruction Manual, Volume I, Section 6. Refr: DR/QR Report #02-345B.
		2. Verify that cam rollers are free to rotate and that there is no measurable clearnace between the cam rollers and the roller pins.		X				Complete TDI Inspection and Maintenance Record Form No. 345-1-1 TDI Instruction Manual, Vol. I, Section 6. Refr: DR/QR Report #02-345B.
02-350A	Cam Shaft Assembly	1. Perform a visual inspection of all cam lobe surfaces for signs of cracking, pitting or spalling.		X				Any signs of cracking, pitting or spalling shall be followed by a detailed analysis to evaluate the expected life based on the size and extent of surface distress and any corrective measures shall be implemented as indicated by this analysis. Signs of spalling shall result in immediate replacement of the cam Refr: TDI Instruction Manual, Vol. I, Maintenance Schedule. Refr: DR/QR Report #02-350A.
02-350B	Cam Shaft Bearings	1. Inspect and measure cam shaft bearing shells.				X		Complete TDI Inspection and Maintenance Record For No. 350-1-1, TDI Instruction Manual, Volume I, Section 6. Use Volume I, Section 8, Appendix III for clearance values.

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COMANCHE PEAK MAINTENANCE MATRIX

Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
02-350C	Cam Gear	1. Visually inspect cam gear for chipped or broken teeth, pitting, excessive wear, or other abnormal conditions.		X				Refr: Memo from B. Bickford to E. Montgomery dated 6/23/84, Refr: DR/QR Report #02-350C.
		2. Measure gear back lash. NOTE - if cam gear hub is removed, it is ESSENTIAL that the nut be relocked at the position corresponding to the prescribed torque range of 80 (-0+10) ft-lbs. Insertion of the cotter pin must be accomplished at a torque $\geq$ 80 ft-lbs force and $\leq$ 90 ft-lbs force. If this is not possible another bolt, nut or washer should be used. The above is applicable to 4-bolt arrangments only. The torque range for 6-bolt arrangements is 70 ± 20 ft-lbs with the same restrictions as described above for insertion of the cotter pins.			X			Complete applicable sections of TDI Inspection and Maintenance Record, Form No. 355-1-1, TDI Instruction Manual, Volume I, Section 8, Appendix III-1 for clearance values. Refr: DR/QR Report #02-350C.
02-355A	Crank to Lube Oil Pump Gear	1. Visually inspect crankshaft to lube oil pump gear for chipped or broken teeth, excessive wear, or progressive pitting or other abnormal conditions.		X				Any abnormal situations or indications of progressive pitting should be reported for an engineering evaluation. Refr: DR/QR Report #02-355A.
		2. Measure gear backlash.			X			Complete applicable sections of TDI Inspection and Maintenance Record Form No. 355-1-1, TDI Instruction Manual, Volume I, Section 6. Use Volume 1, Section 8, Appendix III-1 from clearance values.

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
								Refr: TDI Instruction Manual, Vol. I, Maintenance Schedule.
02-355B	Idler Gear Assembly	1. Visually inspect idler gears for chipped or broken teeth, excessive wear pitting, or other abnormal conditions.		X				Any abnormal indications should be reported for an engineering evaluation. Refr: DR/QR Report #02-355B.
		2. Measure gear backlash. NOTE: If idler gear hub is removed, it is recommended that the nut be relocked at the position corresponding to the torque of 70±20 ft-lbs. Insertion of the cotter pin must be accomplished at a torque $\geq$ 50 ft-lb and $\leq$ 90 ft-lb. If this is not possible, another bolt, nut or washer should be used.			X			Complete applicable sections of TDI Inspection and Maintenance Record Form No. 355-1-1. TDI Manual, Volume I, Section 6, use Volume I, Section 8, Appendix III-1 for clearance values. Refr: TDI Instruction Manual, Vol. I, Maintenance Schedule. Refr: DR/QR Report #02-355B.
02-359	Air Start Valves	1. Remove, clean and inspect air start valves. (Replace copper valve-to head gasket).		X				Ensure valve installation includes retorque requirements. Refr: 5/3/84 IOC from P. Ziminsky to P. Martin Refr: DR/QR Report #02-359 (Items 1, 2, 3).
		2. Inspect the piston, cap, guide and housing sliding surfaces to evaluate wear or corrosion.		X				
		3. Ensure that the desiccant dryer between the air compressor after cooler and the air receivers is working properly by blowing down the air receivers daily and monitoring the moisture content.						To be performed daily. Refr: DR/QR Report #02-359.

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
02-360A	Cylinder Head	1. Visually inspect cylinder heads (all cylinders).				X		Complete TDI Inspection and Maintenance Record Form No. 360-1-1, TDI Instruction Manual, Volume I, Section 6. One sheet for each head.
		2. Record cold compression pressures and maximum firing pressures		X				If so indicated remove cylinder heads, grind valves and reseat. Ref: TDi Instruction Manual, Volume I, Section 6.
		3. Blow-over the engine per TDI maintenance requirements, Volume I or at appropriate intervals after shutdown of the engine to ensure against harmful effects of water leaks.						In the event water is detected, the cylinder head should be replaced or returned to the vendor for repair. Refr: DR/QR Report #02-360A.
		4. Visually inspect the fuel injection port on each cylinder head "during" the normal monthly engine run for water leaks.	X					If water leakage is detected, the head(s) should be replaced. Refr: DR/QR Report #02-360A.
02-360B	Cylinder Head - Intake and Exhaust Valves	1. Visually inspect intake and exhaust valve, discs, stems and seats for wire drawing, pitting, distortion, concentricity, or any abnormal condition.				X		
		2. Visually inspect subcovers for evidence of valve guide blowby (soot).						This is a one-time-only inspection, to be performed after 500 or 600 hours of operation after rebuild of a cylinder head. Refr: DR/QR Report #02-360B.
		3. Measure intake and exhaust valves head thickness.				X		Complete applicable sections of TDI Inspection and Maintenance Records Form 360-2-1, TDI, Instruction Manual,

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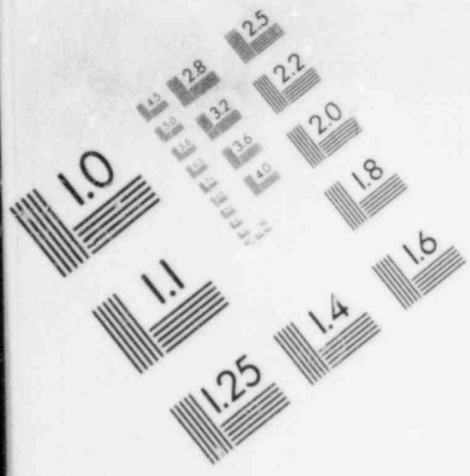
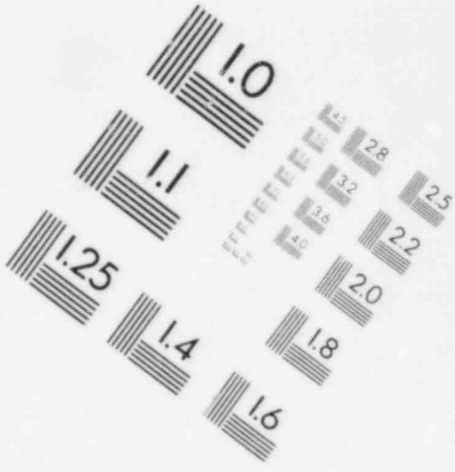
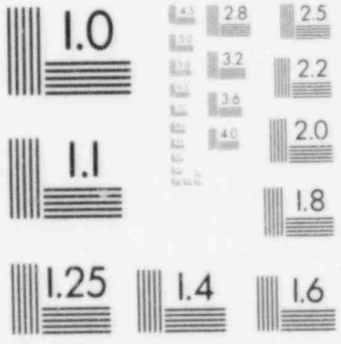
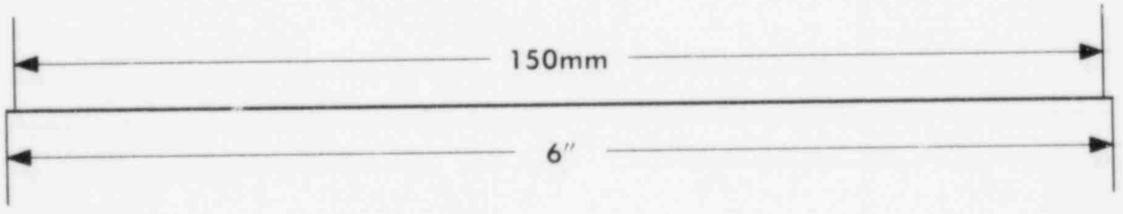
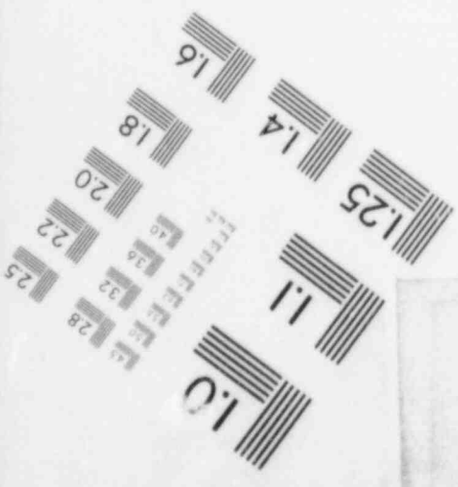
IMAGE EVALUATION TEST TARGET (MT-3)

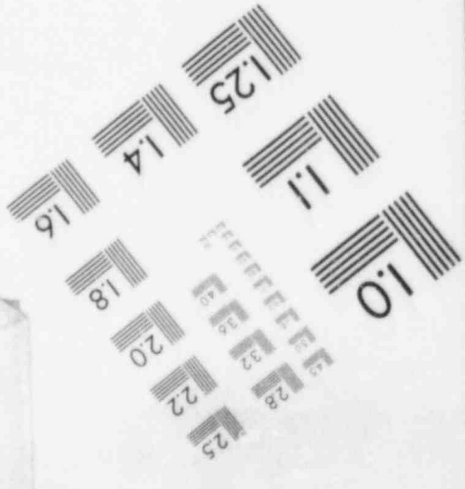












Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
								Volume I, Section 6. One sheet for each cylinder. Use Section 8, Appendix III for clearance values. (Items 2, 3).
		4. Measure intake and exhaust valves - valve-to-guide clearances.				X		Complete applicable sections of TDI Inspection and Maintenance Record Form 360-2-1, TDI Instruction Manual, Volume I, Section 5. One sheet for each cylinder. Use Section 8, Appendix III for clearance values.
02-362A	Cylinder Head Covers - Subcover Assembly	1. Perform a liquid penetrant examination of the rocker arm pedestals top and vertical machined surfaces. (connector pushrod side only).				X		This inspection is to be performed in conjunction with the rocker arm bushing inspection when the rocker arm shafts are removed from the subcovers [Refr: DR/QR Report #02-390E] or whenever the rocker arm shaft assembly is removed. Subcovers with pedestal cracks that extend through the counter bore web down to the threads should be replaced. Refr: DR/QR Report #02-362A.
02-365A	Fuel Injection Pumps	1. Visually check pressure bleed screws for erosion.		X				To be performed on all sixteen pumps.
		2. Tear down one pump for inspection.			X			Use representative pump to determine need to overhaul other pumps.
		3. Complete fuel injection pump inspection in accordance with TDI Instruction and Maintenance Manual, Volume I.			X			Based on inspection results and operating parameters. NOTE - Disassembly of fuel injection pumps should be performed by a Bendix Corp. representative.

Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
								Complete TDI Instruction and Maintenance Record Form No. 365-1-1, Section 6. Items 1, 2 Refr: 3/26/84 IOC from M. Wehmeyer to T. Fritsch; Refr: 4/27/84 Letter from R. Johnston to R. Jaquinto. Refr: TDI Instruction Manual, Volume I, Maintenance Schedule for Item 3. Refr: DR/QR Report #02-365A (Items 2&3).
02-365B	Fuel Injection Nozzles	1. Remove, inspect and clean tips.		X				Ensure that a new copper gasket is used upon reinstallation of nozzle into head. Complete TDI Inspection and Maintenance Record Form 365-2-1 Instruction Manual, Volume I, Section 6. Refr: TDI Instruction Manual, Vol. I, Section 5 Maintenance Schedule, Refr: DR/QR Report #02-365B. (Items 1-4)
		2. Check nozzle pop pressure.		X				
		3. Check spray pattern.		X				
		4. Check assembly for leakage.	X					
02-365C	Fuel Injection Tubing	1. Check tubing for leaks at compression fittings.	X					All fuel oil leak inspections to be performed while the engine is running or whenever the compression fittings have been disturbed. Refr: DR/QR Report #02-365C.
		2. Visually inspect tubing lengths for F.O. leaks or cracks.	X					Fitting inspection for leaks to be performed at first engine operation following the installation of tubing. Subsequent inspections to be performed periodically as indicated. Fuel oil leakage from

Component Number	Component Identification	PM Recommendation		Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
									shrouded fuel oil lines can be detected at the leakoff ports in the base nuts, which are provided for this purpose.
02-371A	Fuel Pump Control Shaft	1.	Check lube oil cups and fill as necessary.	X					Refr: 5/17/84 IOC from T. Fritsch to Paul Martin.
02-371B	Fuel Pump Linkage Assembly and Bearings	1.	Grease swivel link, all sixteen F.O. pump assemblies.		X				
02-375	Intake Manifold	1.	Care should be exercised in assembly of cylinder heads to the engines, to avoid cracking of the intake manifold elbows.						If required, other castings may be tried to achieve an acceptable fit, or bolt hole diameters may be increased to 1/8" oversize. Component should under no circumstances be jacked to fit. Refr: DR/QR Report #02-375.
02-380A	Exhaust Manifold	1.	Perform an MP examination to a sample of circumferential pipe welds and corresponding heat affected zones. This examination is to be performed in accordance with Impell memo from G. Shears to J. Kammeyer dated 08/13/84.			X			To be performed during the first refueling outage and alternate outages thereafter. However, diesel operation should not exceed 200 hours between inspections. Refr: DR/QR Report #02-380A.
02-385A	Crankcase Relief Valve	1.	Clean flame arrestors.		X				Refr: 3/26/84 IOC from M. Wehmeyer to J. Kammeyer.
		2.	Inspect seat and disc.		X				
02-387A	Crankcase Vacuum Fan	1.	Clean and inspect fan.			X			Refr: 3/26/84 IOC from M. Wehmeyer to J. Kammeyer.
		2.	Check bearing for roughness.			X			

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
02-390E	Rocker Arm Bushings	1. Visually inspect and measure intake rocker arm bushings.						The visual and dimensional inspection of the rocker arm bushings should be conducted at the fuel outage which precedes 2300 hours of operation by at least the sum of expected hours of operation in a LOOP/LOCA event plus the expected hours of operation between outages. Refr: DR/QR Report #03-390E (Items 1, 2, 3).
		2. Visually inspect and measure exhaust rocker arm bushings.						Not to exceed 1300 maximum hours of engine operation between inspections as described above.
		3. Visually inspect and measure intermediate rocker arm bushings.						Not to exceed 730 maximum hours of engine operation between inspection as described above.
02-390F	Hydraulic Valve Lifters	1. Check valve lash.		X				
		2. Reinstall and adjust lifters - perform leak down test.		X				Ensure lifters are installed with the fill holes up. Verify condition of lifters via comparison of lifter leak down rate (actual) to specifications noted on TDI Maintenance Manual. Refr: TDI Maintenance Manual, Section 6-B-5. Refr: 04/16/84 letter to R. Johnson from R. Jaquinto.
02-390G	Rocker Arm Capscrews, Drive Studs (Pop Rivets)	1. Verify capscrew torque values.		X				Use TDI Instruction Manual, Volume I, Section 8, Appendix IV for proper torque values. Refr: DR/QR Report #02-390G (Items 1, 2).
		2. Verify that rocker arm drive studs are intact and tight.		X				

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
02-410A	Overspeed Trip Governor	1. Check trip set point - adjust as required.		X				Modify the surveillance testing procedure to include verification that the overspeed trip is correctly set to an overspeed trip setting of 518 rpm every outage. Ensure that the electric governor setting is properly returned to 450 rpm and the mechanical backup governor returned to 460 rpm following the overspeed test. The test is to be performed with no load on the engine by increasing the normal governor speed setting(s) until a trip occurs. After several inspection periods, the history of the required adjustments should be reviewed to evaluate and possibly modify the testing interval. Refr: DR/QR Report #02-410A (Items 1, 2).
		2. NOTE: After setting the overspeed governor, the adjustment screw settings should be marked with Torque Seal to reveal any unintended changes in the set positions.						
02-410B	Overspeed Trip Governor and Accessory Drive	1. Remove plugs from housing and check for magnetic particles.		X				Refr: IOC dated 03/27/84. from M. Weymeyer to N. Cooperrider. (Items 1, 2, 3)
		2. Check shafts for excessive radial and axial movement.		X				
		3. Visually inspect accessory drive gear for excessive wear.		X				

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
02-410C	Overspeed Trip Drive Couplings	1. Remove the present L-110 Lovejoy couplings and replace them with new units in accordance with SIM 363 and DR/QR Report recommendations.						To be completed at the first refueling outage.
		2. Verify that coupling is tight on shaft.		X				Refr: 06/24/84 memo from D. Limbert to E. Montgomery.
		3. Replace the Lovejoy coupling spiders or test coupling elastomer for hardness.		X				Replace elastomer if hardness is greater than 90 Shore A. Refr: DR/QR Report #02-410C (Items 1, 2, 3).
02-410D	Overspeed Trip Vent Valve	1. Disassemble and replace "O" rings.				X		Refr: 3/27/84 IOC from M. Wehmeyer to J. Dimare.
02-411A	Governor Drive - Governor and Tachometer Drive Gear and Shaft	1. Visually inspect drive gear and shaft for signs of wear.		X				Ref: TDI Instruction Manual, Vol. I, Section 5, Maintenance Schedules.
02-411B	Governor Drive - Couplings, Pins and Keys	1. Check that coupling is tight on shaft.		X				If the coupling is found to be loose, it should be removed, all mating surfaces cleaned and the unit reassembled using Loctite 609 on the mating surfaces. Ref: DR/QR Report #02-411B. Refr: 6/19/84 Memo to E. Montgomery from D. Limbert.
		2. Replace the present elastomeric insert in the Koppers coupling before placing the engine in emergency STANDBY service.		X				Refr: DR/QR Report #02-411B.
02-413A	Governor Linkage	1. Install positive locking hardware to the lever arm clamp bolt heads and shaft roll pins. NOTE: To be performed as necessary after tightening governor linkage hardware to design torque specifications.						Refr: DR/QR Report #02-413A (Item 1-4).

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
		2. Inspect for loose parts on the linkage assembly.	X					
		3. Lubricate cross shaft bearings.	X					Refr: DR/QR Report #02-413A. (Items 3&4)
		4. Grease the rod end fittings, especially those at the ends of the cross shaft.		X				
02-413B	Fuel Pump Linkage: Automatic Shutdown Cylinder	1. Check cylinder for extension and return.		X				To be accomplished during controls system check.
		2. Check tailrod vent for air leakage.		X				To be accomplished during controls system check. Items 1, 2; Refr: IOC dated 3/26/84 from M. Wehmeyer to R. Kaklec.
02-415A	Woodward Governor	1. Drain, flush, refill and vent actuator oil system with new oil from a clean container ensuring the appropriate cleanliness procedures are followed.			X			NOTE: Venting the hydraulic actuator shall be performed per the Woodward manual if more than a half quart of oil is added.
		2. Disassemble, clean and refurbish the actuator.				X		Items 1, 2, 3; Refr: 03/27/84 IOC from M. Wehmeyer to N. Cooperrider. Refr: TDI Instruction Manual, Volume I, Section 5, Maintenance Schedule.
		3. Replace flex element for governor drive coupling.		X				Refr: DR/QR Report #02-411B. Governor Drive Couplings
		4. Verify all governor control knob settings are in appropriate positions: LOAD - Maximum DROOP - Zero Speed - To provide mechanical governor control at 460 rpm.	X					All knob settings should be secured with a commercially available product such as Torque-Seal.

Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
		5. Evaluate electric governor settings to verify overshoot of the 450 rpm set speed is no more than 7.5% or a max. speed of 484 rpm during start or when unloaded by 1400 kW.		X				An evaluation of the governor settings is to be performed during surveillance testing once under joint mechanical and electrical governor control and once under only mechanical governor control, off the grid in the isochronous mode for both start and transient loading conditions. Refr: DR/QR Report #02-415A.
		6. Augment the setting adjustment procedures, as described in the Woodward manuals to include tests of the governor response during an engine start to ensure agreement with the specifications as detailed in Item #5.						Refr: DR/QR Report #02-415A.
02-415B	Governor Booster Servomotor	1. Clean, inspect, and replace "O" rings and gaskets.				X		Refr: 3/27/84 IOC from M. Wehmeyer to J. Kammeyer.
02-415C	Governor Heat Exchanger	1. Clean and inspect.				X		
02-425A	Jacket Water Pump - Gear	1. Visually inspect jacket water pump gear for chipped or broken teeth, excessive wear, or potential/progressive pitting or other abnormal conditions.		X				Any abnormal situations or indications of progressive pitting should be reported for an engineering evaluation. Refr: DR/QR Report #02-355B.
		2. Check the key to keyway interface for a tight fit on both the pump shaft to impeller and the spline to pump shaft during pump reassembly.		X				This along with the drive fit of the impeller onto the shaft will preclude past problems where relative motion between shaft and impeller caused fretting and upset of

Component Number	Component Identification		PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
									the keyway sides. Refr: DR/QR Report #02-425A.
		3.	It is recommended that the castle nut that drives the external spline on its taper, have minimum and maximum torque values of 120 ft-lbs and 660 ft-lbs respectively.						Refr: DR/QR Report #02-425A.
02-435A	Jacket Water Fittings - Pipe and Fittings (Small Bore Scope Only)	1.	Visually inspect for leaks. Note: In the event of a leak developing in the existing Dresser Style 65 couplings, these couplings should be replaced with Dresser Style 90 couplings equipped with Viton gaskets.	X					This recommendation is made on the basis that the maximum suggested operating temperature of 150°F for the Style 65 coupling may be exceeded. The maximum suggested operating temperature of the Style 90 is 212°F. Ref: Letter dated 12/13/84 from C. L. Ray to J. George.
02-437	Turbo Water Piping-Pipe and Fittings	1.	Visually inspect for leaks. Note: In the event of a leak developing in the existing Dresser Style 65 couplings, these couplings should be replaced with Dresser Style 90 couplings equipped with Viton gaskets.	X					This recommendation is made on the basis that the maximum suggested operating temperature of 150°F for the Style 65 coupling may be exceeded. The maximum suggested operating temperature of the Style 90 is 212°F. Ref: Letter dated 12/13/84 from C. L. Ray to J. George.
02-441A	Starting Air Manifold: Air Vent	1.	Ensure that the starting air manifold vent is open and unobstructed.	X					Refr: DR/QR Report #00-442 (STAD).
02-441B	Air Filter to Starting Air Distributor	1.	Inspect filter elements.	X					Replace as necessary. Refr: TDI Instruction Manual, Vol. I, Maintenance Schedule, Ref: DR/QR Report #02-441B (Items 1, 2).

Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
		2. Replace filter elements.		X				It is also recommended that the filter be changed at a maximum pressure drop of 25 psi. Refr: DR/QR Report #02-441B.
		3. Blowdown strainer DAILY.						Refr. DR/QR Report #02-441B.
		4. Clean and inspect strainer monthly.	X					If the strainer is excessively dirty, the frequency of cleaning and inspecting should be increased. Refr. DR/QR Report #02-441B.
	Air Start Block Valves	5. Clean and refurbish valves -replace "O" rings and clean the screened fitting. Ensure leak tightness after reassembly.		X				Refr: DR/QR Report #02-441B (Items 5, 6, 7).
		6. Inspect for tightness of fittings and bolts and apply locking compound, as required, during reassembly of components.		X				
		7. Replace "O" rings of the shuttle valve.		X				
02-455A	Fuel Oil Filter	1. Record filter d/p.	X					Change filter elements when filter d/p reaches 20 psid rise above the clean d/p - Purge entrapped air from the filter canister using the vent valve provided, and divert some fuel oil into the newly replaced cartridge. After air has been purged close vent valve and return handle to previous operating position. Refr: DR/QR Report #02-455A.

Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
		2. Inspect canister gaskets and replace as necessary.		X				Refr: 3/27/84 IOC from M. Wehmeyer to J. DiMare. To be performed during change out of filter elements.
		3. Inspect tubing and mechanical connections for tightness and/or leaks.	X					Refr: TDI Instruction Manual, Volume I.
02-455B	Fuel Oil Strainers	1. Record strainer d/p.	X					If greater than 5 psid shift/clean element. Bolt torques of 120-150 in-lbs should be utilized during reassembly. Refr: DR/QR Report #02-455B.
		2. Purge air from stand-by strainers.						As required.
02-465A	Lube Oil Lines External: Tubing Fitting and Couplings	1. Ensure that a minimum installation gap of 0.171 in. is maintained between pipe ends at the 12-inch Dresser coupling.						To be performed whenever piping is installed or reinstalled. Refr: DR/QR Report #02-465A.
02-467A	Turbocharger Lube Oil Fitting: Pipe, Tubing, Fittings, and Flexible Coupling (Small Bore Scope Only)	1. Visually inspect leaks. Note: In the event of a leak developing in the existing Dresser Style 65 couplings, these couplings should be replaced with Dresser Style 90 couplings equipped with Viton gaskets.	X					This recommendation is made on the basis that the maximum suggested operating temperature of 150°F for the Style 65 coupling may be exceeded. The maximum suggested operating temperature of the Style 90 is 212°F. Ref: Letter dated 12/13/84 from C. L. Ray to J. George.
02-475A,C	Turbocharger: Bracket Bolting and Gaskets	1. Each month for the first three months of commerical operation, these screws should be inspected to assure that no screw has loosened because of engine operating loads. If during these inspections						Refr: DR/QR Reports #02-475A,C

Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
		none of the screws are found loosened or damaged, from then on inspections are to be conducted on a yearly basis (or during plant shutdown). But if any time during inspection any screw is found loosened or damaged, it must then be replaced (if damaged) and all screws retorqued as follows; 125 ft-lbs for the bracket to engine screws and 75 ft-lbs for the bracket to turbo base screws. Note: To avoid damage to bracket to engine, and/or bracket to turbo, base screws, the proper torques as delinated above should be utilized for each respective bracket bolting application.						
02-475B	Air Butterfly Valve	1. Lube valve shaft via grease fittings.		X				Refr: IOC dated 3/28/84 from M. Wehmeyer to J. DiMare. If oil cups are used, this should be completed monthly.
		2. Check valve disc for freedom of movement.	X					Check by visually observing valve/actuator operation. Refr: 04/16/84 letter from R. Jaquinto to R. Johnson.
		3. Verify that associated locking devices (jam nuts and lock washers) are tight.	X					Refr: DR/QR Report #02-475B.
02-500A	Engine Control Cabinet	1. Inspect interior of cabinet for cleanliness and clean as required.		X				Refr: 3/29/84 IOC from M. Wehmeyer to T. Jacobs for Items 1-5. Refr: 07/30/84 IOC from J. Cadogan to R. Horelik for Items 1-6.
		2. Visually check wiring for insulation degradation.		X				

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
		3. Check instrument tubing for leaks.		X				
		4. runctionally check cabinet heater and calibration of thermostat.		X				
		5. Test pneumatic S/D board logic.		X				
		6. Replace "O" rings, gaskets and filter in pressure regulator.		X				
02-500C	Circuit Breakers and Contact Blocks	1. Check all terminals clean/tighten.		X				Accomplished during panel clean/inspection.
		2. Visually check wiring insulation for degradation.		X				Accomplished during panel clean/inspection.
		3. Trip check circuit breakers.		X				
02-500G	Control Panel Valves	1. Inspect and clean control panel valves		X				This recommendation interval should be reassessed depending on the degree of of system fouling. Refr: DR/QR Report #02-500G.
		2. Inspect and clean the 200 mesh screen in the check valve.		X				Refr: DR/QR Report #02-500G.
02-500J	Control Panel Assembly: Relays	1. Inspect contacts and clean as required.		X				Refr: 08/10/84 IOC from K. Horelik to J. Cadogan.
		2. Visually check condition of wiring and tightness of terminations.		X				
02-500N	Control Panel Switches Terminal Boards and Wiring	1. Clean terminal boards and switch contacts.		X				Refr: IOC dated 3/29/84 to J. Kammeyer from M. Wehmeyer for Items 1, 2, 3.
		2. Visually check wire insulation and terminals for tightness and degradation.		X				

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
		3. Inspect for arcing and overheating.		X				
02-525B	Barring Device Control Valve and Press Regulator	1. Replace control valve "O" rings/lube shaft.		X				
		2. Replace press regulator elastomeric parts.				X		
02-525C	Barring Device Air Filter	1. Replace filter element.		X				Refr: IOC dated 3/30/84 from M. Wehmeyer to J. Freeman.
		2. Drain barring device air filter. *See Comments*						This should be performed on a DAILY basis when barring device is in use. Refr: 5/10/84 IOC from M. McGerigle to W. Brown.
02-525D	Barring Device - Mounting Bracket/Supports	1. Replace old cotter pin with new cotter pin after each reassembly.						To be performed after each reassembly. Refr: 5/8/84 IOC to P. Martin from P. Titus.
02-550	Foundation Bolts	1. Visually inspect foundation for breaks in the bond between the sole plates and grout.		X				Items 1, 2; Refr: TDI Instruction Manual, Maintenance Schedule Section 5.
		2. Check foundation bolts for correct torque. Retorque as necessary then retheck crankshaft web deflections.		X				Use TDI Instruction Manual, Volume I, Section 8, Appendix IV for proper torque values.
		3. Generator foundation bolts are to be retorqued after a generator short circuit if the bolts were initially torqued to 480 ft-lbs. If initial bolt torque was 600 ft-lb no retorque is required.						Refr: DR/QR Report #02-550.
02-630D	Thermocouples	1. Check that thermocouple indicates ambient engine temperature when the engine is cold.		X				An inconsistant reading traced to thermocouple trouble should result in replacement of the thermocouple.

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
		2. Clean and inspect thermocouples and thermocouple shields.			X			Indications of fatigue should result in replacement of the thermocouple and/or thermocouple shield. Refr: 7/31/84 Memo from S. Riess to W. Littmann.
		3. Pyrometer wiring-check that terminations are tight.						To be accomplished during control panel check-out and initial operation inspections. Items 1, 2, 3; Refr: 07/30/84 IOC from J. Cadogan to S. Riess.
02-695B	Engine Control Air Pressure Regulator	1. Inspect and clean engine shutdown equipment.		X				NOTE: This recommendation should be reassessed depending on the degree of system fouling. Refr: DR/QR Report #02-695B (Items 1&2).
		2. Replace elastomeric parts and gaskets in the pressure regulator.		X				
02-695C	Engine Control Pneumatic Trip Switches	1. Check switch set points.		X				Pressure switches. Refr: 3/30/84 IOC from M. Wehmeyer to J. DiMare.
		2. Replace elastomeric parts.				X		
02-695C	Engine Control Pneumatic Trip Swtiches	1. Check switch set points.		X				Temperature switches.
02-700B	Jacktet Water Standpipe: Valves	1. Replace elastomeric parts in circle seal valves.				X		Refr: DR/QR Report #02-717B.
02-700F	Jacket Water Standpipe and Miscellanenous Bolting	1. Visually inspect jacket water standpipe, pump suction and engine return nozzle welds during each routine engine run and every 100 hours during extended engine runs.						Any visible cracking or minor jacket water leakage should result in rework of nozzle welds. Refr: DR/QR Report #02-700F
02-717B	Auxiliary Sub Base & Oil & Water Piping - Jacket Water: Valves	1. Inspect the valves for packing leakage.	X					Replace packing as necessary. Refr: DR/QR Report #02-717B.

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
02-717C	Auxiliary Sub-Base & Oil & Water Piping - Jacket Water: Pipe, Couplings, Fittings Orifices, Y-Strainers (Small Bore Scope Only)	1. Visually inspect for leaks. Note: In the event of a leak developing in the existing Dresser Style 65 couplings, these couplings should be replaced with Dresser Style 90 couplings equipped with Viton gaskets.	X					This recommendation is made on the basis that the maximum suggested operating temperature of 150°F for the Style 65 coupling may be exceeded. The maximum suggested operating temperature of the Style 90 is 212°F. Ref: Letter dated 12/13/84 from C. L. Ray to J. George.
02-717F	Auxiliary Sub-Base Lube Oil Pipe and Fittings	1. Visually inspect pipe and joints for leakage. Note: In the event of a leak developing in the existing Dresser Style 65 coupling, these couplings should be replaced with Dresser Style 90 couplings equipped with Viton gaskets.	X					This recommendations made on the basis that the maximum suggested operating temperature of 150°F for the Style 65 coupling may be exceeded. The maximum suggested operating temperature of the style 90 is 212°F. Ref: Letter dated 12/13/84 from C. L. Ray to J. George. Ref: 4/2/84 IOC from M. Wehmeyer to J. Freeman
		2. Clean and inspect L.O. keep-warm pump suction strainer.		X				Complete when L.O. tank is drained. Refr: 04/16/84 letter from R. Jaquinto to R. Johnson.
02-717G/K	Auxiliary Sub-Base Lube Oil/ Fuel Oil Valves	1. Disassemble, inspect and refurbish.		X				Refr: IOC dated 4/6/84 from M. Wehmeyer to J. DiMare. Ref: DR/QR Report #02-717G/K.

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
		2. Dissassemble, clean and check relief valve lift pressure.				X		Refr: 07/31/84 IOC to M. McGerigle from J. Cadogan. Refr: 08/16/84 IOC from M. McGerigle to J. Cadogan. Refr: DR/QR Report #02-717G/K.
02-805B	Intake Air Filters	1. Inspect air intake filters every 3 to 6 months.						Replace if necessary. Refr: DR/QR Report #02/805B.
02-805D	Flex Connection	1. Visually inspect for evidence of cuts, holes, or dents.			X			Check for exhaust leakage.
02-810C	Jacket Water Heat Exchanger	1. To avoid corrosion and fouling, jacket water heat exchanger and associated service water piping should be flushed on a periodic basis (continuous service flow is sufficient.) Alternatively, service water chemistry control can be used to maintain heat exchanger performance and integrity.						Refr: DR/QR Report #02-810C, Refr: 04/20/84 IOC from M. Wehmeyer to R. Kadlec.
		2. Perform a daily visual inspection for leakage at packing whenever the engine is in the emergency STANDBY mode. Verify that no leakage is present through the leak-off ports of the lantern ring.						To be performed daily. Refr: 07/19/84 Telecon D. Pasquale and R. Chii.
		3. Record heat exchanger performance by checking engine operating parameters.	X					Use for trend data.
		4. Evaluate heat exchanger performance data.		X				

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
		5. Inspect tubes and tube sheet for fouling and errosion - remove entrance and exit channel covers.		X				Refr: TDI Instruction Manual, Volume 1, Maintenance Schedule.
		Replace packing rings at floating tube sheet after tube inspection.						Refr: DR/QR Report #02-810C.
		6. Inspect and clean lantern ring. Verify leak-off holes are not plugged.		X				Replace/rework lantern ring as necessary to ensure concentricity prior to reinstallation.
		7. Replace packing rings.		X				Replace packing when packing becomes hard or leakage at the packing is noted and cannot be stopped by tightening. Refr: DR/QR Report #02-810C.
02-810D	Thermostatic Valves	1. Replace thermal power elements.				X		Refr: DR/QR Report #02-810D.
		2. Visually inspect valve body for evidence of leakage.	X					To be accomplished during monthly test run. Ensure that any replacement valves have cast steel valve bodies. Refr: DR/QR Report #02-810D.
02-810E	Jacket Water Heaters	1. Measure heater insulation resistance.		X				Replace heater if degradation of insulation resistance is noted. Refr: 5/10/84 IOC from M. McGerigle to W. Brown for Items 1, 2, 3.
		2. Clean and inspect heater elements.		X				
		3. Check calibration and inspect thermostat.		X				
02-820A	Lube Oil Sump Tank Heaters	1. Measure heater insulation resistance.		X				Replace heater if degradation of insulation resistance is noted.

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
		2. Inspect and clean heater elements.		X				To be accomplished during tank inspection.
		3. Check calibration and inspect condition of thermostat.		X				Refr: 05/10/84 IOC from M. McGerigle to W. Brown for Items 1, 2, 3.
02-820C	Lube Oil Keep-Warm Pump	1. Check operation of pump/motor bearings.	X					Items 1-6; Refr: 04/05/84 IOC from M. Wehmeyers to T. Fritsch.
		2. Check mechanical seal leakage.	X					
		3. Clean, inspect and megger motor.		X				
		4. Check coupling alignment.		X				
		5. Record pump discharge pressure.	X					Use for trend data.
		6. Measure unit vibration (pump/motor).		X				
		7. The pump should be inspected for signs of leakage and corrective modifications (addition of flexible piping connections) be implemented as required.						To be performed daily Refr: DR/QR Report #02-820C
02-820D	Lube Oil Keep-Warm Strainer	1. Check strainer differential pressure daily.						Refr: DR/QR Report #02-820D.
		2. Clean/replace strainer element at 20 psid.						
02-820E	Lube Oil Keep-Warm Filter	1. Record filter d/p.	X					Refr: 04/05/84 IOC from M. Wehmeyer to J. DiMare.
		2. Change filter elements.						To be performed before the filter d/p reaches 20 psid. Refr: DR/QR Report #02-820E.

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
02-820F	Full Flow Lube Oil Filters	1. Record filter d/p.	X					Use for trend data. Refr: 04/02/84 IOC from M. Wehmeyer to J. DiMare. Refr: TDI Instruction Manual, Volume I, Maintenance Schedule.
		2. Drain water and/or sludge from lubricating oil full flow filter.	X					
		3. Replace filter cartridges and perform a visual inspection to determine the nature of the material caught in the filter.						To be performed before the filter d/p reaches 20 psid Refr: 05/30/84 IOC from M. McGerigle to B. Brown. Refr: DR/QR Report #02-820F. Refr: 07/31/84 IOC from J. Cadogan to M. McGerigle.
		4. Lube oil filter gauge - calibration check.		X				
02-820G	Lube Oil Heat Exchanger	1. Perform a daily visual inspection for leakage at packing. Verify that no leakage is present through the leak-off ports of the lantern ring.						Refr: DR/QR Report #02-820G. Refr: 06/12/84 IOC from R. Chii to P. Martia. Refr: 04/02/84 IOC from M. Wehmeyer to R. Kadlec.
		2. Record heat exchanger performance by checking engine operating parameters.	X					Use for trend data.
		3. Evaluate heat exchanger performance data.		X				
		4. Inspect tubes and tube sheet for erosion and fouling - remove entrance and exit channel covers.		X				Refr: TDI Instruction Manual, Volume I, Maintenance Schedule. Refr: 07/19/84 Telecon D. Pasquale and R. Chii.

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
		5. Inspect and clean lantern ring. Verify leak-off holes are not plugged.		X				Replace/rework lantern ring as necessary to ensure concentricity.
		6. Replace packing rings at the floating tube sheet during reassembly after each inspection.		X				When packing becomes hard or leakage at the packing is noted and cannot be stopped by tightening.
		7. Perform a spectrochemical analysis of the lube oil. Particular attention shall be given to percent moisture content.						To be performed at approximately quarterly intervals.
02-820H	Full Pressure Lube Oil Strainer	1. Record strainer d/p.	X					Use for trend data.
		2. Inspect and clean elements.		X				To be performed when the differential pressure across the strainer rises significantly. Refr: DR/QR Report #02-820H. Refr: TDI Instruction Manual, Volume I, Maintenance Schedule.
		3. Lube oil strainer pressure gauge - calibration check.		X				
02-835B	Diesel Starting Air Compressors	1. Check operating oil pressure.	X					All items, Refr: 04/02/84 IOC with attached Maintenance Chart from M. Wehmeyer to J. Kammeyer.
		2. Overall visual inspection.	X					
		3. Clean fins on inter and after coolers.		X				
		4. Replace intake filter element.		X				

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
		5. Change compressor oil.		X				
		6. Check belt tension.		X				
		7. Check pulley clamp bolts/set screws tight.		X				
		8. Inspect filter felts on unloader system.		X				Replace as necessary.
02-835I	Air Dryers and Moisture Traps	1. Blow down trap sediment bowls.	X					Refr: 04/05/84 IOC from M. Wehmeyer to J. Kammeyer Refr: TDI Instruction Manual, Volume I, Maintenance Schedule.
		2. Inspect and service moisture traps.		X				
		3. Check proper operation of desiccant dryer.	X					Replace desiccant charge as required.
02-835J	Starting Air Storage Tank	1. Drain air receiver float traps DAILY and monitor the quantity of moisture produced at the float traps.						If quantity of moisture is excessive correct immediately. Check air dryer operation Refr: DR/QR Report #02-835J.
		2. Disassemble and clean the float trap.		X				Refr: 05/08/84 IOC from P. Titus to P. Martin (Items 2 & 3).
		3. Starting air tank pressure gauges - calibration check.		X				
		4. Starting air tank pressure switches - calibration check.		X				
	Jacket Water System	1. Check pH factor of jacket water and correct as recommended by chemical supplier.	X					Refr: TDI Instruction Manual, Volume I, Maintenance Schedule.
		2. Replace elastomeric parts in jacket water valves.				X		Refr: DR/QR Report # 02-717B.

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
	Lube Oil System	1. Check lubricating oil with a viscosimeter for fuel oil dilution. Send a sample of oil to laboratory for analysis.	X					Refr: TDI Instruction Manual, Volume I, Maintenance Schedule, Items 1, 2.
		2. Drain lubricating oil system and clean sump tank. Depending on the results of lube oil analysis, refill with new oil.		X				When replacing engine oil use H.D. oil that meets or exceeds series 3 standards. The base stock should be more resistant to thermal degradation and coke formation. The additive package should provide high detergent dispersant properties with high alkalinity and a high level of antiwear additive such as zinc dithiophosphate. Total Base Number (TBN) should be 12 to 15 for use with #2 fuel oil and a sulfated ash content of 1.5% to 2.0% is preferred. An engine oil with such properties, Mobilguard 412 or equivalent product may be used to insure improved lubrication.
		3. Visually inspect lube oil sump tank level switch floats. Check switch set points.		X				To be performed after lube oil has been drained from sump.
		4. Perform a spectrochemical analysis of the lube oil.						To be performed at approximately quarterly intervals. Refr: TDI Instruction Manual, Volume I, Maintenance Schedule.
	System Operation	1. Record all operating parameters. Compare with base line data to ensure engine is operating properly.	X					To be performed during monthly engine test run.

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Component Number	Component Identification	PM Recommendation	Monthly	Outage	Alt. Outage	5 Year	10 Year	Comments
	Piping System	1. Conduct a detailed visual and audible inspection of all fuel, air, oil, and water piping and valves for leakage.	X					Tighten, repair or replace as required. Refr: TDI Instruction Manual, Volume I, Maintenance Schedule.
		2. Inspect, clean and lubricate manual valves on skid as applicable.		X				
		3. Bolted flanges which are utilized as connecting points for pipe supports and should be torqued in accordance with TDI Instruction Manual Appendix IV.						
	Engine Internals	1. Remove alternate left side doors and examine the inside of the engine for any abnormal conditions. Check with a good light for evidence of babbit flakes.		X				If excessive water, sludge or any indication of bearing failure is present, drain crankcase, determine cause, and take necessary corrective action.
Miscell-aneous	Engine Mounted Pressure Switches	1. Replace elastomeric parts.				X		
	Gear Train	1. Inspect gears for general condition.		X				
		2. Measure gear back lash on all gears.			X			Replace worn gears exceeding maximum clearance. Complete TDI Inspection and Maintenance Form No. 355-1-1 TDI Instruction Manual, Vol. I, Section 5. Use Vol. I, Section 8 Appendix III-I for clearance values. Refr: 04/16/84 letter from R. Jaquinto to R. Johnson.

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If, after completing the review, the engineer determines that the component is acceptable, based on the existing documentation, the Component Design Report will be issued stating the conclusion of acceptability.

If TDI documentation is not available, or if it is determined that the available documentation does not readily lead to a conclusion of accpetability the engineer will alternatively continue the review as outlined in the following paragraphs.

4.2 Review of Small Bore Piping for Acceptability

In cases where the review of TDI documentation does not lead to component acceptability, the engineer will judge if the component will perform its intended function under all normal and earthquake loadings. This judgment will be based on a review of the following information:

Quality approved as built piping isometrics

System operating parameters

Physical piping data

Site specific amplified response spectra

System function

In addition to reviewing the above information, a physical walkdown of the engine and skid piping may be required. The walkdown would include a review of the piping to determine pipe support type and function, as well as a review for the following:

Thermal flexibility: The engineer will determine if sufficient flexibility exists for each between support section of small bore piping. The thermal movement imparted by the supports onto the piping will also be considered.

Deadweight spans: The deadweight spans between supports will be reviewed by the engineer and acceptability will be based on judgment.

Seismic spans: The seismic spans between supports will be reviewed by the engineer and acceptability will be based on judgment. The engineer's judgment will consider the site specific amplified response spectra and all components, fittings and branch connections. Engine induced vibration will also be considered in determining acceptability of seismic spans and is further discussed in paragraph 4.5.

The engineer will document the reviews of the individual components by a written trip report. The trip report will serve as a summarization of the engineering walkdown. 1