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PNL-5444

Technical Evaluation Report

Review of Design Review and Quality Revalidation Report for the Transamerica Delaval Diesel Generators at Comanche Peak Steam Electric Station Unit 1

October 1985

Prepared for
the U.S. Nuclear Regulatory Commission
Division of Licensing
Office of Nuclear Reactor Regulation
under Contract DE-AC06-76RLO 1830
NRC FIN B2963

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
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Project Title: Assessment of Diesel Engine Reliability/Operability

NRC Lead Engineer: C. H. Berlinger

Pacific Northwest Laboratory
Richland, Washington 99352

PACIFIC NORTHWEST LABORATORY

PROJECT APPROVALS

W. W. Laity Date 9/24/85

W. W. Laity, Project Manager
Pacific Northwest Laboratory

W D Richmond Date 9-25-85

W. D. Richmond, Chairman
Senior Review Panel
Pacific Northwest Laboratory

FOREWORD

This report is supplied as part of the Technical Assistance Project, Assessment of Diesel Engine Reliability/Operability, being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Licensing, by the Pacific Northwest Laboratory. The U.S. Nuclear Regulatory Commission funded this work under authorization B&R 20-19-40-42-1 FIN No. B2963.

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ABSTRACT

This report documents Pacific Northwest Laboratory's (PNL) review of the Owners' Group (OG) design review and quality revalidation (DR/QR) of the critical components of the Transamerica Delaval, Inc. (TDI) emergency diesel engine generators installed at the Comanche Peak Steam Electric Station. The OG effort, conducted for the Texas Utilities Generating Company (TUGCO), is reported in TDI Diesel Generator Design Review and Quality Revalidation Report (September 7, 1985) and Revision 1 (January 1985).

PNL and its consultants reviewed this multi-volume report on an audit basis. Based on this review, PNL concluded that the OG study addressed the critical engine components in sufficient detail. In addition, PNL found that the studies conducted on the individual engine components were generally adequate and sufficiently detailed to establish that the components in service will perform their intended functions.

PNL recommends that additional consideration be given to several maintenance items. These recommendations are not of sufficient or immediate concern to require TUGCO commitments prior to licensing. However, PNL feels that TUGCO should commit to them prior to the end of the first refueling outage.

On the basis of its audit review for completeness and adequacy, PNL concludes that no further reviews of the Comanche Peak DR/QR need be done. That is, PNL concludes that 1) the audit size (80 of 174 components) and 2) the favorable results found are sufficient to provide a basis to assume the adequacy of the OG review on the remaining components. PNL therefore concludes that the OG DR/QR effort for the Comanche Peak Steam Electric Station has requalified the Phase II engine components for their intended service.

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APPENDIX - COMANCHE PEAK STEAM ELECTRIC STATION ENGINE COMPONENT SELECTION AND RESOLUTION A.1

ABBREVIATIONS

ASME	American Society of Mechanical Engineers
BMEP	brake mean effective pressure
CPSES	Comanche Peak Steam Electric Station
DBA	design basis accident
DR/QR	design review/quality revalidation
EDG, EDGs	emergency diesel generator(s)
EDGCTS	Emergency Diesel Generator Component Tracking System
ESF	engineered safety feature
LOCA	loss-of-coolant accident
LOOP	loss of offsite power
M/S	maintenance/surveillance
NRC	U.S. Nuclear Regulatory Commission
OBE	operating base earthquake
OG	Owners' Group; the TDI Diesel Generator Owners' Group
O/R	operability and reliability
PNL	Pacific Northwest Laboratory
SCR	silicon controlled rectifiers
SIM	Service Information Memo
SNPS	Shoreham Nuclear Power Station
SSE	safe shutdown earthquake
TDI	Transamerica Delaval, Inc.
TER	technical evaluation report
TUGCO	Texas Utilities Generating Company

REVIEW OF
DESIGN REVIEW AND QUALITY REVALIDATION REPORT
FOR THE TRANSAMERICA DELAVAL DIESEL GENERATORS
AT COMANCHE PEAK STEAM ELECTRIC STATION UNIT 1

1.0 INTRODUCTION

The Pacific Northwest Laboratory (PNL) is supporting the U.S. Nuclear Regulatory Commission (NRC) staff in addressing questions on the reliability, operability, and quality assurance of the Transamerica Delaval, Inc. (TDI) diesel engines used to provide emergency standby power in some nuclear power plants. These questions were raised because of a major failure in one TDI diesel engine at the Shoreham Nuclear Power Station (SNPS) in August 1983 and other problems encountered with TDI diesels in both nuclear and non-nuclear applications.

Texas Utilities Generating Company (TUGCO) and twelve other U.S. nuclear utilities that own generators driven by TDI-manufactured diesel engines established an Owners' Group (OG) to address and resolve the concerns pertaining to these emergency diesel engine generators. This group formulated a program that, through a combination of design reviews, quality revalidations, engine tests, and component inspections, is to provide an in-depth assessment of the adequacy of the respective utilities' TDI engines to perform their intended safety-related functions. This program has involved a comprehensive review of the crucial components in the TDI diesel engines at each of the TDI diesel owners' facilities.

The OG concluded that 16 components of the TDI emergency diesel generators (EDGs) warranted priority attention because of known problems or special concerns for the component quality. Each of these components has generic application in the TDI R-4 series engines. Each component was evaluated individually to determine and resolve the area of concern and to ensure that the resultant component is adequate for the intended purpose. This effort has been designated as Phase I of the OG program.

Phase II of this program, the Design Review/Quality Revalidation (DR/QR), is the OG identification and review of a large number of engine components or systems to ensure the adequacy of their design and manufacture, including quality control/assurance, and the adequacy of the provisions for their operational surveillance and maintenance. Plant-specific data on each of the Phase I components as well as the additional Phase II components are included in the individual DR/QR reports for each facility covered.

A principal task in PNL's effort is to evaluate the DR/QR reports prepared by the OG on the diesel engines owned by the respective utilities. The OG study conducted on the Comanche Peak engines was documented in the TDI Diesel Generator Design Review and Quality Revalidation Report dated September 7, 1984, and its Revision 1 dated January 1985. PNL's evaluation of the Owners' Group effort and DR/QR report prepared for TUGCO's Comanche Peak Steam Electric Station (CPSES) Unit 1 is the subject of this technical evaluation report (TER). Emphasis is placed on the actions taken by the OG and TUGCO.

In a previous report (PNL-5234 issued to NRC in September 1984), PNL addressed diesel generator issues pertinent to CPSES's engines reliable performance and capability to serve their intended function. PNL's evaluation included the resolution of Phase I component problems, EDG tests and inspections, and maintenance and surveillance (M/S) programs.

1.1 BACKGROUND

Comanche Peak Steam Electric Station Unit 1 is served by two standby engines to meet its emergency service or engineered safety feature (ESF) loads. Each is a TDI DSRV-16-4 engine, nameplate rated by TDI at 7000 kW, operating at 450 rpm with a brake mean effective pressure (BMEP, a computed measure of the average cylinder pressure over the working cycle) of 225 psig. TUGCO has designated these engine-generators as Train A and Train B. In Chapter 8 of their Final Safety Analysis Report TUGCO specifies the emergency loads for these engines as a maximum of 7019 kW for Train A and 6686 kW for Train B under station blackout conditions.

In response to concerns about the operability/reliability (O/R) of TDI engines, TUGCO with OG assistance has undertaken a comprehensive analysis of all major engine components and has replaced some of the engine components. To verify or ensure engine O/R, TUGCO has also subjected the CPSES EDGs to additional inspections and tests beyond those specified by the manufacturer and the NRC Regulatory Guides, or those routinely conducted prior to actual engine operation. Further details regarding these engine tests and the requalification activities undertaken by TUGCO can be found in the PNL report, Review and Evaluation of Transamerica Delaval, Inc., Diesel Engine Reliability and Operability - Comanche Peak Steam Electric Station Unit 1 (PNL-5234), dated September 1984.

1.2 REPORT ORGANIZATION

In Section 2.0 of this TER, the overall Owners' Group DR/QR program is described, followed by a summary of the OG DR/QR efforts and conclusions specifically related to the CPSES EDGs. Section 3.0 documents the PNL evaluation of the OG DR/QR study. The various facets of PNL's evaluation, including the scope, objectives, and approach taken, are described. Section 4.0 provides PNL's overall conclusions and recommendations. Finally, Section 5.0 presents an account of PNL's detailed review of the OG DR/QR analysis of 80 individual EDG components.

2.0 OWNERS' GROUP DESIGN REVIEW/QUALITY REVALIDATION EFFORT

This section first presents an overview of the Owners' Group Design Review/Quality Revalidation program. The generic description also serves to document the objective of and methodology used in the DR/QR effort conducted specifically for the CPSES EDGs. Second, this section summarizes the outcomes of the DR/QR conducted at CPSES and presents the results obtained and conclusions reached by the OG.

2.1 PROGRAM DESCRIPTION

The Owners' Group DR/QR program was established to provide a standardized means for examining each owner utility's engine(s) in order to assess each engine's ability to reliably perform its intended design function. The examinations and reviews are conducted by a centralized team of engineering personnel with specialized skills in appropriate fields including diesel engine and generator design, operation, and manufacture.

Implementation of the DR/QR program involves a stepwise progression of activities. The first is to select the components of each engine that warrant a detailed design review and/or quality revalidation. The engine components selected are then subjected to either a design review, a quality revalidation, or both. When these reviews are completed, the Owners' Group technical staff reviews and approves the inspection results, document packages, design review findings, and calculation results. These activities are described in more detail in the following subsections.

2.1.1 Component Selection

The diesel generator components to be included in the DR/QR program are determined by a Component Selection Committee. Selection is based on

- the component's function and role in the overall operation of the engine
- the component's nuclear and non-nuclear industry experience
- the Committee's engineering judgment.

To ensure that all relevant experience is considered, the selection process includes a review of available operating information on TDI diesels and TDI-recommended product improvements.

As part of the component selection process, each component is classified as type A, B, or C, depending on the potential effect of its failure on the diesel generator performance. Type A components are those whose failure would result in diesel generator shutdown or failure to start in an accident mode. Type B components include those whose failure would result in reduced capacity of the diesel generator or, if undetected, the eventual failure of a Type A component. Components whose failure would have little or no effect on diesel generator operation are classified as Type C.

2.1.2 Task Description Preparation

Following classification, the Committee establishes appropriate design review and quality revalidation requirements. These requirements are then forwarded to the Design Review Group and Quality Revalidation Group who prepare descriptions to define the tasks (e.g., reviews, inspections, calculations) to be performed on each component. The task descriptions include recommendations identified in the selection process as well as component inspections recommended by the Design Review Group and/or Quality Revalidation Group.

The design review task descriptions include, as applicable:

- primary component function and required attributes
- applicable codes and standards
- alternative codes, standards, or analytical techniques
- analysis or evaluation to be performed to assure satisfactory design
- available verifications of TDI analysis (if any)
- final documentation requirements.

The quality revalidation task descriptions (also referred to as the Component Revalidation Checklist) include:

- component to be validated
- attributes to be verified
- methodology to be used (e.g., documentation review, NDE techniques)

- acceptance criteria
- final documentation requirements.

In some cases the Design Review Group and/or the Quality Revalidation Group prepared task descriptions that required no additional DR or QR for certain components. The individual task descriptions contain the justification for this reduction in scope. In general, the basis for not requiring Design Review and/or Quality Revalidation is the following:

- Lead Engine Component Reviews - The identical component was reviewed on a lead engine. Any recommendations that supported the conclusions in the lead engine report are included in the task description.
- Experience - Either no adverse site or industry experience exists or, if it does exist, the task description addresses its resolution.

2.1.3 Design Review

Because of the number and diversity of the components and standards involved, the design review is tailored to each component. The actual design review is accomplished using one or more of several methods, including 1) an independent calculation performed by the Design Review Group; 2) an independent review of the adequacy, appropriateness, or correctness of existing vendor and/or subvendor calculations; 3) testing specified by the Design Review Group; and 4) other methods specified and approved in the task descriptions.

During implementation of the task descriptions, the Design Review Group specifies quality attributes (in addition to those identified during the component selection process) for incorporation into the quality revalidation process. The Design Review Group also identifies any components for which corrective action may be required to improve reliability of the diesel generators. This may include recommendations for design modifications or for increased frequency of component replacement and/or maintenance, or additional inservice inspection.

2.1.4 Quality Revalidation

Each component requiring quality revalidation is subjected to a documentation review. Through this process, all appropriate documentation (e.g.,

material test reports, nondestructive examination results, vendor/subvendor records, site records) associated with the component is identified and catalogued. With assistance from Quality Engineering, each document is reviewed for acceptability. These document packages are then made available to the Design Review Group to assist in the engineering review. Important attributes identified by the Design Review Group, but for which acceptable documentation did not exist in the component file, are verified by tests and/or inspections performed by the Quality Revalidation Group.

Tests or inspections required to be performed on components are forwarded to Quality Engineering to develop detailed methodology and procedures to be followed. These instructions are issued to Quality Inspection. Field inspections and tests are performed by qualified personnel. Depending upon the specified test or inspection, a spare or surplus part in lieu of the installed part may be used as the test/inspection article. Results of inspections and tests are summarized by the Quality Revalidation Group and reviewed by the Design Review Group as necessary to make a final determination on the component's suitability to perform its intended function.

2.2 COMANCHE PEAK STATION STUDY

The OG DR/QR program described in Section 2.1 was applied to the TDI diesel engines at CPSES. The results obtained and the conclusions drawn by the OG from the CPSES DR/QR are summarized in the following subsections.

2.2.1 Results

The Comanche Peak engine components considered by the OG Component Selection Committee are listed in the Appendix. The Committee's determination of type of attention needed--design review, or quality revalidation, or both DR and QR, or no review--is noted for each of the components considered.

As indicated in the Appendix, most of these components were judged to be acceptable for their intended service with unlimited life, provided that the recommendations identified are followed. The recommendations deal primarily

with additional inspection requirements, as well as improvements in installation, operating, and maintenance procedures. In some cases, procurement specification recommendations are identified to aid the utility in its spare parts program.

Some components required modifications, as identified in the Appendix column headed Recommended Action. The utility's implementation of these recommended actions is intended to result in a component that is acceptable for its intended service with unlimited life.

The OG DR/QR effort for CPSES produced a detailed assessment of 174 TDI diesel generator components. The OG indicated that many of these components were examined using analytical techniques comparable to or exceeding the detailed engineering effort of the original design. The OG also pointed out that extensive component inspections were an integral part of the DR/QR program, and the performance of these inspections contributed to the level of confidence for these critical diesel generator components.

2.2.2 Owners' Group Conclusions and Recommendations

The OG concluded that the DR/QR effort had contributed substantially to quantifying the reliability of the CPSES EDGs by establishing the acceptability of critical engine components. The OG also stated the belief that this effort verifies the acceptability of the CPSES EDGs for nuclear service by showing that the engines' important components have been assessed to be adequate for their intended functions. In cases where component adequacy was judged by the Owners' Group to be marginal, corrective action was recommended to ensure the adequacy of the component.

The OG concluded that the TDI diesel generators installed at the Comanche Peak Steam Electric Station are acceptable for their intended safety-related function. Further, they concluded that the incorporation of the maintenance and surveillance recommendations into the plant's existing program provides added assurance that these diesel generators will continue to perform their intended function for the expected lifetime of the plant.

3.0 PACIFIC NORTHWEST LABORATORY'S EVALUATION

The TDI Diesel Generator Owners' Group document, TDI Diesel Generator Design Review and Quality Revalidation Report, prepared for TUGCO's Comanche Peak Steam Electric Station Unit 1, was evaluated by:

- D. A. Dingee, PNL project team
- J. F. Nesbitt, PNL project team
- P. J. Louzecky, consultant, Engineered Applications Corporation
- N. Jaffray, consultant, Ricardo Consulting Engineers
- N. N. Rivera, consultant, Designers and Planners, Inc. (TRACOR Hydronautics, Inc.)
- L. Wechsler, consultant, TRACOR Hydronautics, Inc.
- A. Wendel, consultant, TRACOR Hydronautics, Inc.

3.1 SCOPE

The PNL evaluation addressed the general conduct of the DR/QR program at Comanche Peak and focused on the actions taken by the Owners' Group and TUGCO to perform the DR/QR effort. The scope of this evaluation was limited to primarily an audit-type review of specific actions taken and conclusions reached by the Owners' Group regarding certain components of the CPSES EDGs.

3.2 OBJECTIVES

The objectives of PNL's evaluation were

1. to determine whether the OG DR/QR effort included all of the components considered critical to the continued safe operation of the CPSES EDGs

2. to determine if the OG had adequately reviewed the critical components in terms of design and/or quality assurance considerations, such that the intent of the Owners' Group Program Plan[(a)] was satisfied

3. to determine if an adequate maintenance/surveillance plan was in place to ensure that the engine components would continue to perform their function for the life of the plant.

3.3 METHODOLOGY

The approach taken to accomplish the objectives of confirming the completeness and adequacy of the OG efforts consisted of 1) independent identification of key components, 2) audit reviews of the DR/QR report information, 3) onsite audit reviews of backup and reference information, 4) engine observation, 5) meetings with OG and TUGCO staff, and 6) consultant judgment. These elements are described below as they relate to the objectives of assessing completeness and adequacy of the OG component DR/QR review and the review of the maintenance and surveillance program.

3.3.1 Assessment of Completeness of Owners' Group DR/QR

PNL evaluators assessed whether the OG DR/QR study had addressed all of the components considered critical to the continued reliable operation of the CPSES EDGs. In May and June 1984, prior to the OG issuing any DR/QR reports, four PNL consultants independently identified from 12 to 20 components or systems (excluding the Phase I generic components) whose importance to engine reliability and operability, in their judgment, warranted their inclusion in the DR/QR effort. These lists were developed for both TDI inline and V engines. As a measure of completeness, PNL evaluators compared the consultant-generated lists with the OG-generated list of components (see Appendix) considered in their DR/QR, to determine the extent to which the two lists matched.

(a) The stated intent of the Owners' Group Program Plan (March 1984) is to establish "...reasonable assurance of the ability of the TDI engines to provide reliable backup power supplies for nuclear power plant service".

3.3.2 Assessment of Adequacy of Owners' Group DR/QR

The PNL consultants were asked to evaluate the appropriateness of the design review performed, and the DR/QR action taken, on each component reviewed in this audit-type effort. PNL chose most of the components for this evaluation on the basis of their importance to engine operability and their relevance to a PNL consultant's specific area of expertise. Some individual components were included because of their relationship to other components and systems. This approach resulted in a review of the OG documentation on at least 80 components. The PNL evaluators then examined the DR/QR report documentation for each of the 80 components.

It was not considered practical for the reviewers to analyze all the relevant documentation for each of the components considered. This is particularly true of the QR documentation. Frequently the components reviewed were dispositioned by the OG by technical evaluation reports or TUGCO documents (e.g., maintenance and repair reports, nonconformance reports) that were referenced in, but not included as part of, the DR/QR report.

The adequacy and thoroughness of the CPSES DR/QR backup documentation was evaluated through a sampling review of the Phase I components, onsite at CPSES in conjunction with a review of the Train B engine. The PNL team ascertained that the recommended OG inspections had been performed and that all reviewed components had a traceable record to the final conclusions documented in the DR/QR report. The PNL sampling review, done in support of the CPSES technical evaluation report (PNL-5234), involved reviewing inspection records and photographs, nonconformance reports, and final dispositioning records.

To resolve questions that developed as a result of the audit review, PNL met with the TUGCO/CPSES and OG staff in July 1985. Results of the discussions at that meeting are included as appropriate in Section 5.0 of this report.

It is to be noted that the Phase II effort was conducted by an OG Task Force established for this purpose. This Task Force provided oversight for DR/QR activities at all nuclear plants with TDI engines. Accordingly, the

extensive review of the DR/QR done for the Shoreham Nuclear Power Station and documented in PNL-5336 is a further measure of the adequacy of the Phase II effort.

3.3.3 Assessment of Adequacy of CPSES Maintenance and Surveillance Plans

PNL has stated in its Review and Evaluation of TDI Diesel Generator Owners' Group Program Plan (PNL-5161, June 1984) that a comprehensive surveillance and maintenance program is "a key aspect of the overall effort for establishing TDI diesel engine operability and reliability." The TUGCO initial maintenance and surveillance (M/S) plan was provided to the NRC in a letter dated August 15, 1984, from J. B. George (TUGCO) to B. J. Youngblood (NRC). PNL reviewed this plan and reported the results in Review and Evaluation of Transamerica Delaval Inc. Diesel Engine Reliability and Operability - Comanche Peak Steam Electric Station Unit 1 (PNL-5234, September 1984).

TUGCO later modified this initial M/S plan on the basis of the Owners' Group Phase II report (Maintenance Review, Appendix II). TUGCO committed to a final M/S plan which incorporated the OG Appendix II with modification and clarification provided in Enclosure 2 to TXX-4501 dated June 27, 1985.

PNL's review of the CPSES M/S plan consists of the overall review provided in PNL-5234 and a review of TUGCO's June 1985 M/S plan. Certain M/S recommendations provided in PNL-5234 have been modified to reflect final review of the Phase I components. The final M/S recommendations for these components were submitted during the Atomic Safety and Licensing Board Hearings on the Perry Nuclear Power Plant (Docket 50-440/50-441). These modifications supercede the corresonding M/S elements of PNL-5234.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Based or the audit reviews conducted, PNL has reached the overall conclusion that the OG Phase II efforts have fulfilled the intent of the Owners' Group Program Plan for the Comanche Peak Steam Electric Station, which is to establish "...reasonable assurance of the ability of the TDI engines to provide reliable backup power supplies for nuclear power plant service."

In particular, the completeness of the Owners' Group DR/QR study was confirmed. PNL evaluators found that all the components determined by PNL consultants to warrant inclusion in the DR/QR effort had been addressed by the Owners' Group. PNL also noted that most of the components listed by PNL's consultants had been subjected to both the DR and the QR by the Owners' Group.

The adequacy of the Owners' Group DR/QR effort was confirmed by several means. The principal confirmation was the satisfactory comprehensive review of the 80 components selected by the reviewers as outlined above. The results of this review, presented in detail on a component-by-component basis in Section 5.0, can be summarized as follows. PNL found that the Owners' Group had adequately addressed the design and/or quality aspects of all of the components included in the audit-type review. PNL evaluators questioned the adequacy of the maintenance and surveillance for several of the components and the resolution of OG recommendations for one component (02-310B) as summarized in Table 4.1. Further comments on these components are provided in Section 5.0. The bases for these M/S comments generally resulted from experiences of the PNL consultants.

Further confirmation of adequacy of the Owners' Group DR/QR was gained from the onsite review of the backup documentation. As noted earlier, PNL performed a sampling review of the TUGCO database pertaining to the requalification of the 16 Phase I components and the Phase II components. Although the design analyses were reviewed, this onsite review concentrated on the quality revalidation in that the focus was on inspection results, nonconformance findings and their disposition, and the method of acceptance of replacement or

TABLE 4.1. PNL Recommendations and Suggestions on Certain Phase II Components

Component	Part Number	Discussed in TER Section	Recommendation [R] or Suggestion [S][a]
Intercooler	F-068	5.3	[S] Monitor air temperature and air and waterside dp for trend analysis
Main bearing shells	02-310B	5.8	[R] Discrepancies noted by the OG in component 02-310B were reviewed and resolved by Failure Analysis Associates. A confirmation review by NRC of this report is recommended.
Camshaft - supports, bolting, and gears	02-350C	5.24	[S] Suggest a redesign to eliminate use of cotter pins
Idler ger assembly	02-355B	5.26	[S] Suggest a redesign to eliminate use of cotter pins
Intake and exhaust valve	02-360B	5.27	[R] Valves should be replaced if they show evidence of flaking and loss of chrome plating
Air intake manifold	02-375	5.33	[R] Further incidence of cracking should be investigated thoroughly
Intake/intermediate and exhaust rocker shaft assemblies	02-390A/B	5.36	[S] Inspect rocker boxes at the rocker shaft bolt at refueling outages
Intercooler pipe - couplings	02-436A/B	5.39	[R] In the event of a seismic event exceeding the Site Seismic Event limit, the couplings should be inspected and evaluated.
Miscellaneous equipment - jacket water standpipe heater	02-810E	5.67	[S] Record jacket water temperatures daily and trend monthly excursions above the set point
Oil prelube filter	02-820E	5.71	[S] Maintain records and trend dp versus time

(a) PNL recommendations [R] should be addressed by TUGCO as modification to their M/S plan. The suggestions [S] are deemed less important and are provided only for completeness.

repaired/reworked components. In all cases, the records reviewed were found to be traceable and in order. The procedures for dispositioning nonconformance findings were found to be acceptable.

As previously stated, PNL's conclusions regarding the initial CPSES M/S program (Appendix II of the DR/QR) were documented in PNL-5234, Review and Evaluation of Transamerica Delaval, Inc., Diesel Engine Reliability and Operability - Comanche Peak Steam Electric Station Unit 1 (September 1984). PNL found that TUGCO has satisfactorily incorporated those PNL maintenance recommendations into their current M/S plan. The final PNL recommendations for the Phase I components that are provided in the Perry Nuclear Power Plant hearings (see p. 3.4) have not been adopted by TUGCO. Further, the engine operating and standby surveillance items identified in PNL-5234 have not yet been adequately addressed. PNL recommends that TUGCO adopt the PNL final Phase I component M/S items and the PNL-identified engine operating and standby surveillance items provided in the Perry hearings and in PNL-5234, respectively.

The review of the final OG/TUGCO M/S plan also identified a few modifications as noted in Table 4.1. PNL recommends that those identified as recommendations be implemented by TUGCO into the M/S plan prior to completion of the first refueling outage. In an attachment to TXX-4501 dated June 27, 1985, TUGCO identified a number of modifications and/or clarifications to the OG-recommended maintenance and surveillance activities. PNL consultants have reviewed these clarifications and modifications and concur with them, contingent on concurrence by the OG and TDI.

5.0 COMPONENT REVIEW

As part of PNL's assessment of the adequacy of the OG DR/QR report for CPSES, PNL evaluators selected 80 of the engine components considered by the OG and then reviewed the OG data on these components. The PNL review sought to determine whether the OG had analyzed these components adequately with respect to both design and quality assurance considerations. The findings of this review could then be used as a basis for inferring the adequacy of OG analyses of the other components addressed in the DR/QR effort.

This section presents a review of this aspect of the PNL evaluation. The section comprises 80 subsections with headings corresponding to the components for which the OG documentation was reviewed. Appearing first are the Owners' Group results and conclusions drawn from their review of:

- component design adequacy (as determined by independent calculations; independent review of the adequacy, appropriateness, or correctness of the existing design basis; or the results from testing)
- results of the quality revalidation (consisting of their review of existing records pertaining to component quality, and inspection results, findings, and dispositions)
- analysis of the component service history (as recorded in the Emergency Diesel Generator Component Tracking System, the Owners' Group database).

In documenting the OG results and conclusions, PNL generally summarized sections directly from the OG DR/QR report. This information is followed by PNL's evaluation of the OG analysis and conclusions for each component. Additional requirements, comments, or other items noted by PNL during the component review are included where appropriate. The maintenance and surveillance plan for the component was often an important consideration in PNL's evaluation of component long-term serviceability. Of similar importance was TUGCO's general commitment to implement all OG recommendations provided in the DR/QR and those resulting from NRC review of the OG plan. This commitment was provided in the July 1985

meeting among TUGCO, the OG, NRC, and PNL. TUGCO agreed to provide NRC with a full rationale for exceptions to the general commitment, should there be any.

5.1 GENERATOR (Part No. CP-101A)

5.1.1 OG Analysis

DR/QR Objective

The objective was to verify the adequacy of the generator design to supply all safety-related loads in the event of loss of offsite power during a loss-of-coolant accident (LOCA) and to supply the normal safe shutdown loads.

Results and Conclusions

Each CPSES generator has a continuous rating of 7000 kW. The maximum coincident demand on the diesel generators (7019 kW on Train A and 6686 kW on Train B) will be during a blackout condition. Thus, the rating of each diesel generator is adequate to meet the maximum demand.

Based upon the calculations and results of the qualification and preoperational tests, the generator performance is acceptable with regard to the specified minimum voltage (80% of rated voltage).

Results of qualification tests were reviewed. The results of the generator onsite test and calculations indicate that these components are adequately designed to perform their intended function at Comanche Peak.

Comanche Peak, nuclear, and non-nuclear industry experience on file in the Emergency Diesel Generator Component Tracking System (EDGCTS) was reviewed. The results of the review indicated no problems that would affect the conclusions of this report.

Quality Revalidation results, consisting of a satisfactory EDGCTS document review, were considered in formulating the OG DR/QR review conclusions.

Based on the above review, the OG concluded that the generators are acceptable for their intended design function at Comanche Peak.

5.1.2 PNL's Evaluation

PNL concludes that the OG adequately analyzed the generators. Considering the satisfactory service record of the Portec Inc. generators, as well as the TUGCO commitment to perform monthly operational checks of brushes, sliprings, and space heaters and servicing at each refueling outage, PNL concurs with the OG conclusions that they are acceptable for their intended function at Comanche Peak.

5.2 GENERATOR CONTROLS (Part No. CP-102)

5.2.1 OG Analysis

DR/QR Objective

The objective of the review was to verify the adequacy of the design and construction of the static exciter to provide field current for the generator and to regulate the voltage of the 6.9-kV emergency bus.

Results and Conclusions

The EDGCTS does not list any failure incidents at Comanche Peak. The CPSES equipment has been recently installed; hence, the running experience is limited. Other nuclear and non-nuclear industry experience indicates 69 incidents involving the generator controls. Seventeen of these were failures of the following subcomponents: diodes of the bridge rectifier assembly and the diverter silicon controlled rectifiers (SCRs); the voltage regulator; the field flashing circuit; and the motor-driven potentiometer. The remaining 52 incidents are random failures and do not present any pattern indicating design problems.

Design review calculations made for the above four subcomponents reveal the following:

- The diodes and the SCRs are adequately rated to conduct the maximum continuous and surge currents if there is free air convection in the exciter cabinet. Recommendations for temperature monitoring are included in Attachment 1 [of the DR/QR report].
- The power rating of one 500-ohm/25-W resistor in the motor-driven potentiometer circuit is marginally adequate. Failure of this

resistor will incapacitate the motor-driven potentiometer. However, the motor-driven potentiometer is not called upon to operate when the diesel generator is supplying the safety-related loads during either the design basis accident (DBA) or the blackout conditions. It is required to operate during periodic testing of the diesel generator. Therefore, replacement of the resistor is not mandatory since the component does not perform a safety-related function. However, reliability may be enhanced by replacing the resistor as discussed in Attachment 2 [of the DR/QR report].

- The field flashing relay marked FF is inadequately rated. Failure of the relay to close would make the diesel generator unavailable to supply the safety-related loads. It is recommended that this relay be replaced by an appropriately rated relay. Detailed recommendations are given in Attachment 1 [of the DR/QR report].

Qualitative evaluation of the design of the voltage regulator shows that, although this subcomponent can perform its intended function, several desirable features that ensure high reliability and performance have not been incorporated in the design. Detailed recommendations to incorporate these features are made in Attachment 3 [of the DR/QR report]. At Comanche Peak a spare voltage regulator is switched in automatically when the original voltage regulator fails. Therefore, redesign of the voltage regulator, although desirable, is not mandatory.

Inspection of the subcomponents reviewed in this report revealed the following construction and mounting inadequacies:

- The diodes of the bridge rectifier assembly are mounted on the heat sinks by tapped holes, contrary to the manufacturer's recommendations. (In fact, two leading manufacturers specifically do not recommend mounting by tapped holes).
- The exciter cabinets are inadequately ventilated.
- Power cables are terminated with up to five lugs on one stud, contrary to good engineering practice.

These deficiencies do not currently endanger the diodes. However, for continued safe operation, these deficiencies must be remedied to ensure proper thermal and electrical contact with the heat sinks, to prevent loosening of the diodes due to vibrations, and to ensure proper contact at all cable terminations. Remedial measures are recommended in the form of maintenance and modification procedures as detailed in Attachment 1 [to the DR/QR], and design and construction modifications as detailed in Attachment 2 [to the DR/QR].

The recommendations of Attachment 1 may be implemented without significant modification of the existing equipment. These recommendations will enable monitoring of the diodes and the heat sinks. The recommendations of Attachment 2 involve remounting of the diodes, installing cooling fans in the exciter cabinet and redesign of the cable terminations. These recommendations may be implemented at the first refueling outage of the plant at the discretion of TUGCO.

Recommendations to remedy the design and construction deficiencies are organized as follows:

- Attachment 1 - The recommendations are to be implemented as soon as possible to enable monitoring the diodes, the heat sinks, and the voltage regulator.
- Attachment 2 - The recommendations are to be implemented at the first refueling outage of the plant or at the discretion of TUGCO, to alleviate the need for the additional maintenance procedures of Attachment 1.
- Attachment 3 - The recommendations are to be implemented at the discretion of TUGCO, to enhance the long-term reliability and performance of the voltage regulator.

Other incidents of failures reported in the EDG Component Tracking System not involving the four subcomponents considered in this report were reviewed. It was found that the failures were not of generic nature and do not impact the conclusions of this report.

Based upon the above review, the OG concluded that the generator controls are adequate for their intended use at Comanche Peak if all the recommendations

of Attachment 1 of the DR/QR report are adopted. The recommendations of Attachment 2 of the DR/QR report may be implemented at the discretion of TUGCO so that the recommendations of Attachment 1 are no longer necessary. Recommendations of Attachment 3 of the DR/QR report may be implemented at the discretion of TUGCO to improve the long-term reliability of the component.

5.2.2 PNL's Evaluation

Discussions were held with TUGCO regarding questions raised by PNL reviewers on the DR/QR for the generator controls. Notes on the PNL concerns and their resolution follow.

PNL reviewers noted that the OG reviewed only four of the generator control elements in depth. PNL considers other elements to be significant to the operation. However, the reviewers note that the monthly inspection of the bridge rectifier assembly temperature, the adjustment potentiometer for secure attachment and the printed circuit board for cleanliness and proper mounting, along with the maintenance items to be done at each outage relating to panel cleanliness, loose wiring, wire insulation degradation, relay contact condition, and meter calibrations, will be adequate to identify any problems before operational failures occur.

PNL questioned whether transient or sustained overvoltage due to out-of-phase paralleling could be a cause of failures noted in the EDGCTS. It was learned that the voltage ratings of the diodes and SCRs were verified to be adequate. Furthermore, the suspected root cause, namely out-of-phase paralleling, occurs only during testing operations tied to the grid. Protection is provided by a transient suppressor rated at 740 volts. Moreover, if overvoltages occur, a damage assessment would be done and repairs undertaken as needed. From this discussion, PNL concluded that the generator readiness is not compromised by potential overvoltage.

PNL questioned the effectiveness of the temperature monitoring of diodes and SCRs; monitoring does not preclude overheating. It was learned that heat run tests were conducted by TUGCO under high ambient conditions and full generator load. The absence of failures under these extreme conditions is evidence that operating temperatures are within acceptable limits. In

addition, temperature monitoring will be continued to detect the onset of any problems such as elements loosening.

In response to questions on ensuring the tightness of electrical connections, TUGCO agreed that trend analysis from frequent monitoring of the glyptol at its junctions would provide adequate, timely information. This approach is acceptable to PNL.

PNL reviewers were concerned that TUGCO recommendations for power supply bypassing and for a current feedback signal were not substantiated. TUGCO explained that the purpose of the bypassing was to reduce the effects of electrical noise, and the current feedback was to reduce its sensitivity of the gain and damping adjustments. The generator exciter is of the vector summing type. PNL reviewers know this excitation concept is inherently highly responsive and stable. In view of the inherent qualities of the exciters, the TUGCO improvements will not affect the reliability/operability of these elements.

At the request of PNL reviewers, TUGCO provided further information about their resolution of the EDGCTS incident reports. Regarding fuse holder failure, the fuse holders at Comanche Peak are of different designs from those that failed. One fuse holder failure at this plant was resolved by changing to a different type of holder. The relay failures at Arkansas NUC Unit 1 and Brunswick Unit 2 were discounted by TUGCO because there was no relevance to the generator controls. TUGCO also explained that relays are the responsibility of a dedicated plant department that continuously evaluates all relay performance and failure histories.

On the bases of TUGCO's concurrence with the OG recommendations, and considering the other information supplied by TUGCO, including the extensive maintenance and surveillance cited above, PNL concludes that the generator controls are adequate to perform their intended functions.

5.3 INTERCOOLER (Part No. F-068)

5.3.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the intercooler for its design and operational adequacy to cool intake air after it becomes compressed and heated by the turbocharger.

Results and Conclusions

A review of intercooler operating experience was conducted via the EDGCTS. Comanche Peak has documented no adverse experience with this component. The only nuclear industry experience problem was a result of abnormal engine vibration causing excessive turbocharger vibration resulting in the intercooler cracking. Most of the non-nuclear industry experience was due to problems with the system and not with the intercooler design.

Structural integrity of the intercooler and supports, bolt loadings, and nozzle loads has been evaluated and found acceptable.

To augment the TDI maintenance manual, the following maintenance recommendations should be incorporated into Comanche Peak maintenance procedures:

- The intercooler should be inspected every month for external leaks.
- The intercooler should be disassembled as necessary and cleaned at every refueling outage.
- The drain connection on the intercooler inlet plenum should be verified open and cleaned daily.

The gasket material on the water side is neoprene, and the gasket material on the air side is asbestos. In its intended use, the material is consistent with industry practice.

Because the Comanche Peak diesel has been operated during startup testing, and the intercoolers exhibited no abnormal vibrations or temperature differentials, the thermal and fluid characteristics of the intercooler are considered acceptable.

Quality Revalidation results were reviewed and considered in the performance of the OG DR/QR review. This consisted of a review of the EDGCTS site experience documents.

Based on the above review, the OG concluded that the intercooler is acceptable for its intended design function at Comanche Peak.

5.3.2 PNL's Evaluation

PNL notes that the heat rejection capacity of the intercooler was not specifically addressed by the OG; however, the EDGCTS does not suggest this is a problem. Considering the favorable operating history and the commitment by TUGCO to the OG-recommended maintenance and surveillance, PNL concurs with the OG conclusion regarding the intercoolers' acceptability.

PNL notes that, in a letter dated December 17, 1984, TUGCO has requested that the OG-recommended frequency for cleaning/inspecting the shell side of the intercooler be changed from each outage to every 5 years. Pending confirmation that this change is acceptable to the OG and to TDI, PNL concurs.

Surveillance Suggestion

PNL suggests that TUGCO monitor air temperatures and air- and water-side pressure losses across the cooler as part of a trend analysis program, to minimize disassembly and cleaning activities.

5.4 LUBE OIL PRESSURE REGULATING VALVE (Part No. 00-420)

5.4.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the lube oil pressure regulating valve for its design adequacy to maintain the engine lube oil header pressure and to act as a relief valve when there is a blockage downstream of the lube oil pump.

Results and Conclusions

The valve in use at CPSES is identical to that in use at Shoreham. It is constructed of carbon steel and cast iron, which are suitable materials for

lube oil service. The valve setpoint is acceptable, based on reviews of the engine factory test logs and the system operating conditions.

Currently there are no maintenance requirements for the lube oil pressure regulating valve. However, to reduce the possibility of valve plugging, it is recommended that it be disassembled and cleaned annually or at each refueling outage. If valve plugging does become a problem, it is further recommended that the dimensions of the valves' internal parts be checked to ensure proper clearance and that the frequency of disassembly and cleaning be increased.

The review of the Comanche Peak and industry experience revealed no relevant problems with the valve.

Quality Revalidation results, consisting of a review of the component document package and a visual inspection to determine dimensions and clearances, were reviewed and considered in the performance of the OG DR/QR review. Even though the inspections were not performed based on the above maintenance recommendations, they are not necessary at this time.

The OG concluded that the lube oil regulating valve is acceptable for its intended design function at Comanche Peak.

5.4.2 PNL's Evaluation

From the data presented in the DR/QR report, PNL cannot conclude that a complete analysis was performed on this component. Page B3 under Component Review indicates that inspection reports were not received. Nevertheless, the QR effort was considered complete. PNL discussed this apparent conflict with TUGCO at the Phase II component review meeting in July 1985. TUGCO reported that 1) there are no reported incidents of TDI related failures due to valve design, 2) the valve is identical to the Shoreham Nuclear Power Station valve, which was found adequate, 3) the valve has had successful continuous operation, and 4) TUGCO has agreed to periodically disassemble and clean the valve. Considering these factors, PNL concludes that the lube oil pressure regulating valve is acceptable for its intended service. PNL noted and agrees with TUGCO's change in maintenance (disassemble and clean) to be done at alternate outages rather than at each outage as recommended by the OG, provided that this change is confirmed to be acceptable to the OG and to TDI.

5.5 STARTING AIR DISTRIBUTOR ASSEMBLY (Part No. 00-442A)

5.5.1 OG Analysis

DR/QR Objective

The objective of this review was to evaluate the adequacy of the starting air distributor (STAD) to provide a sequentially timed pilot air signal to the air start valves.

Results and Conclusions

The V-16 engines at Comanche Peak have a single row STAD connected to each bank of eight cylinders to ensure reliable operation. A supply of oil is provided to the cam and to spool valve contacts. The observed wear rates were within an acceptable range and did not indicate a probable loss of timing control within the expected service life at Comanche Peak.

A review of the TDI Maintenance Manual indicates no specific recommendations regarding possible wear of the poppet valve and cam. It is recommended that an inspection of the poppet valves and cam be conducted during refueling outages, to assess the degree of wear.

It is recommended that Comanche Peak maintain surveillance inspection to ensure that the starting air manifold vent remains open and effective.

The ability of the pilot air port to allow passage of possible airborne particles is satisfactory.

The timing shaft, spool valves, and springs are of appropriate materials and configurations for their functions.

Quality Revalidation results were reviewed and considered in the performance of the design review. This included a visual inspection and a dimensional check of poppets. No EDGCTS site experience documents were in evidence.

Based on the above review and implementation of inspection recommendations, the OG concluded that the starting air distributor is acceptable for its intended use at Comanche Peak.

5.5.2 PNL's Evaluation

PNL concludes that the DR and QR review performed by the OG was adequate. Considering this and the TUGCO commitment to monthly surveillance and inspection of the assembly for wear at each outage, PNL concurs with the OG conclusion that the starting air distributor is acceptable for its intended function.

5.6 FUEL OIL DRIP TANK (Part No. 00-621A)

5.6.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the structural integrity of the fuel oil drip tank assembly in the presence of normal operating and seismic loads.

Results and Conclusions

Calculations showed that the tank shell stresses are well below allowables, and the tank shell has adequate structural integrity for its intended design purpose. Calculation of the stress in the bolts, mounting plates, and gussets showed that these elements of the fuel oil drip tank are well within the allowable stress limits and are therefore also adequate for their design function.

Quality Revalidation results (no EDGCTS site or other nuclear or non-nuclear experience documents in evidence) were considered in the performance of the OG DR/QR review.

Based on the above review, the OG concluded that the fuel oil drip tanks are adequate for their intended use at Comanche Peak.

5.6.2 PNL's Evaluation

Based on information contained in the DR/QR report, PNL concludes that the OG performed an adequate analysis. On this basis, PNL concurs with the OG conclusion that the subject tanks installed at Comanche Peak are adequate for the intended use of collecting fuel oil leakage so it can be pumped back into the day tank.

5.7 TURBOCHARGER THRUST BEARING LUBE SYSTEM (Part No. 02-CFR)

5.7.1 OG Analysis

DR/QR Objective

The objective of this review was to perform an engineering evaluation of the tubing and supports to ensure that the component will perform its intended design function of providing lube oil to the turbocharger thrust bearing prior to engine startup.

Results and Conclusions

The tubing and supports, as defined by this Component Design Review, have been evaluated and found acceptable with modification.

The Quality Revalidation results (a satisfactory EDGCTS documentation package) were considered in the performance of the OG DR/QR review.

Based on the above review, the OG concluded that the tubing and supports will perform their intended design function at Comanche Peak under all normal operating and earthquake loadings, with the provision that two-way supports be added to this lube oil line such that the spans between supports are limited to a maximum of 4 feet 6 inches. Locations of supports should allow for thermal expansion by providing a minimum of a 6-inch offset around elbows.

5.7.2 PNL's Evaluation

PNL concludes an adequate analysis was performed on the subject component. PNL learned at the TUGCO/NRC meeting held in July 1985 that TUGCO has committed to implementing the OG support modifications. Based on these considerations, PNL concurs with the OG conclusions regarding the adequacy of the turbocharger thrust bearing lube system.

5.8 CRANKSHAFT BEARING SHELLS (Part No. 02-310B)

5.8.1 OG Analysis

DR/QR Objective

The objective of this review was to verify that the main bearing shells have sufficient strength, fatigue resistance, and life to support the dynamic loads of the crankshaft while providing a low friction/load supporting interface between the journal and the support base.

Results and Conclusions

Review of Comanche Peak and other nuclear experiences listed in the EDG Component Tracking System shows that no design-related problems have been reported with the main bearing shells.

A review of non-nuclear experiences shows that the M/V Columbia experienced significant bearing wear at 12,000 hours, but this is attributed to inadequate lube oil quality and the thin oil film experienced by some of the bearings. The other problems reported in the EDGCTS also are due to abnormal operating conditions, i.e., loss of lubrication and contaminated oil, and the lack of embedability of the main bearing shell backing.

The minimum oil film thickness calculated in the journal orbit analysis is 147 microinches, which is less than the industry standard of 260 microinches. Possible early wear due to insufficient oil film thickness and contaminative particles passing through the 10-micron oil filter will be adequately monitored at Comanche Peak with the TDI-recommended inspections at every other refueling outage.

The peak oil film pressure was calculated to be 29 ksi due to a 178,000 lbf load (unit loading of 2596 psi). An industry recommendation for the type of material used in the main bearings is 26 kpsi, if no misalignment is present. To include an additional margin of safety for misalignment, the recommended peak oil film pressure is lowered by 30% to 18 kpsi. Because the industry recommendation for peak oil film pressure is exceeded, a more detailed analysis using the finite element method ANSYS was employed.

The maximum equivalent stress (distortion energy theory of failure) resulting from the finite element analysis, which included loadings resulting from the initial interference fit, the additional interference due to a 100°F temperature rise, and the oil film load peaking at 29 kpsi was 13.4 kpsi, which is less than the material yield strength of 16.6 kpsi. Bearing inspection is recommended at the first fuel outage. If evidence of harmful misalignment is disclosed, corrective alignment procedures should be implemented.

After a review of the bearing shell material properties and operating environment and parameters, it has been concluded that the bearing material is acceptable for its intended application.

The TDI inspection schedule and alignment requirements have been reviewed. The bearing inspection schedule is adequate to address normal bearing wear. The alignment procedure, performed to TDI specifications and schedule, is suitable to prevent bearing performance problems.

The information contained in TER 10-070 (a TUGCO technical evaluation report) is not entirely consistent with this report (the OG final DR/QR). Items labeled MEE-027, 029, and 041 in the TER allow for the use of new bearing shells that are outside the TDI tolerance range for main bearing shell thickness when new. The TDI inspection and maintenance procedures for main bearing shells should be followed, i.e., any new shells should be within TDI's tolerance range. This recommendation is based on an analysis that shows that thin bearing shells cause increased oil film pressures that could lead to bearing failures. The bearings of major concern are the main bearings No. 3, 5, and 7. An additional discrepancy in this TER concerns the main bearing upper placement shell No. 10 for the Train B engine. This bearing is 0.003 inch over the TDI specified thickness; however, the clearance for the bearing is still within the TDI recommended clearance range and is not considered detrimental to engine operation.

Quality Revalidation results, consisting of 1) a review of EDGCTS documents, 2) a dimensional check on all bearing shells, and 3) a visual inspection on all shells, were considered in the OG DR/QR review.

Based upon the above review, the OG concluded that the main bearing shells are acceptable for their intended use at Comanche Peak.

5.8.2 PNL's Evaluation

At the NRC/TUGCO/PNL meeting in July 1985, in response to questions, PNL was provided with the following information supplementary to the DR/QR report:

- The effect of crush on radial clearance, side location, 360-degree grooving, and oil supply were considered and found to conform with accepted practice.
- The analysis of crankshaft main bearing shells also considered the effects on bearing performance of particles that pass the 10-micron oil filter, and which are larger than the minimum oil film thickness (Reference 1 of the DR/QR report). The babbitt layer has sufficient thickness and embedability to allow such particles to pass between the journal and the bearing or to be rendered harmless by embedment in the babbitt layer. The recommended inspections at alternate fuel outages will disclose any harmful wear that could adversely affect bearing performance and reliability.
- The QR report and TER 10-029, together with NRC 84-0080, were reviewed to evaluate the results of hardware inspections that were performed. The unsatisfactory results reported were due to scratches disclosed in the visual inspection. These scratches were attributed to foreign particles in the engine that passed through the bearings before they were trapped in the lube oil filter.
- Failure Analysis Associates (FaAA) has reviewed the OG discrepancies noted regarding TUGCO's use of bearings that are out of tolerance. Their review is provided in a report by W. Meacham, ST-84-6-11(b), dated June 11, 1984. PNL has not received this report but learned in telephone discussions with TUGCO licensing staff that FaAA approved all main bearings now in use at Comanche Peak. The FaAA report is being forwarded to NRC.

On the basis of 1) the supplemental information supplied by TUGCO, 2) the acceptable operating experience to date, 3) the replacement of bearings done

by TUGCO in response to unacceptable visual or dimensional inspections, and 4) TUGCO's commitment to the OG-recommended M/S procedures cited above, and assuming a satisfactory review by NRC of confirmatory information on FaAA analysis of main bearing shells, PNL concurs that the crankshaft bearing shells are acceptable for their intended use.

5.9 CRANKSHAFT THRUST BEARING RINGS (Part No. 02-310C)

5.9.1 OG Analysis

DR/QR Objective

The objective of this design review was to evaluate the adequacy of the structural strength and load-bearing surface area of the thrust bearing rings to provide a reaction force to the thrust (axial) loads and to permit rotation of the crankshaft adjacent to the stationary bearing ring.

Results and Conclusions

The axial loads on the thrust bearing ring are due to the axial component of the force on the crankshaft from the gear train; the axial load due to an axial misalignment of mechanical and electrical centers; and the axial load due to rotor, crankshaft, flywheel, connecting rods, and piston weights when the engine is not perfectly level.

The bearing pressure and relative velocity (resulting from the axial loads) are well within the range of full film lubrication. However, at peak load portions of the cycle, the resultant film thickness is close to the minimum recommended film thickness. Under full engine load conditions, the bearing may operate in mixed film lubrication during the peak portions of the cycle, and some wear may occur.

The bearing clearance at installation is 0.022 to 0.033 inch. The instruction manual recommends that at least one bearing be replaced if the clearance exceeds 0.040 inch. Measurement of the bearing clearance at each refueling outage is recommended to ensure that the clearance is within tolerance. In addition, it is recommended that the thrust bearing rings be examined visually for cracks and gouges at alternate refueling outages. The thrust bearing rings may also be subject to wear during startup and shutdown.

Prelubrication is recommended prior to normal engine startup, to minimize wear and prevent gouging during startup.

The EDGCTS reports six instances in which thrust bearing rings were replaced. None of these was on TDI engines. In one case, a thrust bearing ring at Comanche Peak was found to have excessive clearance; this was due to shipping damage and is not associated with normal engine operation.

Quality Revalidation results, consisting of a satisfactory EDGCTS site experience document review, were considered in the OG DR/QR review.

Based on this review and on the recommended inspection schedule and procedure, the OG concluded that the thrust bearing rings are acceptable for use at Comanche Peak.

5.9.2 PNL's Evaluation

Based on the information provided, PNL concludes that the OG has adequately analyzed the thrust bearing rings and that the inspection findings were adequately dispositioned. TUGCO has committed to the OG-recommended M/S plan, except that visual inspections are planned at 5-year intervals rather than at alternate outages. Because bump checks of bearing ring clearance to determine wear are performed at each outage, PNL concurs with this modification; OG and TDI concurrences are pending. On these bases, PNL concurs with the OG conclusion that the crankshaft thrust bearing rings are acceptable for use at Comanche Peak.

5.10 CRANKCASE ASSEMBLY (Part No. C2-311A)

5.10.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the structural adequacy of the crankcase to transmit loads from the cylinder block to the engine base.

Results and Conclusions

The operating history of Catawba and Grand Gulf sites has been reviewed and no occurrences of crankcase failures found.

Two crankcase failures have been identified. Each crankcase reportedly cracked near the top of the nut pocket area for the crankcase to base attachment hardware and the central arch. There is insufficient information in the reference document to determine the exact cause of failure. However, there is a strong belief that the crankcase arches were machined near the nut pocket, causing stress concentrations that ultimately caused the failures. Crankcase machining may have been performed to facilitate the assembly of the crankshaft and bearings. TDI recommends that any crankcases with evidence of machining with sharp corners in the arch wall/nut pocket area be machined with a large radius tool to provide a smooth transition zone in the arch wall area. The inspections of the Comanche Peak crankcase revealed that the crankcase arch walls were not machined and are therefore acceptable.

The casting test specimens taken of the Comanche Peak crankcase material have ultimate strengths of 36.5 ksi and 37.4 ksi. These values are less than the specified value (40,000 psi) for ASTM A48 Class 40 gray cast iron material. However, this is only slightly substandard; based on strain gage test data taken by TDI, the crankcase has adequate strength to resist failure.

Although only two crankcase failures have been reported, there is some uncertainty as to the caus f the failures. It is recommended that the Comanche Peak crankcase be visually inspected at each outage for indications of cracking from the vertical portion of the crankcase arch wall to the nut pocket area.

The following Quality Revalidation inspection results were considered in the OG DR/QR review: 1) a review of EDGCTS site experience documents, 2) the verification of crankcase material, and 3) visual inspection of crankcases with unsatisfactory results (Train A). This latter result was dispositioned via a nonconformance report.

Based on the above review, the OG concluded that the crankcase is acceptable for its intended function at Comanche Peak.

5.10.2 PNL's Evaluation

Based on the information provided, PNL concludes that the OG analysis and the inspection findings were adequate. TUGCO has committed to the

OG-recommended M/S identified above. On these bases, PNL concurs with the OG conclusion that the crankcase is acceptable for its intended function.

5.11 CRANKCASE MOUNTING HARDWARE (Part No. 02-311D)

5.11.1 OG Analysis

DR/QR Objective

The objective of this review was to evaluate the ability of the bolting to withstand the preload and firing loads and to transmit the firing forces from the upper engine to the base assembly.

Results and Conclusions

The conservative analytical modeling of the bolting found that the bolt is the critical element in the fastener system. Results indicate that neither yielding nor fatigue failure of the bolts will occur under engine loading. The preload is adequate for the intended design function.

Quality Revalidation results of no EDGCTS site experience documents in evidence were considered in the OG DR/QR review.

The OG concluded that the crankcase-to-base bolts are acceptable for their intended use at Comanche Peak.

5.11.2 PNL Evaluation

On the bases of the analyses conducted and the good service history of the component, PNL concurs with the OG analysis and conclusions pertaining to the crankcase mounting hardware.

5.12 JACKET WATER MANIFOLD AND PIPING (Part No. 02-315D)

5.12.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the piping components to carry water from the jacket water supply line to the engine inlet during normal operating and earthquake loadings.

Results and Conclusions

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

All pipe loads on the engine were tabulated and evaluated.

The following Quality Revalidation Inspection results were considered in the OG DR/QR review: 1) review of EDGCTS site experience documents, 2) a line walkdown, and 3) field inspections and material comparator tests performed on welds and piping.

The OG concluded that the subject piping components are adequate for the intended design function at Comanche Peak.

5.12.2 PNL's Evaluation

On the bases of the information provided in the DR/QR report, PNL concurs with the OG conclusions on the subject components.

5.13 CYLINDER LINERS AND WATER MANIFOLD: SEALS AND GASKETS (Part No. 02-315G)

5.13.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the suitability of E-60c Viton and Litharge cured E-60c Viton sealing materials for lube oil, fuel oil, and jacket water systems.

Results and Conclusions

TDI Service Information Memo (SIM) No. 315 advises customers that TDI has converted all major engine elastomeric sealing pieces from the Buna N/ethylene propylene/silicone materials to cured E-60c Viton seals. The major engine seals replaced on the DSRV-16-4 engines are shown on SIM 315.

The cylinder liner seals are in contact with Calgon CS inhibited jacket water. During engine operation the jacket water pressure ranges from 15 to 20 psi and has a temperature range of 170°F to 180°F. The cylinder liner seals

also encounter engine lube oil, fuel oil, and starting air, all within the same temperature range as the jacket water or below.

A review of Comanche Peak experience shows that no problems due to degraded or worn cylinder liner seals have occurred. This is indication of the suitability of the specified seal material for its intended service.

A review of industry experience was conducted via the EDGCTS. Engine shutdowns and trips have been attributed to water leaking into lube oil systems or engine cylinders caused by seal or O-ring failures. These failures are not applicable to Comanche Peak as all seal and O-ring materials utilized on Comanche Peak's engines have been verified by this review as compatible for the intended service.

Viton is acceptable for continuous use at temperatures up to 400°F. It is also compatible with lube oil, fuel oil, and Calgon CS inhibited jacket water. Therefore, it is concluded that Viton seals for major engine sealing tasks on the DSRV-16-4 engines at Comanche Peak are acceptable.

Quality Revalidation results (no EDGCTS site experience documentation in evidence and verification of proper cylinder O-rings) were considered in the OG DR/QR review.

Based on the above review, the OG concluded that the cylinder block liner seals are acceptable for their intended design function at Comanche Peak.

5.13.2 PNL's Evaluation

On the basis of the information provided in the DR/QR report, PNL concurs with the OG conclusion that the subject components are acceptable for their intended design functions.

5.14 JACKET WATER INLET MANIFOLD: VENT LINE TO DISCHARGE MANIFOLD (Part No. 02-316C)

5.14.1 OG Analysis

DR/QR Objective

The objective of this review was to evaluate the tubing and supports to provide assurance that the component will provide continuous venting of the jacket water inlet manifold during normal operating and earthquake loadings.

Results and Conclusions

The tubing and supports, as defined by this Component Design Review, have been evaluated and have been found acceptable with modification.

The Quality Revalidation results considered in the DR/QR review consisted of no EDGCTS site experience documentation in evidence and the availability of qualified as-built drawings.

The OG concluded that the tubing and supports will perform their intended design function at Comanche Peak under all normal operating and earthquake loadings, with the provision that the following recommended modification be implemented:

> For support TS-1001A-10161 the horizontal Unistrut member requires a moment type connection at the attachment to C5X9 to accept cyclic horizontal loads.

5.14.2 PNL's Evaluation

PNL reviewed the information in the OG DR/QR report and obtained confirmation during the July 1985 meeting with TUGCO staff that 1) the OG-recommended modifications will be implemented and 2) the vent line is installed at the high point of the inlet manifold. On these bases, PNL concurs with the OG that the tubing and supports are acceptable for their intended use at Comanche Peak.

5.15 JACKET WATER DISCHARGE MANIFOLD, COUPLINGS, AND SEALS (large-bore scope only) (Part No. 02-317A&B)

5.15.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the subject piping components for normal operating and earthquake loadings.

Results and Conclusions

All pipe loads on the engine were tabulated and evaluated. All piping stresses were within the design allowables specified by the ASME Code Section III.

With respect to the Design Review Attributes regarding the Dresser coupling and seals, the couplings were evaluated 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. The Style 65 coupling gaskets are marginal with respect to manufacturer service condition limits. A slightly marginal gasket would develop a leak and the coupling would be replaced.

Support modifications are recommended in order to provide adequate restraint of the subject component. These modifications include increasing weld sizes on supports.

Quality Revalidation results (a satisfactory review of EDGCTS site experience documentation and verification of proper Dresser coupling) were considered in the DR/QR review.

The OG concluded that the subject piping components, with the implementation of the recommended coupling replacement procedure (i.e., replace Style 65 with Style 90 equipped with Viton gaskets when leaks are noted) and the support modifications, are adequate for their intended design function at Comanche Peak.

5.15.2 PNL's Evaluation

PNL concludes that the OG analysis is adequate. Noting that TUGCO has committed to the gasket replacement procedure and support modifications, PNL concurs with the OG findings that the subject couplings and seals are compatible with their intended design function.

5.16 WATER DISCHARGE MANIFOLD SUPPORTS (large-bore scope only) (Part No. 02-317C)

5.16.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the subject piping supports for normal operating and earthquake loadings.

Results and Conclusions

The supports for this component were reviewed and are acceptable with modification. The support modifications are recommended in order to accommodate total support loading. These modifications include increasing weld sizes on supports.

All pipe support loads on engine block and/or skid have been tabulated and evaluated.

Quality Revalidation results (no EDGCTS site experience documents in evidence, support installation inspection, and material comparator tests) were considered in the DR/QR review.

The OG concluded that the subject piping supports, modified, are adequate for their intended service at Comanche Peak.

5.16.2 PNL's Evaluation

PNL concludes that the OG analysis is adequate. Noting TUGCO's commitment to increase the weld sizes on the supports per the OG recommendations, PNL concurs with the OG's conclusion that this component is adequate for its intended function.

5.17 FLYWHEEL (Part No. 02-330A)

5.17.1 OG Analysis

DR/QR Objective

The objective of this review was to evaluate the adequacy of the flywheel to add rotating mass to the crankshaft system as needed to adjust the torsional vibration characteristics.

Results and Conclusions

A review of Comanche Peak site, nuclear, and non-nuclear industry experience listed in the Component Tracking System report indicates no history of any problems during operation.

For the RV-16 engine at Comanche Peak, the calculated value of the rotary inertia is 455.6 lb-s^2-ft, which is in close agreement with the value of 522.8 lb-s^2-ft used in the TDI crankshaft analysis, especially considering that the TDI value includes the rotary inertia of the crankshaft flange and shaft sections.

The maximum stresses in the flywheel at Comanche Peak, calculated at 15% overspeed, are less that 0.065 times the material yield strength.

The OG considered the flywheel acceptable for its intended design function at Comanche Peak.

5.17.2 PNL's Evaluation

PNL concludes that the Owners' Group adequately analyzed the subject component. PNL concurs with the OG conclusion that the flywheels at Comanche Peak are acceptable for their intended purpose.

5.18 FLYWHEEL BOLTING (Part No. 02-330B)

5.18.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the flywheel bolting to transmit engine torque to the generator.

Results and Conclusions

The peak torque transient for the Comanche Peak engine is 25 percent larger than that for the Shoreham engine, and the average torque to produce the required horsepower is twice Shoreham's. These differences are caused by the V configuration of the Comanche Peak engine and a different crankshaft design.

The following table summarizes bolting and coupling parameters.

	Shoreham	Comanche Peak	
Number of bolts:	6	12	
Bolt Circle Diameter:	20 in.	28 in.	
Bolt Diameter:	1-7/8 in.	2-1/2 in.	
Bolt Material:	AISI 4140	AISI 4140	
Bolt Torque:	3000 ft-lb	4500 ft-lb	
Bolt Preload Tension:	102 kips	115 kips	
Crankshaft Torques at the Flywheel Flange			
Peak Torque (FAA Analysis Including Transient)	210 ft-kips	260 ft-kips	4
Average Torque	55 ft-kips	100 ft-kips	4

Comanche Peak's bolts have been assembled in accordance with the TDI Manual, with flange faces lubricated with antiseize compound. Friction torque capacity of the Comanche Peak joint is equal to the peak torque transient for a friction coefficient of 0.17. If the antiseize compound produces a lower friction coefficient (f = 0.04 for the lubricant 'molykote'), the bolts with specified tightening torque are adequately sized to take the full torque transient in shear without fatigue problems. This conclusion is based on the results of the analysis with the conservative assumption that only one bolt will carry applied shear load from engine torque. Note that the bolts are fitted (0.0005-inch clearance).

Bending moments due to shaft misalignment have been assumed to be small, based on the fact that maintenance procedures routinely require realignment.

Quality Revalidation results, consisting of a review of EDGCTS documents and confirmation that bolt torques were measured, were considered.

Based on the above review, the OG concluded that the flywheel bolting is adequate for its intended use at Comanche Peak.

5.18.2 PNL's Evaluation

PNL concludes that an adequate analysis was performed on the subject components. PNL concurs with the OG conclusion that the flywheel bolting is adequate for its intended function at Comanche Peak.

5.19 FRONT GEARCASE: GASKET AND BOLTING (Part No. 02-335B)

5.19.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the front gearcase gasket and bolting. The material selection, assembly torque, and size of the bolts were to be verified as adequate for their design loads. The acceptability of the gasket also was to be verified.

Results and Conclusions

No industry experience for the front gearcase bolts and gasket was reported in the EDGCTS.

Conservatively derived loading did not produce bolt loads in excess of their preload. Based on satisfactory bolt pretension, the gasket performance is acceptable. There was sufficient margin in this evaluation such that gearcase cover flexibility is not expected to alter the conclusion of this review.

Quality Revalidation results, consisting of EDGCTS review findings (no evidence of site experience) and verification of proper bolting installation, were considered in the DR/QR review.

Based on the above review, the OG concluded that the front gearcase bolting and gasket are adequate for their intended use at Comanche Peak.

5.19.2 PNL's Evaluation

PNL reviewed the information presented in the DR/QR report and obtained TUGCO confirmation (during the July 1985 meeting) that external bolt torques had been verified and that internal bolt torques will be confirmed at the next

scheduled maintenance period. On these bases, PNL concurs with the OG conclusion that the front gearcase gasket and bolting are adequate for their intended use at Comanche Peak.

5.20 PISTON RINGS (Part No. 02-341B)

5.20.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the piston rings to seal the combustion chamber from the crankcase, to allow heat flow between piston and cylinder wall, and to control lube oil consumption and blowby.

Results and Conclusions

The design specifications for the MPR piston rings used on the Comanche Peak engines are typical of industry practice in conservatively rated, turbocharged and aftercooled, medium-speed diesel engines. They are, therefore, appropriate for their intended use at Comanche Peak. The MPR ring sets are identical to those in use at Shoreham, and the application conditions are very similar.

To ensure freedom from harmful scuffing, the cylinder liners should be inspected for liner wear and coke deposits at each fuel outage. Use of lube oil superior to Series 3, having high detergent properties and high thermal degradation resistance, will reduce coke buildup in ring grooves and reduce wear. A high detergency oil such as Mobilgard 412 is suggested. The inspections in conjunction with quality lube oil will verify that acceptable lubrication and wear are obtained on a continuing basis at Comanche Peak.

It is not possible to make a useful evaluation of piston ring wear until after 200 hours of operation. At the first fuel outage, if an evaluation of liner wear indicates the need for additional action to improve ring/liner lubrication and reduce coke buildup, the use of 135° fuel tips could be considered.

Quality Revalidation results were considered. These included a review of EDGCTS site experience documents and verification of proper ring installation.

Based on the above review, the OG considered the MPR piston rings to be adequate for their intended function at Comanche Peak.

5.20.2 PNL's Evaluation

PNL concurs that an adequate analysis and component quality confirmation were done by the OG on the subject components. Noting also TUGCO's commitment to the OG inspection and maintenance recommendations, PNL concurs with the latter's conclusion that the MPR piston rings are acceptable.

5.21 PISTON PIN ASSEMBLY (Part No. 02-341C)

5.21.1 OG Analysis

DR/QR Objective

The objective of this review was to evaluate the adequacy of the piston pin assembly to transmit the loads generated by cylinder firing pressures from the piston to the connecting rod.

Results and Conclusions

During Quality Revalidation Inspection activities for the piston pin assembly, all pins on the two engines were examined; no loose end plugs were found. Comanche Peak end plugs should be checked for looseness whenever the engines are sufficiently dismantled to allow inspection.

No problem with the snap ring-type pin retainer has been reported at Comanche Peak.

Examination of chrome plate damage on Comanche Peak pins (engine 76001) revealed a significant frequency of cracks, blisters, and areas of chromium chipping. These damaged areas are the result of manufacturing defects caused by inadequate cleaning and electroplating process control and/or abusive grinding of the chrome plate on the finished pins.

Liquid penetrant or magnetic particle inspection is recommended for all new or replacement pins. Because many of the pins in the Comanche Peak engines

have not been inspected by liquid penetrant or magnetic particle, it is recommended that all pins be visually inspected at such times that the engines are sufficiently dismantled to allow inspection.

Wrist pin structural analysis results indicate that the design is adequate for the piston firing pressure and inertial loads.

Quality Revalidation Inspection results were considered in the OG DR/QR review. These included 1) a review of the EDGCTS site documents with satisfactory results, 2) material comparator tests, 3) hardness test, 4) visual inspection of oil plug and wrist pins, and 5) a dimensional check on a spare wrist pin.

Based on the above review and recommendations, the OG concluded that the piston pin assembly is acceptable for its intended use at Comanche Peak.

5.21.2 PNL's Evaluation

PNL concludes that the analysis performed by the OG is appropriate and that the quality revalidation was adequate. Because a number of piston pins with inadequate chrome plating have been found on TDI engines and the DR/QR inspection indicated that only the Train B right-bank pins were inspected, the PNL reviewers recommended that TUGCO perform at least a visual inspection of all piston pin bearing areas as soon as possible. At the meeting between NRC/PNL and TUGCO, it was determined that all pins had been visually inspected. On these bases, and noting that TUGCO has committed to the OG-recommended maintenance plan, PNL concurs with the OG conclusion that the piston pins as installed at Comanche Peak are acceptable for their intended function.

5.22 INTAKE/EXHAUST AND FUEL TAPPET ASSEMBLY (Part No. 02-345A&B)

5.22.1 OG Analysis

DR/QR Objective

The objective of this review was to evaluate the adequacy of the intake, exhaust, and fuel tappets to transmit the rotation of the cams into vertical push rod motion via the cam follower rollers.

Results and Conclusions

Review of documentation on the roller failures of the Pride of Texas showed that the cams were misaligned such that the rollers were running at or over the edge of the cam. After these rollers were changed to the same hardness as the rollers at Comanche Peak, they operated without incident. There is no Comanche Peak or other nuclear plant experience with this problem. The Shoreham, Catawba, and Grand Gulf generator tappet rollers (which are of the same design as the Comanche Peak rollers) have rotated over 10^7 times with no incidence of failure. The specified heat treatment of the rollers at Comanche Peak is acceptable.

Analyses were performed that demonstrate the rollers have adequate strength and endurance to withstand the push rod loads to which they are subjected.

The manufacturing process used to create the interference fit between the roller pin and bushing is acceptable, based on analysis and service history.

As part of the routine maintenance for this component at the refueling outage, the tappet assemblies should be inspected to TDI inspection specifications.

Quality Revalidation results were considered in the OG DR/QR review. These consisted of 1) a review of EDGCTS site experience documents with no adverse findings and 2) verification of roller hardness.

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

5.22.2 PNL's Evaluation

Based on the information provided in the DR/QR report, PNL concludes that the OG design review and quality confirmation are adequate. Further, considering that TUGCO has committed to the OG-specified maintenance plan, PNL concurs with the OG that these assemblies are acceptable for their intended service.

5.23 CAMSHAFT (Part No. 02-350A)

5.23.1 OG Analysis

DR/QR Objective

The objective of this review was to evaluate the adequacy of the camshaft to convert the rotary motion of the timing gear to reciprocating motion transmitted to the cam follower, push rod, rocker arm, and valves.

Results and Conclusions

The dynamic analysis of the valve system indicated the peak contact forces on the lobes to be below the endurance limit stress on the lobe surface.

Visual inspection of all cam lobe surfaces for cracking, pitting, or spalling is required at each fuel outage. Identification of cam lobe surface distress as indicated above shall be followed by a detailed evaluation to determine the expected life remaining and reinspection/replacement interval.

A factor of safety against cam lobe slippage due to the applied torques was calculated to be 2.6 for both intake/exhaust fuel cams, indicating that the cam lobes will not rotate or slip on the shaft under normal operation and installation conditions.

The stress analysis of the camshaft confirmed that shear and bending stresses are within the material yield stress.

Evaluation of the torsional loading on the camshaft indicates a mean drive torque of approximately 1500 ft-lb acting on the camshaft gear. Taking into account torsional resonances, the combined shear and bending stresses are well within the material endurance limit.

Quality Revalidation Inspection results, consisting of a review of the status of the component document package, site experience review, and a visual examination of the cam lobes, were considered in this review.

Based on the above design review, and upon the implementation of the recommended inspections, the OG concluded that the camshaft assembly is acceptable for its intended design function at Comanche Peak.

5.23.2 PNL's Evaluation

PNL concludes that the analyses and inspections done by the OG were adequate. Based on the absence of relevant failures of this component, and noting TUGCO's commitment to inspections at each refueling outage, PNL concurs with the OG conclusion that the camshaft assembly is acceptable for its intended use.

5.24 CAMSHAFT: SUPPORTS, BOLTING, AND GEARS (Part No. 02-350C)

5.24.1 OG Analysis

DR/QR Objective

The objective of this design review was to evaluate the ability of the camshaft gear assembly to transmit torque from the idler gear to the camshaft and provide adequate service life under the steady-state and dynamic loads.

Results and Conclusions

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

The four bolts that connect the cam hub to the cam gear are adequate with respect to the preload generated by the initial torque. They do not, however, provide a clamping force sufficient to prevent slipping between the gear and hub. It is recommended that either of two actions be taken:

- the number of bolts, torqued at 70 + 20 ft-lbf, be increased from four to six - This is more consistent with the six bolts connecting the idler gear and hub, particularly because the torque imbalance on the cam gear (four bolts) is larger than on the idler gear (six bolts). The resulting factor of safety with respect to slipping is 1.26.
- the initial torque in the bolts which connect the cam gear to the cam hub be increased to 80(-0,+10) ft-lbf, providing a 1.0 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 1.0 for both slipping and bolt preload.

In addition, the above discussion is based upon the assumption that it is possible to line up the cotter pin with the hole in the bolt within the prescribed torque range. If the cam gear and hub are disassembled and reassembled, it is recommended that the nut be relocked at a position within the prescribed torque. Insertion of the cotter pin must be accomplished at a torque greater than 50 ft-lbf and less than 90 ft-lbf. If this is not possible, another bolt and/or washer should be used.

The overhanging portion of the camshaft is supported in part by a camshaft adapter and camshaft support. The outboard support is adequate to support the loads transferred across the overhang.

There are no Comanche Peak site, nuclear, or non-nuclear experiences associated with this component.

Based on the above review, the OG concluded that, with implementation of either recommendation to increase clamping force and incorporation of the nut locking procedures, the supports, gears, and bolts are acceptable for their intended use at Comanche Peak.

5.24.2 PNL's Evaluation

In PNL's opinion the OG conducted an adequate analysis on the subject components. The quality revalidation was also acceptable. In this regard it is noted that TUGCO advised NRC and PNL in the DR/QR review meeting (July 1985) that visual inspection showed six bolts rather than four in the hub to gear connection. Considering the analysis and quality confirmation, and TUGCO's commitment to visually insect the cam gear at each outage and measure gear backlash at alternate outages, PNL concurs with the OG that these components are suitable for their intended purposes.

Design Suggestion

The conflict between inserting the pin and applying the correct torque to the nut could impact the continued acceptable operation of this assembly. If it is considered essential that the nut remain on the bolt no matter what happens, PNL suggests incorporation of a redesign that eliminates the cotter pins.

5.25 IDLER GEAR ASSEMBLY: CRANK TO PUMP GEAR (Part No. 02-355A)

5.25.1 OG Efforts and Results

DR/QR Objective

The objective of this review was to evaluate the ability of the crank to pump gear to transmit torque from the crankshaft to the lube oil pump and the capscrews to provide adequate service life under steady-state and dynamic loads.

OG Analysis and Conclusions

Pitting and bending resistance of the gear was analyzed. Due to the low factor of safety with respect to pitting (i.e., 1.14), 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 connecting the crank to pump gear to the crankshaft are adequate with respect to the tensile preload in the bolt under the prescribed torque.

Quality Revalidation Checklist results were considered. This included a review of EDGCTS site experience; a visual inspection of gear teeth with satisfactory results; a hardness test on the crank to pump gear; and verification of crank to pump gear material.

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

5.25.2 PNL's Evaluation

PNL concludes that the design analysis and quality revalidation as presented in the OG DR/QR report are adequate. Because of the impacts such as torsional vibrations from the crankshaft gear, PNL supports the OG recommendation for visual inspections of the subject gears at each outage. TUGCO has committed to this. On these bases, PNL concurs that the subject components are acceptable for their intended functions.

5.26 IDLER GEAR ASSEMBLY (Part No. 02-355B)

5.26.1 OG Analysis

DR/QR Objective

The objective of this design review was to evaluate the ability of the idler gear assembly to transmit torque from the crankshaft to the camshaft and to provide adequate service life.

Results and Conclusions

Pitting and bending resistance was analyzed. The analysis shows pitting stress factor of safety may be marginal. It is recommended that the idler gear and especially the jacket water pump gear be inspected at all scheduled fuel outages, with any progressive pitting being reported for an engineering evaluation. A photographic record of these inspections should be maintained at the site to assist in this evaluation.

The bolts that connect the idler hub to the idler gear are adequate with respect to the tensile preload in the bolt under the prescribed torque. If the idler gear and hub are disassembled and reassembled, it is recommended that the nut be relocked at a position within the prescribed torque range. Insertion of the cotter pin must be accomplished at a torque range greater than 50 ft-lbf and less than 90 ft-lbf. If this is not possible, another bolt and/or nut and/or washer should be used.

The peak oil film pressure experienced by the bushing was well below the material fatigue strength. The minimum oil film thickness was 463 microinches, a value greater than the industry recommended minimum value of 140 microinches.

Quality Revalidation Inspection results were considered. These results included no EDGCTS site experience documents in evidence, satisfactory visual inspection of gear teeth, and hardness and material comparator tests on gear teeth.

The OG concluded that, with the recommended inspections and the nut locking procedure, the idler gear assembly is acceptable for its intended service at Comanche Peak.

5.26.2 PNL's Evaluation

Considering the information presented in the OG DR/QR report, and noting TUGCO's commitment to visually inspect the gears at each outage and to measure gear backlash at alternate outages, PNL concurs with the OG conclusions regarding this component. The design suggestion provided on the continued use of cotter pins under Camshaft Supports, Bolting and Gears (see Section 5.24.2) applies also to this component.

PNL notes that the TUGCO M/S plan does not provide for reference to photographic records as requested by the OG. This was discussed in the July 1985 meeting with TUGCO and the OG. Following that discussion, the OG expressed satisfaction with TUGCO's alternative methods for trend analysis which includes tracking the component via their nonconformance reporting system. TUGCO's nonconformance procedures provide for documenting progressive pitting, should this occur. PNL concurs with this approach.

5.27 INTAKE AND EXHAUST VALVES (Part No. 02-360B)

5.27.1 OG Analysis

DR/QR Objective

The objective of this review was to evaluate the adequacy of the valve to control the flow of intake air and exhaust gases by sealing the intake and exhaust passages during compression and expansion strokes.

Results and Conclusions

Review of Comanche Peak and industry experiences listed in the EDGCTS indicated the occurrence of relatively few problems directly related to valve design or manufacturing.

Stresses acting on the valve are low because the engine operates at low rpm. This is confirmed by the service experience in both nuclear and non-nuclear applications; there have been no failures from fatigue, creep, valve warpage, or other mechanisms indicative of high operating stress.

Flaking and loss of chrome plating from the valve stem on nuclear standby diesels are rare events and have little influence on engine performance.

Concentricity problems have been eliminated by improvement in the valve grinding process. However, it is recommended that the subcover be inspected after 500 to 600 hours of operation after rebuild of a cylinder head, for evidence of valve guide blowby (soot).

The following Quality Revalidation Checklist results were considered in this review: 1) quality status of EDGCTS site experience documents was established; 2) visual inspections were made on valve stems, valves, valve rings, on top of the valve stems, and of valve seating; 3) dimensional checks were made on valve to valve guide clearance; and 4) liquid penetrant tests were performed on stem head radius.

Based on the above review, and assuming TUGCO's compliance with the recommended inspections, the OG concluded that the valves are acceptable for their intended use at Comanche Peak.

5.27.2 PNL's Evaluation

PNL concludes that the analysis was adequate and the component inspection was appropriate.[a] TUGCO's commitment to inspect the subcovers after 00 or 600 hours and to conduct valve inspections and measurements at 5-year intervals

(a) The QR called for material determination of valve and valve ring. This was not done. The OG considered this was unnecessary because the vendor's material (TRW) had been confirmed at Shoreham and there was no reason to question the vendor's QA/QC program. PNL concurs, noting all other QR results were positive.

is also judged to be adequate. Based on these considerations, PNL concurs with the OG conclusion that the subject valves are acceptable for their intended uses.

Surveillance Recommendation

Flaking and loss of chrome plating from valve stems has been noted on several TDI engines. This should not be regarded lightly, as it provides a wearing surface, and chrome loss could result in seizure, gross wear, and galling. PNL supports the OG recommendation that TUGCO inspect the valves every 5 years and replace any with evidence of chrome loss.

5.28 VALVE SPRING AND RETAINER (Part No. 02-360D)

5.28.1 OG Analysis

DR/QR Objective

The objective of this review was to evaluate the adequacy of the valve spring to ensure the proper seating and kinematic motion of the intake and exhaust valves and the retainer to ensure the spring is held in proper position on the valve stem.

Results and Conclusions

While there have been no reported deficiencies or abnormalities with the valve springs or retainers at Comanche Peak, the nuclear industry experience indicates one instance at Kodiak in which improperly shotpeened springs may have been supplied on some TDI engines.

All valve springs at Comanche Peak have been visually inspected to ensure that no defective springs are installed on the engines.

Review of the engineering drawings and surface treatment specifications shows that the spring and retainer are fabricated using materials and procedures consistent with industry practice.

Quality Revalidation results (a satisfactory EDGCTS site experience document review and acceptable color codes on installed springs) were considered.

The OG concluded that the valve spring and retainer are acceptable for their intended use at Comanche Peak.

5.28.2 PNL's Evaluation

In PNL's opinion, a complete review of valve spring adequacy should include a consideration of the forces and stresses due to kinematic control of the valve train. If this has been done, it was not so indicated in the DR/QR report. However, noting 1) the good operational history of these components in a number of engines and 2) the actions taken to confirm that CPSES springs were not from the manufacturer that experienced failures at Kodiak, PNL concurs with the OG that the subject components are acceptable for the intended service.

5.29 SUBCOVER (Part No. 02-362A)

5.29.1 OG Analysis

DR/QR Objective

The objective of this review was to evaluate the adequacy of the subcover design to support the rocker arm shaft and provide a lube oil vessel at the top of the cylinder head.

Results and Conclusions

A review of the Comanche Peak, nuclear, and non-nuclear industry experience listed in the EDGCTS shows there have been few problems directly related to the subcover design or manufacturing.

Comanche Peak has reported cracks in the pedestal counterbores due to improper disassembly in which the rocker arm shafts were forced up with the dowels bound in the pedestal counterbores. A cautionary statement was added to the disassembly procedures to prevent this from happening in the future.

When proper disassembly and assembly procedures are followed, the successful service history shows the pedestal strength is satisfactory.

A review of the engineering drawing and open literature indicates that the subcover is fabricated from a material consistent with industry practice.

The Quality Revalidation Inspection results that were considered consisted of 1) a satisfactory EDGCTS site experience documentation review, 2) visual inspection of web areas, and 3) liquid penetrant tests performed on bolt boss areas.

The OG concluded that the subcover is acceptable for its intended use at Comanche Peak.

5.29.2 PNL's Evaluation

On the basis of the information provided in the DR/QR report, and noting TUGCO's commitment to inspect the subcover assembly at 5-year intervals, PNL concurs with the OG conclusions on the subcovers.

5.30 FUEL INJECTION PUMP (Part No. 02-365A)

5.30.1 OG Analysis

DR/QR Objective

The object of this review was to verify that the fuel injection pumps are suitable to increase the fuel pressure sufficiently to inject the fuel into the cylinder via the high pressure fuel injection line and the fuel injection nozzle.

Results and Conclusions

A review of the operating history of the Bendix fuel injection pumps at Comanche Peak and other nuclear power plants indicates no reported history of the Bendix pumps failing to supply sufficient fuel to this engine. Further, any leaks were attributed to loose connections, fittings, and bleed screws, and not to the primary pressure boundary.

One significant failure occurred at Catawba. A delivery valve holder, which experiences full discharge pressure, fractured. The parc was examined at the Babcock & Wilcox Alliance Research Center, where it was concluded that the fracture initiated at a casting defect in the part and was not a design deficiency.

Each pump is shop-tested and calibrated at 225 rpm and the equivalent operating pressure of 12,800 psig at three rack settings.

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.

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.

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

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.

The OG concluded that the fuel injection pump is acceptable for its intended design function at Comanche Peak.

5.30.2 PNL's Evaluation

Based on the analysis presented in the DR/QR report and on TUGCO's commitment to the OG-recommended maintenance, PNL concurs with the OG that the fuel injection pump is capable of performing its intended design function.

5.31 FUEL INJECTION NOZZLE ASSEMBLY (Part No. 02-365B)

5.31.1 OG Analysis

DR/QR Objective

The objective of this review was to verify that the fuel injection nozzle assemblies were suitable for the service of opening and spraying fuel into the cylinder in the proper pattern.

Results and Conclusions

A review of the operating history of the Bendix fuel injection nozzle assemblies at Comanche Peak and other nuclear plants indicates that leaks are not a recurring problem.

Bendix Corp. reported that the fuel injection nozzle assembly design pressure is 15,000 psig; it is not subject to a hydrotest. The normal full load operating pressure is 14,000 psig with No. 2 fuel oil.

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 fuel injection nozzle assemblies to deliver the required fuel in the required spray pattern.

The materials of the pressure boundary and high stress member of the fuel injection nozzle assembly are various grades of steel, heat treated as required for the service.

It is recommended that the utility inspect this component for leaks during the routine engine walk-around. At each refueling outage it is recommended that each assembly be disassembled, inspected, cleaned, and reassembled. At this time, each assembly should also be pop tested and the spray pattern should be checked.

It is recommended that TDI SIMs No. 107 and 108, which provide information on cleaning fuel spray tips and torque values for nozzle assembly, be incorporated into the Comanche Peak maintenance procedures.

Based on the above, the OG concluded that the fuel injection nozzle assemblies are acceptable for their intended design function at Comanche Peak.

5.31.2 PNL's Evaluation

PNL concludes that an adequate analysis was performed by the OG. Noting TUGCO's commitment to the OG recommendations for maintenance, PNL agrees with the OG conclusion that the subject assemblies are adequate for the intended purposes.

5.32 FUEL PUMP CONTROL SHAFT, LINKAGE ASSEMBLY, AND BEARINGS (Part No. 02-371A&B)

5.32.1 OG Analysis

DR/QR Objective

The object of this review was to verify that the fuel pump control shaft, linkage assembly, and bearings are suitable for linking each fuel injection pump rack (16 per engine) to the engine governor and the shutdown cylinder so that the proper amount of fuel is provided to each cylinder for a given governor setting and a means of emergency fuel cutoff is provided.

Results and Conclusions

The operating history at Comanche Peak and other nuclear power plants indicates that the fuel pump control rod, linkage, and bearings adequately perform when the bearings and linkage are properly oiled and greased.

To maintain proper control shaft alignment, it is recommended that a routine inspection and lubrication of the oil cups be performed.

So long as shaft alignment is maintained, the load on the shaft and linkage should be very low, and binding should not be a problem.

The design of the components was reviewed using the TDI drawings and visual inspection. The design is acceptable, provided that the required maintenance procedures are followed.

The following Quality Revalidation Inspection results were considered in the OG DR/QR review: 1) no EDGCTS site experience documents in evidence, 2) hardness test performed on shaft, 3) visual inspection made on linkages and bearings, and 4) bearing lube procedures verified to be in accordance with the TDI manual.

The OG concluded that the fuel pump control shaft, linkage, and bearings are acceptable for their intended design function at Comanche Peak, provided that routine inspection and lubrication of the oil cups is accomplished.

5.32.2 PNL's Evaluation

On the basis of the information provided in the DR/QR report, PNL concludes that the analysis and inspections conducted were adequate. Considering TUGCO's commitment to check lube oil cups monthly and grease all swivel links at each outage, PNL concurs with the OG conclusion that the subject components are adequate for this application.

5.33 AIR INTAKE MANIFOLD (large-bore scope only) (Part No. 02-375)

5.33.1 OG Analysis

DR/QR Objective

The objective of this study was to evaluate the structural integrity of the intake manifold and crossover piping, couplings, and supports to withstand the effects of normal operating and earthquake loading.

Results and Conclusions

An evaluation was performed utilizing the philosophy and intent of the ASME Code, Section III, "Nuclear Power Plant Components"; Subsection ND, the Class 3 Components. All intake manifold components were found to be stressed well within the permissible limits. Therefore, the intake manifold assembly meets the intent and philosophy of the ASME Code, Section III, Subsection ND for Class 3 components, and is acceptable for the intended design service at Comanche Peak.

To qualify supports IM-PSR-10100 and IM-PSR-10101, the missing nuts on the U-bolts must be installed.

All crossover piping stresses were within the design allowables specified by the ASME Code Section III, provided that the above support modifications are implemented. The Dresser coupling is acceptable with respect to manufacturer's service condition limits and relative end movement requirements.

All pipe loads on the engine have been tabulated and evaluated.

The EDGCTS contains an experience item relating to cracks in the intake manifold assembly. To alleviate problems, several options are recommended:

* Other castings may be tried in an attempt at a better fit.

* Increase hole diameters on the intake manifold elbows from 1/16 inch oversize to 1/8 inch oversize. However, under no circumstances shall any component be jacked to fit.

Other options may be acceptable but will require an engineering evaluation to verify structural adequacy.

The following Quality Revalidation Inspection results were considered in the OG DR/QR review: 1) EDGCTS site experience documents were reviewed with satisfactory results, 2) intake elbows were visually inspected, 3) installation instructions were found to comply with TDI procedures, and 4) the size of the U-bolts and their installation were confirmed.[a]

Based on the above review, the OG concluded that the air intake manifold, associated piping, couplings, and supports are acceptable for their intended design functions at Comanche Peak.

5.33.2 PNL's Evaluation

Based on the information provided in the DR/QR report and in the July 1985 meeting with TUGCO staff, PNL concludes that an adequate analysis and component quality confirmation has been accomplished. PNL also notes that the support modifications recommended by the OG have been completed by TUGCO. On these bases, PNL concludes that this component is capable of fulfilling its intended function.

Surveillance Recommendation

Any further incidence of cracking of pressurized components should be investigated thoroughly, and the cause eliminated wherever practical. Further incidence of assembly difficulties may indicate some deficiency in design or quality.

(a) At a meeting with TUGCO/NRC/PNL representatives, an open item noted in the QR (inspection of U-bolts) was reported to have been completed.

5.34 EXHAUST MANIFOLD PIPING (large-bore score only) (Part No. 02-380A)

5.34.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the subject piping and the water jacket for normal operating and earthquake loadings.

Results and Conclusions

An analysis of the piping was performed in accordance with the philosophy and intent of the ASME Code Section III, for Class 3 Nuclear Piping. Based on this analysis, all piping stresses are acceptable.

Also consistent with the intent and philosophy of the ASME Code, the adoption of an inspection program that provides a means for identifying the possible degradation of the exhaust manifold piping components, particularly the welded joints, is recommended.

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, operating base earthquake (OBE) and safe shutdown earthquake (SSE) loads, thermal effect, and the effects of all applicable load combinations. 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 capscrews holding 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. However, the equipment will continue to operate safely after a SSE event.

The exhaust manifold must be subjected to 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 at 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 evaluated.

Quality Revalidation Checklist results (the EDGCTS site experience document review) were considered in the DR/QR review. At the time of the DR/QR, field inspections were in progress.

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

5.34.2 PNL's Evaluation

Based on data included in the DR/QR report and obtained in the July 1985 meeting with TUGCO, PNL concludes that the analysis and quality revalidations are adequate. At that meeting, PNL learned that the replacement flanges are planned, the action to be taken is in engineering review, and a field inspection report was transmitted to the OG confirming material and thickness of piping and water jacket. On these bases, PNL concurs with the OG that the exhaust manifold piping is suitable for its intended service.

5.35 EXHAUST MANIFOLD BOLTING AND GASKETS (Part No. 02-380B)

5.35.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the exhaust manifold bolting and gaskets to fasten the exhaust piping to the exhaust flange of the cylinder heads.

Results and Conclusions

The exhaust manifold capscrews are torqued to 60 ft-lb per the TDI Instruction Manual. This torque value is sufficient to resist the applied tensile loads. It is also below the maximum allowable torque for the lowest grade stainless steel.

The applied tensile and shear loads develop tensile and shear stresses well below the yield stresses for stainless steels.

The thread engagement of the capscrews to the cylinder block is sufficient to ensure that the required torque value is developed, based on the capscrew length and the exhaust manifold flange to head assembly.

The exhaust manifold gasket is rated by the manufacturer for service up to 1500°F. This rating is above the maximum temperature of the exhaust gases, which is 1060°F.

Quality Revalidation Inspection results considered included 1) a satisfactory EDGCTS documentation review, 2) torque verification, 3) dimensional inspection of capscrews, 4) gasket and bolting installation verification, and 5) verification that no cracks exist in flange fillets and that the manifold is not binding.

The OG concluded that the exhaust manifold bolting and gaskets are acceptable for their intended design function at Comanche Peak.

5.35.2 PNL's Evaluation

In PNL's opinion, based on the data provided in the DR/QR report, the OG has adequately analyzed the subject components. PNL therefore concurs with the OG conclusion that the subject components are acceptable for their intended function.

5.36 INTAKE/INTERMEDIATE AND EXHAUST ROCKER SHAFT ASSEMBLIES (Part No. 02-390A&B)

5.36.1 OG Analysis

DR/QR Objective

The objective was to evaluate the adequacy of the rocker shafts to translate the motion of the main push rods into the reciprocating motion of the intake and exhaust valves and connector push rod.

Results and Conclusions

The maximum push rod and rocker arm forces were computed and used to compute the peak shear and bending stresses in the rocker shaft assemblies. The maximum shear stress and the maximum bending stress were both below the endurance limit stresses.

Conservative stress analysis of the intake, intermediate, and exhaust rocker arms indicates a minimum factor of safety of 1.1 against failure. The forces acting on the push rod sockets induce stresses in the sockets that are below the allowable.

The capscrew connecting the rocker shaft to the rocker support is torqued and develops a tensile preload that is sufficient to provide frictional resistance to lateral forces on the intake rocker-side of both rocker shaft assemblies. On the other side (intermediate rocker), the support dowel is engaged by the rocker shaft end, and transfers the shear from the rocker shaft to the sub-base assembly boss. The shear resistance supplied by friction at this end is minimal, due to the uplift forces on the rocker shaft by the main exhaust and intermediate push rods. Calculations indicate that these shear stresses exceed the endurance limit stress for the dowel at full engine load. However, there is no evidence (nuclear or non-nuclear) indicating dowel failures.

Specifically, Shoreham experience indicates that approximately 400 hours have been logged on these dowels at full engine load. Recognizing that the push rod loads and material strengths used in the calculations may be conservative, and that the dowels have been subjected to more than 5×10^6 cycles at full load without failures, it is concluded that the dowels are capable of transferring the shear loads to the sub-base assembly.

Quality Revalidation Inspection results were considered. These included a satisfactory review of EDGCTS site experience documents, visual inspections, and verification of material by material comparator tests.

The OG concluded that the intake/intermediate and exhaust rocker shaft assemblies are acceptable.

5.36.2 PNL's Evaluation

Based on the information provided in the DR/QR report and by TUGCO at the July 1985 meeting, PNL concludes that an adequate analysis and component requalification of these assemblies was performed by the OG. At the meeting PNL learned that the unsatisfactory visual inspection reported in the DR/QR was resolved by replacing two push rods and refurbishing a third. PNL concurs with the OG conclusion that the subject assemblies are acceptable.

M/S Suggestion

In view of the high calculated stresses and potential for cracking, PNL feels it would be prudent to inspect the rocker boxes at the rocker shaft bolt holes at refueling outages when other elements of the rocker assembly are inspected.

5.37 GOVERNOR DRIVE: COUPLINGS, PINS, AND KEYS (Part No. 02-411B)

5.37.2 OG Analysis

DR/QR Objective

The objective of this review was to evaluate the adequacy of the coupling, pins, and keys to transmit mechanical power between the governor drive shafts and gears and to provide vibration isolation between the drive gear and governor.

Results and Conclusions

The EDGCTS listings for the nuclear industry experience show that TDI issued a Part 21 notification regarding the Koppers coupling in June 1982. The isoprene rubber used in the coupling at that time was not compatible with the high-temperature, oily environment in the diesel engine, and the insert was to be replaced with one using neoprene. Both Koppers and others report that the neoprene polymer is acceptable for use in 170°F environments, and its oil resistance is considered adequate. The EDGCTS listing for Comanche Peak shows only the TDI Part 21 notification. No non-nuclear experience was reported.

The load analysis on the drive assembly shows that the nominal or average coupling torque is well within the continuous duty torque rating of the coupling.

The manufacturer has expressed concern that the use of the neoprene elastomer under the present dynamic loading conditions will lead to a shorter life than that under any of the single frequency load components individually, and that, without testing, the life of the coupling could not be predicted. Nevertheless, the neoprene Koppers coupling does not have a history of elastomer failure.

The dynamic analysis shows that the coupling provides very little vibration isolation for the governor in the 0 to 60 Hz range because the natural frequency of the governor inertia on the coupling is 53 Hz. However, there is no vibration specification for the governor itself, and there has been no governor failure as a result of these transmitted vibrations, except that found on Shoreham EDG 102 following the crankshaft failure.

A fatigue failure analysis was conducted on the dowel pins, Woodruff keys, and square keys. These calculations show that the keys and pins have sufficient strength to carry their static and dynamic loads if there is a tight (Class 2) fit between them and their keyways.

The setscrews supplied with the Koppers coupling are 8-32 UNC x 1/2 inch long cup point. Comparison with a setscrew guide for use over keys shows that they are not an appropriate size for use with the 3/16-inch key on a 5/8-inch shaft.

The experience at Shoreham indicated a number of problems with the couplings hubs becoming loose on the shafts. Engineering changes there included using larger setscrews, additional setscrews at 90 degrees to those over the keys, and the use of Loctite adhesive between the hubs and shafts. The modified design was considered acceptable.

At Comanche Peak, the loadings are not as severe as those at Shoreham; the Catawba plant, with about 800 hours of operation of a V-16 diesel, shows no history of difficulties. This experience indicates that, despite the inappropriately sized setscrews, the couplings are unlikely to loosen at

Comanche Peak. However, should the coupling be found loose on the shafts, it is recommended that Loctite 609 be used between the hubs and shafts to eliminate this problem.

The governor drive pins and keys have sufficient strength to transmit mechanical power from the crank gear to the governor. The Koppers coupling has demonstrated its acceptability, although the life of the elastomer is not predictable at present. Thus, the following items are recommended to further ensure reliability:

- Modify the maintenance schedule to include checking the coupling tightness at refueling outages. If the coupling is found loose, it should be removed, all mating surfaces cleaned, and the unit reassembled using Loctite 609 on the mating surfaces.
- Modify the maintenance schedule to include replacement of the coupling elastomeric insert at refueling outages.

The following Quality Revalidation Inspection results were considered; 1) the satisfactory EDGCTS document review, 2) visual inspections performed on the spider coupling, and 3) verification of coupling material.

Based on the above review, the OG concluded that the governor drive coupling, pins, and keys are acceptable for their intended use at Comanche Peak.

5.37.2 PNL's Evaluation

PNL concludes that the OG analysis is adequate and the modification of the coupling material is appropriate. On these bases, and noting that TUGCO has committed to the OG-recommended maintenance items, PNL concurs with the OG conclusions on the subject components.

5.38 ENGINE DRIVEN LUBE OIL PUMP (Part No. 02-420)

5.38.1 OG Analysis

DR/QR Objective

The objective of this review was to verify that the engine driven lube oil pump is suitable for supplying lube oil to the engine and accessories to maintain proper lubrication during engine operation.

Results and Conclusions

The pressure boundary parts are Class 30 cast iron. The pump operates at a maximum pressure of 100 psig. The casing and suction elbow do not have a specific design and hydrostatic test pressure, and they are not hydrostatically tested. The proof of these parts is their ability to hold pressure during shop test and field operation. There have been no reported leaks from the pressure boundary. Therefore, the integrity of the pressure boundary has been demonstrated.

The pump delivers approximately 600 gpm of lube oil at the rated engine speed of 450 rpm. There is no history of the pump failing to maintain the required lube oil pressure and temperature. Therefore, the pump has adequate performance.

This pump is not furnished with a mechanical face type seal. It has a balance piston and bushing to balance out the axial thrust. This bushing also breaks down the pump discharge pressure to the engine crankcase pressure. This allows a small quantity of lube oil to leak back to the crankcase during engine operation; it also lubricates the pump radial antifriction bearing. This is a simple, very reliable seal where this leakage can be tolerated. There is no history of this seal degrading the pump performance so that it does not deliver the lube oil requirements of the engine.

This pump design has been used by the IMO Division of TDI (now the Pyramid Pump Division) for over 25 years. The pump cartridge is designed and manufactured by IMO for use on the V-16 engines as the engine driven lube oil pump.

It is driven through a spline coupling by the lube oil gear, which is driven by the bull gear off the crankshaft. The spline coupling allows the pump to be properly aligned during assembly.

Using the total torque, which includes the hydraulic and fluctuating torque from the crankshaft, the stresses in the pump shaft, spline coupling and lube oil gear were roughly estimated to be all under 10,000 psi, which is very conservative for heat treated steel. For this reason a detailed calculation was not performed. The mechanical design is satisfactory.

The pressure boundary parts are ASTM Class 30 cast iron. The idler and drive screws and shafts are hardened carbon steel. The balance piston bushing is brass. The bearing is a conventional steel ball bearing. All of the materials are suitable for the lube oil service.

These 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.

The nozzle loads on these pumps have been addressed.

Quality Revalidation results (a satisfactory review of the EDGCTS site experience documents) were considered in the performance of the design review.

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

5.38.2 PNL Evaluation

PNL reviewers were concerned with seismic qualification of the cast iron pump body and nozzle. At the July 1985 meeting with the OG, TUGCO, and NRC, it was determined that the adequacy of the seismic response was addressed in Stone & Webster Engineering Corp. Calculation No. 11600.60 NM(B)-001-C2C-040. With this information, and noting the satisfactory service history on V-16 engines, PNL concludes that the OG analysis and quality review were adequate and that the engine driven lube oil pump is suitable for its intended service.

5.39 INTERCOOLER PIPING: COUPLINGS, GASKETS, AND BOLTING (Part No. 02-436A&B)

5.39.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the subject piping components for normal operating and seismic loadings, and to verify that couplings, gaskets, and bolting have sufficient strength to seal the jacket water and accommodate thermal expansion.

Results and Conclusions

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

The total movements of two of the Dresser couplings are within the manufacturer's allowables. The movements due to thermal, deadweight, and pressure on the intercooler inlet pipe coupling are within the manufacturer's allowables. However, the increment due to seismic loading exceeds allowables by less than 20 percent. Because the seismic loading is occasional, this is acceptable.

TERs indicate that the Dresser couplings are Style 450 and Style 38, as listed in the Comanche Peak TDI Parts Manual. However, the Dresser Manufacturing Co. does not manufacture a Style 450 coupling. Field walkdown has confirmed that a Style 38 is installed and is acceptable.

There are no service life constraints because these couplings have no significant history of failure. Shelf life is unlimited so long as the gaskets remain packed and protected from light, water, and other adverse elements. The coupling is adequate with respect to manufacturer's service condition limits.

All pipe loads on the intercooler were tabulated and evaluated.

Quality Revalidation Inspection results were considered, and the results are consistent with the final conclusion of this report except for information in TERs 10-060 and 10-108, which was superseded by field walkdown.

The OG concluded that the subject piping components are adequate for the intended design function at Comanche Peak.

5.39.2 PNL's Evaluation

On the basis of the information provided in the DR/QR report, PNL concurs with the OG conclusion that the subject components are adequate for service at Comanche Peak. PNL notes that the calculated movement of the Dresser couplings due to the seismic increment does exceed allowable. PNL concurs with the OG conclusion that this is acceptable in view of the low probability of seismic events and the fact that the motion exceeds allowable by only 20%. However, PNL recommends that, in the event the Site Seismic Event (SSE) limit is exceeded, the Dresser couplings be inspected and the results evaluated.

5.40 STARTING AIR MANIFOLD: PIPING, TUBING, AND FITTINGS (large-bore scope only) (Part No. 02-441A)

5.40.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the subject piping for normal operating and earthquake loadings.

Results and Conclusions

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

The movements at the Dresser couplings are within the manufacturer's end movement requirements.

There are no service life constraints because this style coupling has no significant history of failure. Shelf life is unlimited so long as the gaskets remain packaged and protected from the elements. The coupling is adequate with respect to manufacturer's service condition limits.

Support modifications are recommended to provide stiffer load paths to accommodate the axial discontinuity loads at the Dresser couplings and to relieve restraint in the axial directions (by partial removal through bolt hole elongations) to accommodate thermal expansion. The support modifications are summarized in the DR/QR report for Component No. 02-441C.

Historical corrosion data for carbon steel starting air systems was not available. However, the subject starting air piping and interconnecting welds have a limiting wall thickness of 5.15 times that required, which should be sufficient margin against corrosion.

The following Quality Revalidation Inspection results were considered in the DR/QR: 1) no EDGCTS experience documents are in evidence, 2) field inspections of pipes and welds were performed, and 3) installation of piping and fittings was checked.

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

5.40.2 PNL's Conclusions

On the basis of the information provided in the DR/QR, PNL concludes that the OG review was adequate. Considering this, and noting TUGCO's commitment to monthly surveillance of this component, PNL concurs with the OG conclusion that the subject components are compatible with the intended function.

5.41 STARTING AIR MANIFOLD: SUPPORTS (large bore only) (Part No. 02-441C)

5.41.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the subject piping supports for normal operating and earthquake loadings.

Results and Conclusions

The supports for this component were reviewed and are acceptable with modifications. These support modifications are recommended to provide stiffer load paths to accommodate the axial discontinuity loads at the Dresser couplings and to relieve over-constraint in the axial direction due to thermal expansion.

All pipe support loads on engine blocks or skid have been tabulated and issued for evaluation.

The following Quality Revalidation Inspection results were considered: 1) no EDGCTS site experience documentation is in evidence, 2) material comparator tests and clearance checks were performed, 3) installation of supports was checked.

The OG concluded that the subject piping supports, modified, are adequate for their intended design services at Comanche Peak.

5.41.2 PNL's Evaluation

On the basis of the information provided in the DR/QR report, PNL concurs with the OG conclusions regarding the adequacy of this component.

5.42 FUEL OIL BOOSTER PUMP (Part No. 02-445)

5.42.1 OG Analysis

DR/QR Objective

The object of this review was to verify that the engine driven fuel oil booster pumps are suitable to take suction from the day storage tank and boost the fuel oil pressure to 30 psig in the supply header to the fuel injection pumps.

Results and Conclusions

The pump operates at a maximum of 40 psig, and has a design pressure of 150 psig and a hydrotest pressure of 225 psig. There have been no reported leaks from the pressure boundary.

The pump delivers 30 gpm at full engine operating speed, which is more than double the full load engine requirements. There is no history of this pump failing to provide adequate fuel at sufficient pressure for the fuel injection pumps.

The pump has one mechanical seal to prevent fuel oil leakage. The seal operates in an environment of filtered, room temperature fuel oil. It seals against pump discharge pressure, which is 40 psig maximum. It is designed to seal against the pump design pressure of 150 psig. The pump speed is a maximum of 1225 rpm and the seal face diameter is approximately 1-1/4 in. This calculates to a very conservative 10 fps velocity. All of the seal failures to

date at Comanche Peak occurred during startup when there was the greatest probability of foreign matter getting between the seal faces and causing damage and leaking. The mechanical seal is satisfactory for its intended service.

The pump is a simple gear pump design that has been manufactured for over 20 years.

The fluctuating torque from the crankshaft has been considered. Its magnitude is considerably reduced because it is transmitted through two couplings on the governor drive assembly, both of which have Buna N (a synthetic elastomer) spiders. Using twice the hydraulic torque, which is very conservative, the shear stress in the pump shaft is approximately 200 psi, which is negligible for the heat treated steel shaft.

All of the pump materials are satisfactory for fuel oil service.

End reactions on this pump are considered acceptable because the relative strength of the pump is much greater than that of the attached small-bore piping/tubing.

Quality Revalidation results (a satisfactory EDGCTS documentation review) were considered.

Based on the above, the OG concluded that the fuel oil booster pump is acceptable for its intended design function at Comanche Peak.

5.42.2 PNL's Conclusions

On the basis of the information provided in the DR/QR report, PNL concurs with the OG conclusions on the subject component.

5.43 FUEL OIL FILTERS (Part No. 02-455A)

5.43.1 OG Analysis

DR/QR Objective

The objective of this review was to ensure that the filter application meets both the system flow requirements and fuel cleanliness recommendations, while allowing proper flow of clean fuel and preventing dirt/debris particles from fouling the injector pumps and injectors.

Results and Conclusions

Comanche Peak at present intends to change the filter element at a differential pressure of 20 psid, in agreement with manufacturer's recommendations. Manufacturer's instructions and operating procedures are specific regarding the maximum differential pressure permissible across the filter. Although not reflected on the fuel oil piping schematic, there are gauges to read differential pressure across the fuel oil filter.

The fuel oil filter application is suitable for the intended service and will allow adequate fuel flow while maintaining the desired filtration requirements of 3 to 5 microns.

Operating and maintenance instructions were found to be complete in specifying cleaning/replacement procedures for filter components. Operating and maintenance procedures were specific regarding the requirements or method for purging air from the standby chamber and bolt retorquing subsequent to disassembly/reassembly. The duplex design will permit one filter to be online under pressure while the other filter is being cleaned or replaced. Venting plugs are provided on each chamber to allow the purging of air after servicing the filter.

End reactions on small-bore filters, i.e., 2 inches and smaller, are considered acceptable because the relative strength of small-bore components is much greater than that of the attached small-bore piping/tubing.

There is no industry experience to indicate that the design of the fuel oil filter is unacceptable.

Quality Revalidation results of no EDGCTS site experience documents in evidence and the checking of filter serial numbers were considered.

The OG concluded that the fuel oil filter is acceptable for its intended design function at Comanche Peak.

5.43.2 PNL's Conclusions

Based on the information provided in the DR/QR report, and noting TUGCO's commitment to record filter differential pressure and inspect tubing/connections monthly and inspect/replace gaskets at each outage, PNL concurs with the OG conclusion of component acceptability.

5.44 FUEL OIL STRAINERS (Part No. 02-455B)

5.44.1 OG Analysis

DR/QR Objective

The objective of this review was to ensure that the engine driven pump strainer is properly sized and designed to meet both the system flow requirements and booster/feed pump cleanliness requirements while allowing adequate flow of filtered fuel oil to the diesel and protecting the booster pumps from harmful particulates.

Results and Conclusions

Based on the engine fuel flow requirement, the strainer will allow adequate flow to the pump suction. Selection of a duplex-type strainer is correct to allow switchover/cleaning during diesel operation.

Mesh size was recommended by the manufacturer at 100 to 200 mesh for the engine-driven pump. The Air-Maze strainer is sized at 300 mesh. With regard to particle filtration size, the Air-Maze strainer capability of 300 mesh is finer than would be normally recommended in this application. The problem with such a fine filtration system would be the possibility of excessive cleaning frequency of the strainer element. Consideration should be given to replacing the strainer element with a coarser design, which would require less maintenance but would still satisfy the filtration requirements for the booster pump.

TDI recommends cleaning or replacing the strainer elements at 5 psid. To augment the TDI Maintenance Manual, this recommendation should be incorporated into Comanche Peak's maintenance procedure.

A review of the EDGCTS indicates that Comanche Peak experience with the fuel oil strainers has involved routine maintenance items only. No record of industry problems with the strainers was found in the EDGCTS.

The manufacturer's maintenance procedures were reviewed and found to be complete regarding methods for cleaning the strainer. The following information is provided as guidance for minimizing air in the system and for torque values. The proper procedure for venting the Air-Maze strainers prior to placing in service recommends that vent petcocks be installed in each head of the strainer and that a bowl bolt torque of 120 to 150 in-lb be implemented. To augment the TDI Maintenance Manual, this recommendation should be incorporated into Comanche Peak's maintenance procedures.

Based on the above review, the OG concluded that the Air-Maze fuel oil strainer is acceptable for its intended design function at Comanche Peak. However, it is recommended that the strainer be observed during operation and, if excessive cleaning is required, the 300 mesh unit should be replaced with a 100 to 200 mesh unit to meet the pump manufacturer's recommendations. This recommendation is made to enhance operation but is not required for system operation.

5.44.2 PNL's Evaluation

Based on data in the DR/QR report, and noting TUGCO's commitment to monitor filter differential pressure monthly and purge air from standby strainers as needed, PNL concurs with the OG that the subject component is acceptable for its intended application.

5.45. LUBE OIL LINES EXTERNAL: TUBING, FITTINGS, COUPLINGS (large-bore scope only) (Part No. 02-465A)

5.45.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the subject piping components to carry lube oil from the lube oil pump discharge and engine drain to the lube oil sump tank and from the three-way valve connection to the lube oil strainers during normal operating and earthquake loadings.

Results and Conclusions

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

The movements at the Dresser coupling are within the manufacturer's end movement requirements. However, it is recommended that a minimum installation gap, between the pipe ends, of 0.171 inch be included to avoid contact of the pipe ends.

There are no service life constraints because this style of coupling has no significant history of failure. Shelf life is unlimited so long as the gaskets remain packaged and protected from the elements. The coupling is marginal with respect to manufacturer's service condition limits, and will be replaced by an upgraded model if leaks develop.

All pipe loads on the engine, pump, and sump tank were tabulated and issued for evaluation.

Quality Revalidation Inspection results considered by the OG in reaching their conclusions included 1) satisfactory review of EDGCTS site experience documents, 2) inspections of piping and welds performed, and 3) checks of system installation and as-built drawings.

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

5.45.2 PNL's Evaluation

On the basis of the information provided in the DR/QR report, PNL concludes that the OG adequately analyzed the subject component. Noting that the OG minimum installation gap has been confirmed, PNL concurs with the OG conclusion of piping component acceptability.

5.46 LUBE OIL LINES EXTERNAL: TUBING, FITTINGS, COUPLINGS (small-bore scope only) (Part No. 02-465A)

5.46.1 OG Analysis

DR/QR Objective

The objective of this review was to perform an engineering evaluation of the small-bore piping/tubing and coupling to ensure that they will perform the intended design function during normal operating and earthquake loadings.

Results and Conclusions

The small-bore piping/tubing and couplings were evaluated and found acceptable, with the following modifications:

- Add a three-way support on the riser of the 1-1/2-inch diameter gear case lube oil line, to provide axial and lateral support of the cantilevered configuration.
- Add two-way supports to the following tubing lines such that the between-support spans are limited to a maximum of 4 feet 6 inches for 1/4-inch tubing and 5 feet 6 inches for 3/8-inch tubing:
  - the 1/4-inch crossover tube between the north sump large bore discharge lines
  - the 3/8-inch tube between the main lube oil header (crossover) and the large-bore three-way valve.

The Quality Revalidation Inspection results considered were 1) a satisfactory review of EDGCTS site experience documents, 2) inspections of piping and welds, and 3) a check of system installation and as-built drawings.

5.46.2 PNL'S Evaluation

On the basis of the information provided in the DR/QR report, and noting the commitment by TUGCO at the July 1985 meeting to implement all OG-recommended modifications, PNL concurs with the OG conclusions on the subject components.

5.47 LUBE OIL LINES EXTERNAL: SUPPORTS (small-bore scope only) (Part No. 02-465B)

5.47.1 OG Analysis

DR/QR Objective

The objective of this review was to perform an engineering evaluation of the small-bore piping/tubing supports to ensure that they will provide adequate restraint to the external lube oil small-bore piping/tubing during operating and earthquake loadings.

Results and Conclusions

The following Quality Revalidation Inspection results were considered by the OG in their DR/QR review: 1) no EDGCTS site experience documents in evidence, 2) material comparator tests performed on supports, 3) proper installation of supports verified, and 4) as-built drawings to be issued.

Based on the above review, the OG concluded that the supports will perform their intended design function at Comanche Peak under all normal operating and earthquake loadings, with the provision that the following recommended modification be implemented:

- The plate 1/4 inch x 1-1/2 inches x 1 foot 2-1/8 inches long on support PS-1001A-LO-10519-1 should be removed and replaced with a two-way plug and axial restraint.

5.47.2 PNL's Evaluation

Based on the information provided in the DR/QR report and TUGCO's commitment to implement the OG-recommended modification, PNL concurs with the OG conclusion regarding the adequacy of this component.

5.48 LUBE OIL LINES EXTERNAL: VALVES (Part No. 02-465C)

5.48.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the lube oil check valves to permit flow in only one direction, and of the three-way plug valve to transfer flows.

Results and Conclusions

The single Comanche Peak experience listed in the EDGCTS indicated that a check valve was not installed by the vendor on the 76003 diesel. The valve has been installed.

Materials of construction and the pressure rating are acceptable for the intended service at Comanche Peak.

Nozzle loads on large-bore valves (2-1/2 inch and larger) have been evaluated and found acceptable.

End reactions on small-bore components (e.g., valves, filters, and regulators 2 inches and smaller) are considered acceptable because the relative strength of small-bore components is much greater than that of the attached small-bore piping/tubing.

The Quality Revalidation results (a satisfactory review of the EDGCTS site documents) were considered.

The OG concluded that the lube oil valves are acceptable for their intended design function at Comanche Peak.

5.48.2 PNL's Evaluation

On the basis of the information provided in the DR/QR report, PNL concurs with the OG conclusion that these components are acceptable for service at Comanche Peak.

5.49 TURBOCHARGER: LUBE OIL FITTINGS - PIPING (large-bore scope only) (Part No. 02-467A)

5.49.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the subject piping components to carry lube oil from the turbocharger to the sump tank during normal operating and earthquake loadings.

Results and Conclusions

All piping stresses were evaluated and found to be within the design allowables specified by the ASME Code Section III.

In the original configuration, the seismic relative end movements at both Dresser couplings exceeded the manufacturer's allowables. Tying the existing common U-bolt installation, JW-PSR-10031 and JW-PSR-10033, back to the skid created thermal expansion problems. Therefore, the piping will be modified by replacing the couplings with slip-on flanges.

All pipe loads on the turbocharger and sump tank were tabulated and issued for evaluation.

To ensure adequate restraint in the lateral direction, it is recommended that two supports be modified. These modifications are summarized in the DR/QR report for Component No. 02-467B.

The following Quality Revalidation Inspection results were considered in the OG review: 1) no EDGCTS site experience documents in evidence, 2) field inspections performed on pipe, coupling and welds, 3) system installation check in field, and 4) as-built drawings to be issued.

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

5.49.2 PNL's Evaluation

Based on the information presented in the DR/QR report, and noting TUGCO's commitment to implement the OG-recommended modifications, PNL concurs with the OG conclusions on the subject components.

5.50 TURBOCHARGER: LUBE OIL FITTINGS - PIPE, TUBE, FITTINGS, AND FLEXIBLE COUPLING (small-bore scope only) (Part No. 02-467A)

5.50.1 OG Analysis

DR/QR Objective

The objective of this review was to perform an engineering evaluation of the tubing to ensure that the component will provide lube oil to the turbocharger during normal operating and earthquake loadings.

Results and Conclusions

The tubing as defined by this Component Design Review has been found acceptable with modification.

The following Quality Revalidation Inspection results were reviewed by the OG in reaching conclusions: 1) no EDGCTS site experience documents in evidence, 2) field inspections performed on pipe, coupling and welds, 3) system installation check in field, and 4) as-built drawings to be issued.

Based on the above review, the OG concluded that the piping, tubing, fittings, and couplings will perform their intended design function at Comanche Peak under all normal operating and earthquake loadings, with the provision that a two-way lateral support be added to the left-bank turbocharger supply line (3/4-inch line between the crossover pipe and cross connection at the sightglass) such that the span between the support is limited to a maximum of 7 feet 6 inches.

5.50.2 PNL's Conclusions

Based on the information provided in the DR/QR report, and noting TUGCO's commitment to implement the OG-recommended modifications and to perform monthly visual inspections for leaks, PNL concurs with the OG conclusion that these components are adequate for service at Comanche Peak.

5.51 TURBOCHARGER: LUBE OIL FITTINGS - SUPPORTS (large-bore scope only), (Part No. 02-467B)

5.51.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the subject piping supports to provide adequate restraint to the large bore piping system, in the intended load directions, for the loading conditions specified for normal operating and earthquake loading.

Results and Conclusions

The evaluation of the pipe supports was performed in accordance with the philosophy and intent of AISC. Supports LO-PSR-10031 and LO-PSR-10033 were found to be structurally adequate and will perform their intended design function at Comanche Peak.

Modifications to supports LO-PSR-10030 and LO-PSR-10032 are recommended. Both supports should have angles added on the sides of the U-bolts to accommodate the lateral loads. Also, the welds connecting the plates at both supports should be increased to all-around welds.

All pipe support loads on the engine block and/or skid were tabulated and issued for evaluation.

Quality Revalidation Inspection results that were considered are 1) no EDGCTS site experience documents in evidence, 2) material comparator tests performed on supports, 3) installation of supports verified by the walkdown, and 4) as-built drawings to be issued.

The OG concluded that the subject piping supports are adequate for their intended design function at Comanche Peak.

5.51.2 PNL's Evaluation

Based on the information provided in the DR/QR report, and noting TUGCO's commitment to implement the OG-recommended modifications, PNL concurs with the OG conclusions on the subject components.

5.52 TURBOCHARGER: LUBE OIL FITTINGS - SUPPORTS (small-bore scope only) (Part No. 02-467B)

5.52.1 OG Analysis

DR/QR Objective

The objective of this review was to perform an engineering evaluation of the tubing supports to ensure that the component will provide adequate restraint of the tubing system in the intended support load direction during normal operating and earthquake loadings.

Results and Conclusions

The tubing supports have been evaluated and have been found acceptable.

The Quality Revalidation Inspection results considered included 1) no EDGCTS site experience documents in evidence, 2) material comparator tests performed on supports, 3) installation of supports verified by walkdown, and 4) as-built drawings to be issued.

Based on the above review, the OG concluded that the tubing supports will perform their intended design function at Comanche Peak under all normal operating and earthquake loadings.

5.52.2 PNL's Evaluation

Based on the information provided in the DR/QR report. PNL concurs with the OG conclusions on the subject components.

5.53 TURBOCHARGER: BRACKET, BOLTING, AND GASKETS (Part No. 02-475A&C)

5.53.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the turbocharger bracket and bolting for dead weight, seismic, and normal operating loads including engine vibration; and to verify the adequacy of the bolt torque specifications, thread engagement, material selection, and installation procedures.

Results and Conclusions

A Structural Dynamic Research Corporation (SDRC) seismic report was used to evaluate seismic loads on the turbocharger bracket. This report adequately modeled the turbocharger bracket; however, loads were based upon only seismic inertia loads and dead weight. Analyses of the Shoreham bracket 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 analyzed, it can be concluded that the bracket is designed to have a high stiffness and would not be a weak point.

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. 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, it is recommended that the bracket to engine and bracket to turbocharger base screws (Part Nos. GB-001-143 and GB-001-120) be inspected on a regular basis as discussed below:

> Each month for the first 3 months of commercial operation, these screws should be inspected to ensure that no screw has loosened due to engine operating loads. If during these inspections none of the screws is 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-lb for the bracket to engine screws and 75 ft-lb for the bracket to turbocharger base screws.

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

Quality Revalidation results (no EDGCTS site experience documents in evidence) were considered.

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

5.53.2 PNL's Evaluation

On the basis of the information presented in the DR/QR report, and noting TUGCO's commitment to the OG recommendations and the confirmation received at the July 1985 meeting with TUGCO, NRC, and PNL that engine vibration levels were measured and are acceptable, PNL concurs with the OG conclusions regarding these components.

5.54 AIR BUTTERFLY VALVE (Part No. 02-475B)

5.54.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the design of the intake air butterfly valve assembly (i.e., valve and operator) to shut off combustion air in the event of an engine overspeed trip.

Results and Conclusions

To verify the operator size, a calculation was performed. The results of the calculation verify that the operator and roll-pin are suitably sized to close the valve.

The review of the EDGCTS did not indicate any problems with the design of the valve assembly at Comanche Peak. However, it is recommended that the grease fittings be added to the butterfly valve shaft as a design improvement.

Preventive maintenance requirements were reviewed from the TDI Instruction Manual. Although the review of Comanche Peak and industry experience had revealed no problems with valve components loosening, it is recommended that the snugness of the locking devices on the valve linkages be verified on a monthly basis.

The nozzle loads on this component are considered to be negligible.

Quality Revalidation Inspection results that were considered in this review are 1) EDGCTS site experience documents reviewed with satisfactory results, 2) visual inspections performed on butterflies, attachment pipe, and shafts, 3) installation and alignment of butterfly valve verified, and 4) hardness test performed on shaft.

Based on the above review, the OG concluded that the air butterfly valve assembly is acceptable for its intended design function at Comanche Peak.

5.54.2 PNL's Evaluation

PNL reviewers noted that the Quality Revalidation information had open items, namely 1) a microhardness report requested by the OG but not documented as having been received and 2) no notation of grease fitting installation records. At the July 1985 meeting the OG confirmed that they had decided not to require the microhardness tests. This review and conclusions were supported by four other measures of component quality. The grease fittings are in engineering for implementation. Based on this new information, the information in the DR/QR report, and TUGCO's commitment to monthly functional checks and OG-recommended maintenance actions at each outage, PNL concurs with the OG that the subject valve is acceptable for its intended service.

5.55 LUBE OIL SUMP TANK STRAINER ASSEMBLY AND MOUNTING HARDWARE (Part Nos. 02-540A&C)

5.55.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the lube oil sump tank with a strainer for normal loads including hydrostatic pressure, piping loads, thermal expansion loads, and seismic inertia loads. Also, the mounting hardware was reviewed for structural integrity.

Results and Conclusions

Review of Comanche Peak site, nuclear, and non-nuclear industry experience recorded in the EDGCTS indicated only minor instances related to routine maintenance of the strainer.

The seismic qualification analyses have been found to be in agreement with the latest revisions of drawings, specifications, and ASME Code Section III, Class 3 requirements. During the site visit, no obvious discrepancies were found between the installed condition of the lube oil sump tank and the TDI drawings.

Additional stresses in the tank cylindrical shell due to thermal expansion and base constraint may exceed yield, but failure of the shell due to these self-limiting stresses is not expected because the shell is ductile. Displacements are minor.

There are no displacement-sensitive features of the design, and the number of thermal cycles for the lube oil system is low.

Nozzle loads have been reviewed and found acceptable.

Quality Revalidation results (no site experience documents in evidence) were considered.

Based on the above review, the OG concluded that the lube oil sump tank with strainer and mounting hardware is structurally adequate for its intended design function at Comanche Peak.

5.55.2 PNL's Evaluation

PNL learned at the July 1985 meeting with TUGCO that the OG reviewed and accepted this component for service without requiring the confirmation of bolt torque (specified in the component Quality Revalidation Checklist for Comment 02-540C). Their conclusion of adequacy was based on the fact that TUGCO had done the installation and their quality control was deemed acceptable.

Based on this information, and on the review of the DR/QR report, PNL concludes that the subject components are adequate for their intended service.

5.56 LUBE OIL SUMP TANK: MISC. FITTINGS, GASKETS, PIPE AND BOLTING MATERIAL, VALVE (small-bore scope only) (Part No. 02-540B)

5.56.1 OG Analysis

DR/QR Objective

The objective of this review was to perform an engineering evaluation of the small-bore piping and supports to provide assurance that the component will perform its intended design function during normal operating and earthquake loadings.

Results and Conclusions

The small-bore piping and supports have been evaluated and have been found acceptable.

The Quality Revalidation Inspection results were considered. These included the satisfactory review of EDGCTS site experience documents, the satisfactory results of leak tests performed on the system, and material comparator test results.

Based on the above review, the OG concluded that the tubing and supports will perform their intended design function at Comanche Peak under all normal operating and earthquake loadings.

5.56.2 PNL's Evaluation

Based on the review of the DR/QR report information, PNL concurs with the OG conclusions on the subject components.

5.57 OFF-ENGINE ALARM SENSORS: WIRING (Part No. 02-689)

5.57.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the off-engine alarm sensor wiring for its intended service at Comanche Peak.

Results and Conclusions

A review of the EDGCTS shows no nuclear, non-nuclear, or site experience relative to the off-engine alarm sensor wiring.

A conservative estimate of the maximum ambient temperature to which this wiring would be exposed is 180°F. All wire in the system has a rating of 194°F (90°C) or higher, based on Underwriter Laboratories temperature ratings for these material types. In addition, all wire used is of an acceptable flame-retardant construction.

Quality Revalidation results of no EDGCTS site experience documents in evidence were considered.

Based on the above review, the OG concluded that the off-engine alarm sensor wiring is acceptable for its intended use at Comanche Peak.

5.57.2 PNL's Evaluation

Based on information provided in the DR/QR report, PNL concurs with the OG that the subject wiring is acceptable for its intended use.

5.58 AUXILIARY SUB-BASE AND OIL AND WATER PIPING: PIPE, COUPLINGS, FITTINGS, ORIFICES, Y STRAINERS (large-bore scope only) (Part No. 02-717C)

5.58.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the subject piping to carry jacket water from the jacket water standpipe, through the jacket water pump, the jacket water and lube oil coolers, and the intercooler to the jacket water inlet manifold during normal operating and earthquake loadings.

Results and Conclusions

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

The movements at five of the ten Dresser couplings in the subject component exceed the manufacturer's end movement requirements. This requires modi-

fications 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, to mitigate the excessive movements of the coupling located in the jacket water inlet manifold, it is recommended that a support be added. In addition, extra nuts are required on the tie-rod assemblies of the other two couplings.

Specifically, the following modifications are recommended:

- Remove three 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:
  - 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.

There are no service life constraints because couplings of this style have no significant history of failure. Shelf life is unlimited so long as the gaskets remain packaged and protected from the elements. The coupling is adequate with respect to manufacturer's service condition limits.

To provide adequate load transfer capability, the 6-inch-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.

To ensure adequate restraint of the piping system, modifications of some supports are recommended. Details on support modifications are summarized in Impell Report No. 02-0630-12271, Rev. A, August 1984, for component No. 01-717E.

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

The following Quality Revalidation Inspection results were considered in this review: 1) no EDGCTS site experience documents in evidence, 2) material comparator tests performed, 3) piping installations verified by field walkdown, and 4) as-built drawings to be issued.

The OG concluded that the subject piping components, with the recommended modifications, are adequate for their intended design function at Comanche Peak.

5.58.2 PNL's Evaluation

Based on the information provided in the DR/QR report, and noting TUGCO's commitments to monthly inspections and to implement the OG-recommended modifications, PNL concurs with the OG conclusions regarding these components.

5.59 AUXILIARY SUB-BASE AND OIL AND WATER PIPING: LUBE OIL VALVES (Part No. 02-717G)

5.59.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the lube oil valves for their intended service at Comanche Peak.

Results and Conclusions

The maximum design lube oil conditions are a pressure of 100 psi and a temperature of 200°F. Materials of construction and pressure rating are acceptable for the intended service at Comanche Peak.

The globe valves, three-way valves, shutoff valves, and plug valves may be installed in any orientation without operational impairment.

Review of the EDGCTS shows that the lube oil keepwarm relief valve leaked on both diesel generators at Comanche Peak.

No preventive maintenance is listed in the TDI Maintenance Manual for the lube oil valves. It is recommended that preventive maintenance for these valves consist of checking the lift pressure. This maintenance will be performed during the 5-year maintenance outages.

End reactions on small-bore valves (2 inches and smaller) are considered acceptable because the relative strength of small-bore valves is much greater than that of the attached small bore piping/tubing.

Nozzle loads on large-bore valves (2-1/2 inches and larger) have been evaluated and found acceptable.

Quality Revalidation results (the EDGCTS site documentation review) were considered.

Based upon the above review, the OG concluded that the lube oil valves are acceptable for their intended design function at Comanche Peak.

5.59.2 PNL's Evaluation

Based on the information contained in the DR/QR report, and noting TUGCO's commitment to implement the OG-recommended M/S,[a] PNL concurs with the OG conclusion that the subject valves are acceptable for their intended purpose.

(a) TUGCO plans to disassemble, inspect, and refurbish the lube oil valves at 5-year intervals rather than at each outage. PNL reviewers concur with TUGCO's change.

5.60 AUXILIARY SUB-BASE AND OIL AND WATER PIPING: LUBE OIL GASKETS AND BOLTING (Part No. 02-717H)

5.60.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the suitability of the gaskets and bolting for their intended service at Comanche Peak.

Results and Conclusions

TDI has not recommended a maintenance program for the lube oil gaskets. However, as part of the daily suggested maintenance schedules, the auxiliary piping should be walked down to check for leaks, and corrective action taken.

The material selected for use as gaskets is specified for use with lube oils. Therefore, it is satisfactory for its intended use in the lube oil system at Comanche Peak.

The bolting used on the flanged joints requires no specific torque value. However, the bolting will be tightened to satisfy leaktightness criteria. The material selected (SAE Grade 5 or better) is satisfactory based on its past history of providing a leaktight connection during normal operation and hydro testing without any incidence of joint leaks or bolt failures. It is therefore concluded that the bolting selected is satisfactory in its intended design function.

Review of the EDGCTS showed no Comanche Peak, nuclear, or non-nuclear industry experience items for this component.

The Quality Revalidation results (no EDGCTS site experience documents in evidence) were considered.

The OG concluded that the gaskets and bolting are acceptable for their intended design function at Comanche Peak.

5.60.2 PNL's Evaluation

Based on the information presented in the DR/QR report, and noting TUGCO's commitment to conduct daily checks for leakage, PNL concurs with the OG conclusions on these components.

5.61 AUXILIARY SUB-BASE LUBE OIL PIPING: SUPPORTS (large-bore scope only) (Part No. 02-717I)

5.61.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the subject piping supports for normal operating and earthquake loadings.

Results and Conclusions

To accommodate the total support loads provided by the subject component configuration, it is recommended that some supports be modified. These modifications involve primarily the reinforcement of supporting members to provide adequate restraint. Also, to mitigate the movements at the Dresser coupling on the piping between the lube oil cooler and the duplex filter, a support should be stiffened.

All pipe support loads on engine blocks or skid have been tabulated and issued for evaluation.

Quality Revalidation Inspection results were considered. These included 1) satisfactory review of EDGCTS site experience documents, 2) field inspections performed on U-bolts and supports, 3) installation of supports and mounting hardware checked by line walkdown, and 4) as-built drawings to be issued.

The OG concluded that the subject piping supports, modified as noted, are adequate for their intended design services at Comanche Peak.

5.61.2 PNL's Evaluation

On the basis of the information provided in the DR/QR report, and noting that TUGCO has committed to the OG-recommended modifications, PNL concurs with the OG findings on the subject component.

5.62 AUXILIARY SUB-BASE AND OIL AND WATER PIPING AND LUBE OIL: SUPPORTS AND MOUNTING HARDWARE (small-bore scope only) (Part No. 02-717I)

5.62.1 OG Analysis

DR/QR Objective

The objective of this review was to perform an engineering evaluation of the small-bore piping/tubing supports to ensure that the component will perform its intended design function during normal operation and earthquake loadings.

Results and Conclusions

The small-bore piping/tubing supports, as defined by this Component Design Review, have been found acceptable with modification.

The Quality Revalidation Inspection results were considered (see Section 5.61.1).

Based on the above review, the OG concluded that the small-bore piping/tubing supports will perform their intended design function at Comanche Peak under all normal operating and earthquake loadings, with the provision that tubing supports ST-PSR-10733 and 10738 be removed and replaced by two-way lateral supports for each individual tube.

5.62.2 PNL's Evaluation

On the same bases identified in Section 5.61.2, above, PNL concurs with the OG conclusions regarding this component.

5.63 INTAKE AIR FILTERS (Part No. 02-805B)

5.63.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the intake air filters to protect the working parts of the engine from dust or particulate entry which could cause abrasion or wear.

Results and Conclusions

Filters for inlet air systems are not selected based on opening size but by an efficiency rating. The filter cells used in these FIDM Model filters are rated at 90 percent efficiency. Based on conversations with the filter manufacturer, the 90 percent efficient filter provided for the TDI engines is a standard rating for diesel engine intake. The 90 percent efficiency is based on filter testing per AFI Test Method.

The filter has a clean pressure drop of 3 inches W.G. and a maximum allowable pressure drop of 6.5 inches W.G. The design does not include a vacuum gauge option, which would give visual indication of intake pressure loss. This is not considered necessary at this time because Comanche Peak and industry experience has not indicated filter clogging to be a major problem, and, under normal conditions, the engines are not operating except for monthly surveillance testing.

Filter cartridges may be changed while the unit is operating, if necessary; the replacement procedure is detailed in the TDI Manual. It is recommended that the filter cartridges be inspected and/or replaced at 3- to 6-month intervals. This maintenance is important to help the engine attain rated power.

Quality Revalidation results (a satisfactory review of EDGCTS site experience documents) were considered.

Based on the above review, the OG concluded that the intake air filters are acceptable for their intended design function at Comanche Peak.

5.63.2 PNL's Evaluation

PNL concludes that an adequate analysis was performed. TUGCO's maintenance schedule for these filters is based on filter differential pressure rather than on the 3- to 6-months intervals recommended by the OG. PNL reviewers concur with this change. On these bases, PNL concurs with the OG conclusions on the adequacy of the intake air filters.

5.64 MISCELLANEOUS EQUIPMENT - AUXILIARY JACKET WATER PUMP (Part No. 02-810A)

5.64.1 OG Analysis

DR/OR Objective

The objective of this review was to determine the adequacy of the auxiliary jacket water pumps to maintain sufficient jacket water flow through the engine for cooling in the event of the loss of the main engine driven jacket water pumps.

Results and Conclusions

A review of site and industry experience was not performed because a formal design review for this component is neither needed nor required.

Component Revalidation results were reviewed. The OG concluded that the auxiliary jacket water pumps are installed properly and will perform their intended design function at Comanche Peak.

5.64.2 PNL's Evaluation

PNL reviewers noted that the pump capacity was not evaluated. This was reviewed with the OG and TUGCO at the July 1985 meeting. TUGCO cited the favorable operating history at CPSES and the absence of any reported cases of inadequate capacity as sufficient evidence of adequate design capacity. On the basis of this and the information in the DR/QR report, PNL concurs with the OG conclusions regarding the subject component.

5.65 JACKET WATER HEAT EXCHANGER (Part No. 02-810C)

5.65.1 OG Analysis

DR/OR Objective

The objective of this review was to verify the adequacy of the jacket water heat exchanger to maintain the jacket water temperature at the outlet of the engine within the range of 170° to 180°F.

Results and Conclusions

A review of the EDGCTS shows no adverse experience with the jacket water heat exchangers at Comanche Peak. The majority of applicable industry experience can be avoided by proper preventive maintenance, including daily flushing of jacket water heat exchangers.

ASME Form N-1, "Manufacturer's Data Report for Nuclear Vessels" for the jacket water heat exchangers, was reviewed and found acceptable. In addition, the design conditions in this form satisfy system requirements, thereby ensuring structural integrity.

The jacket water heat exchangers at Comanche Peak have outside packed floating tube sheets and lantern rings designed for external leakoff. Leakage through the packing is visible and can be eliminated by careful bolt adjustment to compress the neoprene packing. To minimize this type of leakage, it is recommended that the packing rings be replaced and not reused if head removal is required.

The TDI Maintenance Manual was reviewed and found to be acceptable except as noted in this report.

The jacket water heat exchanger was observed to operate adequately from thermal and fluid flow viewpoints during startup testing.

Nozzle loads have been evaluated and found acceptable.

Quality Revalidation results (a satisfactory review of the EDGCTS site documents) were considered.

Based on the above review, the OG concluded the jacket water heat exchanger is acceptable for its intended design function at Comanche Peak.

5.65.2 PNL's Evaluation

PNL reviewers questioned the heat exchanger performance under extremes of temperature that might occur at CPSES and the compatibility of the pump, strainers, and thermostats with the heat exchanger. TUGCO responded to these questions at the July 1985 meeting, reporting that the heat exchanger has operated at Texas summer temperatures without incident. TUGCO also noted that favorable operating history at CPSES and at other nuclear sites having

comparable heat exchangers is evidence of system reliability/operability. Based on TUGCO's responses, the DR/QR report information, and TUGCO's commitment to extensive maintenance at outages in conformance with OG recommendations, PNL concurs with the OG conclusions regarding this component's acceptability for its intended service.

5.66 JACKET WATER THERMOSTATIC VALVE (Part No. 02-810D)

5.66.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the thermostatic valve to maintain the jacket water temperatures within the specified limits.

Results and Conclusions

Based on the valve materials, pressure rating, temperature modulation range, and installation, as well as system design requirements, the valve is suitable for its intended function at Comanche Peak.

The TDI Maintenance Manual was reviewed for adequacy of the maintenance program with regard to the jacket water thermostatic valve. To augment the Maintenance Manual, it is recommended that the power element be replaced at 3- to 5-year intervals, which agrees with the manufacturer's recommendation.

Review of the EDGCTS indicates no Comanche Peak experience to date. The industry experiences listed do not indicate any problems with the design of the thermostatic valve.

Nozzle loads have been evaluated and found acceptable.

The OG concluded that the jacket water thermostatic valve is acceptable for its intended design function at Comanche Peak.

5.66.2 PNL's Evaluation

Based on the DR/QR information and TUGCO's commitment to the OG M/S recommendations, PNL concurs with the OG conclusions regarding the subject valve.

5.67 MISCELLANEOUS EQUIPMENT - JACKET WATER STANDPIPE HEATER (Part No. 02-810E)

5.67.1 OG Analysis

DR/QR Objective

The objective of this review was to determine the adequacy of the jacket water standpipe heater to maintain jacket water at a controlled temperature whenever the engine is in a standby mode.

Results and Conclusions

A review of site and industry experience was not performed since a formal design review for this component is neither needed nor required.

Component Revalidation results (a satisfactory review of the EDGCTS site experience documents) were reviewed. The OG concluded that the jacket water standpipe heater is installed properly and will perform its intended design function at Comanche Peak.

5.67.2 PNL's Evaluation

PNL reviewers noted that problems had been encountered at SNPS with this component. It was learned at the July 1985 meeting that the CPSES and SNPS component differed in that the CPSES unit has one immersion heater and has proper circulation to prevent stagnant water around the element. PNL reviewers considered TUGCO's M/S plan, which proposes to observe and record jacket water temperature daily and to conduct maintenance on an alternate outage basis rather than at each outage as recommended by the OG. The proposed change is acceptable to PNL, subject to concurrence by the OG and TDI. On these bases, PNL concurs with the OG conclusions pertaining to the subject component.

Surveillance Suggestion

PNL suggests that the trends in jacket water temperature be evaluated using the daily recorded temperatures.

5.68 MISCELLANEOUS EQUIPMENT - AUXILIARY LUBE OIL PUMP (Part No. 02-820B)

5.68.1 OG Analysis

DR/QR Objective

The objective of this review was to determine the adequacy of the auxiliary lube oil pumps to supply the total quantity of oil required to lubricate and cool the engine in the event of the loss of the main engine driven lube oil pumps.

Results and Conclusions

A review of site and industry experience was not performed because a formal design review for this component is neither needed nor required.

Component Revalidation Inspection results were reviewed. The Owners' Group concluded that the auxiliary lube oil pumps are installed properly and will perform their intended design function at Comanche Peak.

5.68.2 PNL's Evaluation

PNL reviewers noted that the pump capacity had not been confirmed as part of the DR/QR. This was discussed with TUGCO and OG at the July 1985 meeting. TUGCO reported that the acceptability of the auxiliary lube oil pump is established based on the pumps' proven ability to satisfactorily maintain the required system pressure. Furthermore, the auxiliary lube oil pump maintains a lube oil system pressure that exceeds that of the engine driven lube oil pump. Finally, many of the TDI diesels operating in nuclear standby service do not have these pumps. As stated, the pump is an "auxiliary", which is not required, and is not "standard equipment" on the engine.

In view of this information and the review of the DR/QR report, PNL concludes that the auxiliary lube oil pump is adequate for its intended service at Comanche Peak.

5.69 PRELUBE OIL PUMP (Part No. 02-820C)

5.69.1 OG Analysis

DR/QR Objective

The objective of this review was to verify that the prelube oil pumps can circulate adequate warm lubricating oil through the engine so that it is ready for immediate startup.

Results and Conclusions

There have been no reported leaks from the pressure boundary. Therefore, the integrity of the pressure boundary has been demonstrated.

The capacity requirement of the pump was determined and verified by TDI during engine shop testing by checking that oil flow reached the highest point, the piston crown cavity. There is no history of the engines not being ready to start because of the lube oil keepwarm pump. The hydraulic performance is adequate.

The pump has one mechanical seal to prevent oil leakage. The seal operates in an almost ideal environment of filtered, warm lubricating oil. The mechanical seal is suitable for the intended service.

The mechanical design is satisfactory.

The pressure boundary parts are carbon steel. The internal wetted parts are cast iron and carbon steel. The mechanical seal has stainless steel metal parts and Teflon secondary seals. All are satisfactory for lubricating oil service.

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 on other V-16 engines using the same model prelube pump. It is recommended that, as part of daily engine walkdown, the pump be inspected for signs of leakage, and that corrective modifications (addition of flexible piping connections) be implemented as required.

Quality Revalidation results (no EDGCTS site experience documents in evidence) were considered in performing this review.

The OG concluded that the lube oil keepwarm pump is acceptable for its intended design function at Comanche Peak.

5.69.2 PNL's Evaluation

Based on the DR/QR information, and noting TUGCO's commitment to monthly and outage maintenance and to the OG-recommended daily checks for leaks, PNL concurs with the OG conclusion regarding the prelube oil pump.

5.70 LUBE OIL KEEPWARM STRAINER (Part No. 02-820D)

5.70.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the lube oil keepwarm strainer to catch potential collapsed cartridge debris from the upstream keepwarm lubricating oil filter.

Results and Conclusions

The TDI Manual specifies acceptable procedures for cleaning the strainers. The TDI Maintenance Manual does not specify inspection or cleaning/replacement intervals for the strainers.

To augment the TDI Maintenance Manual, it is recommended that the strainer differential pressure be inspected daily, and that the strainer be cleaned/replaced at 20 psid.

The strainers are acceptable based on the operating conditions for the keepwarm oil system.

The strainer element retains 98 percent of particles greater than 40 microns and 100 percent of particles greater than 80 microns. Because this strainer's primary function is to catch potential collapsed cartridge debris from the upstream 10-micron keepwarm filter, the strainer size is acceptable.

There has been no Comanche Peak or industry experience indicating any problems with the design of the strainer.

Nozzle loads were evaluated and found acceptable.

Quality Revalidation results (no EDGCTS site experience documents in evidence) were considered.

The OG concluded that the lube oil keepwarm strainer is acceptable for its intended design function at Comanche Peak.

5.70.2 PNL's Evaluation

PNL concurs with the OG conclusions on the subject component. In response to PNL reviewer questions about the strainer capacity, TUGCO verified at the July 1985 meeting that the strainer had been confirmed to be of adequate capacity to service the prelube oil pump. Considering this and TUGCO's commitment to the OG-recommended M/S, PNL concurs with the OG conclusion regarding the adequacy of this component.

5.71 OIL PRELUBE FILTER (Part No. 02-820E)

5.71.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the oil prelube filter for removing foreign materials and debris from the lube oil system.

Results and Conclusions

The maintenance procedures give adequate instruction for taking the filter off line, changing cartridges, and venting and returning the filter to service. It is recommended that the oil prelube filter cartridge differential pressure be checked monthly and that the cartridge be changed at 20 psid. These maintenance procedures will ensure that the filter cartridge will not plug during operation.

The filter is constructed in accordance with the ASME Code Section III for pressure vessels and is rated for 150-psig service at 175°F. Because the maximum pressure to which the filter is subjected is 25 psig (based on the relief valve set pressure on the discharge of the keepwarm pump), this filter is suitable for the service conditions.

Comanche Peak, nuclear, and non-nuclear industry experiences have not revealed any problems with the design of the filter.

Nozzle loads have been evaluated and found acceptable.

Quality Revalidation results (no EDGCTS site experience documents in evidence) were considered.

The OG concluded that the oil prelube filter is acceptable for its intended design function at Comanche Peak.

5.71.2 PNL's Evaluation

PNL concludes that an adequate analysis was made by the OG. TUGCO informed PNL at the July 1985 meeting that this filter had been confirmed to be of adequate capacity to service the prelube oil pump. Noting this and TUGCO's commitment to the OG M/S, PNL concludes that the service history of the oil prelube filters at Shoreham and Comanche Peak is sufficient to establish this component's acceptability.

M/S Suggestion

PNL suggests that TUGCO maintain and analyze records of differential pressure versus time to analyze trends of filter clogging.

5.72 FULL FLOW LUBE OIL FILTERS (Part No. 02-820F)

5.72.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the full flow lube oil filter to remove foreign materials and debris from the lube oil system.

Results and Conclusions

The manufacturer gives adequate instructions for taking the filter off line, changing cartridges, venting and returning the filter to service. The TDI Instruction Manual specifies that the filter differential pressure will be

checked monthly, but does not indicate the differential pressure at which the filter will be changed. It is recommended that the filter cartridge be changed at approximately 20 psid.

The particle retention size of the filter is 10 microns, which is suitable for lube oil service, in accordance with API Standard 614.[a]

The filter is constructed in accordance with the ASME Code Section III for pressure vessels. It is rated for 150-psig service at 200°F and was hydrotested to 225 psig. This filter is suitably designed and rated for the service conditions.

Comanche Peak and industry experiences have not revealed any problems with the design of the filter.

Nozzle loads have been evaluated and found acceptable.

Quality Revalidation results (no EDGCTS site experience documents in evidence) were considered.

Based on the above review, the OG concluded that the lube oil full flow filter is acceptable for its intended design function at Comanche Peak.

5.72.2 PNL's Evaluation

In response to questions raised by PNL reviewers regarding filter capacity and whether a relief valve and bypass around the filter is provided, TUGCO supplied the following information.

- Verification of equipment capacity is not required. The engine driven positive displacement lube oil pump maintains system pressure at 50 psi by incorporating a pressure regulating valve and recirculation line back to the pump. The performance curve of a positive displacement pump is relatively flat and will maintain the required system pressure over a range of flow rates.

(a) During the audit review in early July 1985, PNL learned that the filters in place were 20-micron, not 10-micron, retention size. TUGCO licensing reports that the 20-micron filters have since been replaced with 10-micron retention size filters.

- It should be noted that lube oil system pressure control feedback is from a point downstream of the subject equipment. This being the case, plus successful system/engine operation, the pump and downstream equipment of the system, correlate the performance of the system component as being compatible and adequate.

  There is no relief valve and bypass around the subject equipment. The concerns raised regarding this component are not related to the attributes to be verified.

  The pressure boundary, nozzle loads, pressure drop, and particle retention size were the attributes to be verified; all were found acceptable.

On the basis of this information and the information contained in the DR/QR report, PNL concludes that these filters will serve their intended function at Comanche Peak.

5.73 LUBE OIL HEAT EXCHANGER (Part No. 02-820G)

5.73.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the lube oil heat exchanger to maintain the lube oil temperature at the outlet of the engine within the range of 170 to 180°F.

Results and Conclusions

The lube oil heat exchanger was observed to operate adequately from thermal and fluid flow viewpoints during engine startup testing.

The information provided in ASME Form N-1, "Manufacturer's Data Report for Nuclear Vessels" for the lube oil heat exchangers, was found acceptable.

Review of the industry experience indicated that failures of the lube oil heat exchanger for the nuclear emergency diesel generator applications were confined almost exclusively to tube failure.

At Comanche Peak the lube oil heat exchanger is cooled by the jacket water system. The lube oil heat exchanger is arranged in series with the engine driven jacket water pump, which is running at constant speed, so that coolant flow rate through the lube oil heat exchanger will always be constant and equal to the full flow rate of the jacket water system.

The design of the heat exchanger and the Comanche Peak operating experience, therefore, indicate that the lube oil heat exchanger will not be susceptible to localized erosion at the tubes and the tube/tube sheet interface.

Review of the Comanche Peak and industry experience has not identified any incident of emergency diesel generator failure caused by excessive temperature of the lube oil. For lube oil heat exchangers cooled by the engine jacket water as at Comanche Peak, high lube oil temperature because of excessive fouling on heat surfaces is not anticipated.

Preventive maintenance efforts outlined below should be followed to ensure availability of the lube oil heat exchanger for operation of the emergency diesel generator.

The heat exchanger tube side should be inspected during refueling maintenance outages to assess the condition of the tubes and the tube sheet for fouling, corrosion, and other symptoms of deterioration.

During the refueling outage, both the jacket water system and the lube oil system should be drained completely. Then the entrance and the exit channel covers should be removed for heat exchanger tube side inspection. The packing rings at the floating tube sheet should be replaced during reassembly.

Spectrochemical analysis of lube oil samples should be performed approximately every 3 months, to monitor the condition of the diesel engine.

Nozzle loads have been evaluated and found acceptable.

Quality Revalidation results (a satisfactory review of the EDGCTS site experience documents) were considered.

The OG concluded that the lube oil heat exchanger is acceptable for its intended design function at Comanche Peak.

5.73.2 PNL's Evaluation

On the basis of the information provided in the DR/QR report, and noting TUGCO's commitment to the OG-recommended M/S plan, PNL concurs with the OG that the lube oil heat exchanger is acceptable for its intended service.

5.74 LUBE OIL FULL PRESSURE STRAINER (Part No. 02-820H)

5.74.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the lube oil full pressure strainers to catch potential collapsed cartridge debris from the upstream full flow lubricating oil filter.

Results and Conclusions

The TDI Manual specifies acceptable procedures for the operation and servicing of the strainer. The TDI maintenance manual specifies that the strainers are to be checked at monthly intervals, but does not indicate the differential pressure at which the strainer should be cleaned/changed. It is recommended that the strainer differential pressure be recorded and used for trend data. Also, at each outage or when the strainer differential pressure increases significantly, as indicated by the trend data, the strainer should be inspected and the element cleaned.

The strainer element retains 98 percent of particles greater than 40 microns and 100 percent of particles greater than 80 microns. Because this strainer's primary function is to catch potential collapsed cartridge debris from the upstream 10-micron full flow filter, this strainer size is acceptable.

Comanche Peak, nuclear, and non-nuclear industry experiences have not indicated any problems with the design of the strainer.

The strainers comply with the ASME Code and are acceptable, based on the lube oil system operating conditions.

Nozzle loads were evaluated and found acceptable.

Quality Revalidation results (a satisfactory review of EDGCTS site experience documents) were considered.

The OG concluded that the lube oil full pressure strainer is acceptable for its intended design function at Comanche Peak.

5.74.2 PNL's Evaluation

PNL concludes that an adequate analysis was made. Based on their positive service history at Comanche Peak and Shoreham, and TUGCO's commitment to the OG-recommended M/S, PNL concludes that the subject filters have proven their acceptability.

5.75 FUEL OIL DAY TANK (Part No. 02-825A)

5.75.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the fuel oil day tank for operational loads and to review available ASME Code Section III design information.

Results and Conclusions

The tank vendor was a qualified ASME Code Section III vendor at the time of manufacture, and this review has found no reason to question the competence of the vendor. The TDI design specification for the tank adequately describes the service conditions and design requirements for the tank. The construction details shown on the design drawings are substantial for an atmospheric tank, and the choice of ASME Code Section III as a design code produces a tank design that is conservative with respect to its service requirements.

Using load summaries and drawings, the pedestal was found to have adequate strength.

Nozzle allowables are greater than the expected actual piping loads, based on Kellog formulas. Therefore, nozzle loads are considered acceptable.

Quality Revalidation results (a satisfactory review of EDGCTS site experience documents) were considered.

Based on the above review, the OG concluded that the fuel oil day tank is adequate for its intended use at Comanche Peak.

5.75.2 PNL's Evaluation

PNL reviewers questioned whether there is adequate means to remove water from the fuel oil to ensure that the fuel injection pumps are protected from accumulated water. In the July 1985 meeting, TUGCO informed PNL that at least once per 92 days, the fuel oil storage tanks are checked for any accumulated water. At least once per 31 days and after each operation equal to or greater than 1 hour, the day tank is also checked for accumulated water. This is done per procedure OPT-214A by taking a sample at the fuel oil pump suction strainer. This prevents any water from entering the fuel oil system, and, if any water is found, it is removed.

On the basis of TUGCO's response and information provided in the DR/QR report, PNL concurs with the OG conclusion that the fuel oil day tank is adequate for its intended function.

5.76 FUEL OIL SYSTEM DUPLEX STRAINER (Part No. 02-825E)

5.76.1 OG Analysis

DR/QR Objective

The objective of this effort was ᵗ review the Component Revalidation Checklist and determine the adequacy of the fuel oil duplex strainer to prevent harmful particulate from entering the pump.

Results and Conclusions

A review of site and industry experience was not performed because a formal design review for this component is neither needed nor required.

Component revalidation results (no EDGCTS site experience documents in evidence) were reviewed. The OG concluded that the fuel oil duplex strainer is installed properly and will perform its intended function at Comanche Peak.

5.76.2 PNL's Evaluation

Based on the DR/QR information, PNL concurs with the OG conclusion regarding acceptability of the fuel oil system duplex strainer.

5.77 AIR START SYSTEM: STARTING AIR SKID BASE (Part No. 02-835A)

5.77.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the structural integrity of the air start skid for normal and seismic loads.

Results and Conclusions

No experience was reported in the EDGCTS for the air start skid.

Seismic qualification documents for Comanche Peak were reviewed, and no qualification report for the skid was found. However, seismic tests of the starting air compressors and starting air aftercoolers, which are mounted on the skid, were performed by Structural Dynamic Corporation. An evaluation of this inconsistency resulted in the addition of a check valve between the air dryer and starting air tank to ensure the integrity of the start air inventory. This modification justified the downgrading of the skid and mounted components to non-QA, non-seismic. This approach is acceptable in that there is no violation of the safety-related functions of the diesel. A fully charged air start system can satisfy the required number of start attempts without operation of the air compressors.

Given the situation described above, seismic qualification of the starting air skid is not required. Also, since flexibility would be of concern relative only to seismic qualification, it is not an issue for Comanche Peak. Structural adequacy of the skid for normal loads is considered acceptable, based on a review of the drawings and engineering judgment.

Quality Revalidation results (a satisfactory review of EDGCTS site experience documents) were considered.

Based upon the above engineering evaluation, the OG found the starting air skid base acceptable for its intended use at Comanche Peak.

5.77.2 PNL's Evaluation

PNL reviewers noted that the starting air relief valve capacity is slightly greater than the compressor capacity. TUGCO was requested to verify that it is not possible to connect more than one compressor to each air tank. At the July 1985 meeting TUGCO confirmed that it is not possible to connect more than one compressor to an air tank.

On the basis of this information and the information in the DR/QR report, PNL concurs with the OG conclusions regarding the structural integrity of the starting air skid base.

5.78 STARTING AIR TANK RELIEF VALVE (Part No. 02-835D)

5.78.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the starting air tank relief valve to provide overpressure protection to the starting air tank.

Results and Conclusions

The relief valve is constructed of a stainless steel base and a carbon steel cap with carbon and stainless steel internals and soft steel gaskets. The materials of construction, pressure/temperature ratings, and set pressure are suitable for the system design conditions, and the valve is used in accordance with the manufacturer's intended application.

The starting air compressors at Comanche Peak are rated to 76 scfm, while the relieving capacity of the valve is 95 scfm. Therefore, the relief valve is sufficiently sized.

The review of Comanche Peak, nuclear, and non-nuclear industry experience did not indicate any problems with the design of the relief valve at Comanche Peak.

End reactions on small-bore valves (2 inches and smaller) are considered acceptable because the relative strength of the valves is much greater than that of the attached small-bore piping/tubing.

Quality Revalidation results (a satisfactory review of the EDGCTS site experience documentation) were considered.

The OG concluded that the starting air tank relief valves are acceptable for their intended design function at Comanche Peak.

5.78.2 PNL's Evaluation

On the basis of the information provided in the DR/QR report, and noting that it is not possible to connect more than one compressor to an air tank, PNL concurs with the OG that the subject valves are acceptable for use at Comanche Peak.

5.79 STARTING AIR FLOAT TRAP (Part No. 02-835F)

5.79.1 OG Analysis

DR/QR Objective

The objective of this review was to verify the adequacy of the starting air float traps for automatically draining water from the air start tanks and aftercooler at Comanche Peak.

Results and Conclusions

The pressure rating is acceptable for the float trap's intended service.

The materials of construction are hardened chrome steel (valve and seat); stainless steel (leverage system and float); ASTM A-105 forged steel (body and cap); and compressed asbestos (gasket). These materials are acceptable for air/water service.

There has been no Comanche Peak, nuclear, or non-nuclear industry experience with this component.

The float traps are located below the aftercooler and below the air start tanks, which agrees with the manufacturer's recommended installation procedure.

At Comanche Peak the maintenance schedule specifies daily draining of water from the air start tanks; this is the primary function of the float trap. Therefore, to comply with manufacturer's recommendations, it is recommended that Comanche Peak maintenance procedures be revised to specify daily

verification of float trap operability, and disassembly and cleaning of the float trap annually or at each refueling outage.

End reactions on small-bore float trap/valves (2 inches and smaller) are considered acceptable, because the relative strength of small-bore float trap/valves is much greater than that of the attached small-bore piping/tubing.

Based on the above review, the OG concluded that the starting air float trap is acceptable for its intended design function at Comanche Peak.

5.79.2 PNL's Evaluation

Based on the information provided in the DR/QR report, and noting TUGCO's commitment to the OG-recommended maintenance (entered in Appendix B under component No. 02-835J), PNL concurs with the OG conclusions pertaining to the starting air float trap.

5.80 STARTING AIR TANK (Part No. 02-835J)

5.80.1 OG Analysis

DR/QR Objective

The objective of this review is to perform an engineering evaluation of the structural adequacy of the starting air tank for normal and seismic loads and to verify that the tank design complies with ASME Code Section III.

Results and Conclusions

The ASME publication was consulted, and the tank manufacturer was found to have an "N" stamp throughout the time that the tank was being designed and built.

The SDRC seismic analysis report, which includes an analysis of stresses due to normal loads such as pressure and deadweight, was reviewed and found to adequately address the structural integrity of the tank.

It was found from the embedment design that the tank was adequately secured.

In comparing the pictures of the actual tank and the PX drawing, it was found that the 3-inch outlet was installed with a reinforcement pad at the

outer wall of the shell. While no such pad was required by the specifications or the PX drawing, it acts to reduce the nozzle stresses. No other discrepancies between the actual tank and the design were found.

Allowable nozzle loads were calculated and are considered to be acceptable.

No corrosion allowance was used in the design of this vessel. This is consistent with ASME III, Division I, requirements since no corrosion allowance is required for this type of service and this vessel thickness (1/2 inch).

To eliminate moisture from the tank, a desiccant type air dryer was installed between the compressor and the tank. In addition, the tank is equipped with float traps that automatically release accumulated water. Maintenance procedures including daily checks of the drain traps have been recommended in the DR/QR report for component number 02-835 F to ensure a minimally corrosive environment for the tank.

Quality Revalidation results of no EDGCTS site experience documents in evidence were considered.

Based on the engineering evaluation discussed above, the OG concluded that the starting air tank is structurally adequate for its intended use at Comanche Peak and that no technical deficiencies have been found in the qualifying documents.

5.80.2 PNL's Evaluation

PNL concludes that the OG analysis is adequate. Based on this, and noting the daily and outage M/S committed to by TUGCO (drain air receiver float tanks daily and conduct assembly and cleaning of the float trap and calibration of the pressure gauges and switches at each outage), PNL concurs with the OG concerning the structural adequacy of the subject tank.

APPENDIX

COMANCHE PEAK STEAM ELECTRIC STATION

ENGINE COMPONENT SELECTION AND RESOLUTION

TABLE A.1. Comanche Peak Engine Component Selection and Resolution

Part Number	Description	DR Req'd	QR Req'd	No Rev'w	Acceptability	Recommended Action
CP-101A	Generator: Generator	X	X		Unlimited Life	None
CP-101B	Generator: Shaft and Bearings	X	X		Unlimited Life	None
CP-102	Generator Controls	X	X		Modifications	Additional maintenance requirements. Replace relay. Evaluate additional modification that will decrease maintenance requirements and improve long term reliability of controls.
F-068	Intercooler	X	X		Unlimited Life	Additional maintenance requirements.
F-139	Tools Turbo			X		
F-161	Pyrometer Wire			X		
MP022/3	Turbocharger	X	X		Unlimited Life	Additional testing and maintenance requirements. Revision of operating procedures. Additional analysis of the of the nozzle ring vane and capscrew.*
00-420	Lube Oil Pressure Regulating Valve	X	X		Unlimited Life	Additional maintenance requirements.
00-442A	Starting Air Distributor: Distributor Assembly	X	X		Unlimited Life	Additional maintenance requirements.
00-442B	Starting Air Distributor: Tubing, Fittings, Gaskets	X	X		Not Applicable	This component is addressed on DR reports for 02-441A and 02-411C.
00-491A	Turbocharger: Air Inlet Adapter - Adapter			X		
00-491B	Turbocharger: Air Inlet Adapter - Mounting Hardware w/Flexible Connector			X		
00-520	Instruction Plate: Warning Plate			X		
00-621A	Fuel Oil Drip Tank	X	X		Unlimited Life	None
00-621B	Fuel Oil Drip Tank Assy: Misc Hardware, Gasket, Switch			X		

*Only a summary is noted here. Results of the reviews on each of the generic components were submitted in separate reports to the NRC.

TABLE A.1. (contd)

Part Number	Description	DR Req'd	QR Req'd	No Rev'w	Acceptability	Recommended Action
02-CFR	Turbocharger Thrust Bearing Lubricant System	X	X		Modifications	Addition of supports.
02-305A	Base and Bearing Caps: Base Assembly	X	X		Unlimited Life	Additional maintenance and inspection requirements.*
02-305B	Base and Bearing Caps: Dowels			X		
02-305C	Base and Bearing Caps: Main Bearing Studs & Nuts	X	X		Unlimited Life	Additional maintenance and inspection requirements.*
02-305D	Base and Bearing Caps: Main Bearing Caps	X	X		Unlimited Life	None
02-305E	Base and Bearing Caps: Seals, Gaskets & Covers			X		
02-307A	Lube Oil Fittings: Internal - Headers	X	X		Modifications	Modification of several supports.
02-307B	Lube Oil Fittings: Internal - Tube & Fittings	X	X		Unlimited Life	None
02-307C	Lube Oil Fittings Internal: Seals			X		
02-307D	Lube Oil Fittings Internal: Supports	X	X		Modifications	Modification of several supports.
02-310A	Crankshaft	X	X		Unlimited Life	Additional testing requirements.*
02-310B	Crankshaft and Bearings: Bearing Shells	X	X		Unlimited Life	Additional inspection, maintenance, and procurement requirements.
02-310C	Crankshaft Thrust Bearing Rings	X	X		Unlimited Life	Additional maintenance requirements.
02-311A	Crankcase: Crankcase Assembly	X	X		Unlimited Life	Additional inspection requirements.
02-311B	Cylinder Block Liners & Water Manifold: Cam Bearing Caps & Dowels			X		
02-311C	Crankcase: Crankcase Seal			X		

*Only a summary is noted here. Results of the reviews on each of the generic components were submitted in separate reports to the NRC.

TABLE A.1. (contd)

Part Number	Description	DR Req'd	QR Req'd	No Rev'w	Acceptability	Recommended Action
02-311D	Crankcase: Crankcase Mounting Hardware	X	X		Unlimited Life	None
02-315A	Cylinder Block Liners & Water Manifold: Cylinder Block	X	X		Unlimited Life	Additional maintenance and inspection requirements.*
02-315B	Cylinder Block: Block to Crankcase Dowel			X		
02-315C	Cylinder Block Liners	X	X		Unlimited Life	Additional maintenance and inspection requirements.*
02-315D	Water Manifold: Jacket Water Manifold & Piping	X	X		Unlimited Life	None
02-315E	Cylinder Block Liners & Water Manifold: Studs	X	X		Unlimited Life	None*
02-315F	Cylinder Block Liners & Water Manifold: Nuts	X	X		Unlimited Life	None
02-315G	Cylinder Block Liners & Water Manifold: Seals & Gaskets	X	X		Unlimited Life	None
02-316A	Jacket Water Inlet Manifold: Manifold Assembly w/Hardware and Coupling and Gaskets	X	X		Modifications	Modification of supports
02-316B	Jacket Water Inlet Manifold: Coupling and Gaskets	X	X		Modifications	Additional nuts required on the Dresser coupling
02-316C	Jacket Water Inlet Manifold: Vent Line to Discharge Manifold	X	X		Modifications	Modification of supports.
02-317A	Water Discharge Manifold: Jacket Water Discharge Manifold, Coupling and Seals	X	X		Modifications	Modification of supports.
02-317B	Water Discharge Manifold: Coupling and Seals	X	X		Unlimited Life	Additional maintenance requirements.
02-317C	Water Discharge Manifold: Supports	X	X		Modifications	Modification of supports.
02-330A	Flywheel: Flywheel	X			Unlimited Life	None
02-330B	Flywheel Bolting	X	X		Unlimited Life	None

*Only a summary is noted here. Results of the reviews on each of the generic components were submitted in separate reports to the NRC.

TABLE A.1. (contd)

Part Number	Description	DR Req'd	QR Req'd	No Rev'w	Acceptability	Recommended Action
02-331A	Guards: Flywheel Guard Assembly			X		
02-335A	Front Gear Case: Gear Case			X		
02-335B	Front Gear Case: Gaskets and Bolting	X	X		Unlimited Life	None
02-340A	Connecting Rods: Connecting Rods & Bushings	X	X		Unlimited Life	Additional inspection requirements.*
02-340B	Connecting rods: Bearing Shells	X	X		Unlimited Life	Additional maintenance requirements.*
02-341A	Pistons: Pistons	X	X		Unlimited Life	None*
02-341B	Pistons: Rings	X	X		Unlimited Life	Additional maintenance requirements. Evaluate need to upgrade present engine oil.
02-341C	Piston: Pin Assembly	X	X		Unlimited Life	Additional maintenance requirements.
02-345A	Intake/Exhaust & Fuel Tappet Assembly	X	X		Unlimited Life	Additional maintenance requirements.
02-345B	Tappets and Guides: Fuel Tappet Assembly	X	X		Unlimited Life	Additional maintenance requirements.
02-345C	Tappets and Guides: Fuel Pump Base Assembly	X	X		Unlimited Life	None
02-350A	Camshaft	X	X		Unlimited Life	Additional maintenance requirements.
02-350B	Camshaft Bearing	X			Unlimited Life	None
02-350C	Camshaft: Supports, Bolting and Gear	X	X		Modifications	Modification to increase clamping force between gear and hub and nut locking maintenance procedure.
02-355A	Idler Gear Assembly: Crank to Pump Gear	X	X		Unlimited Life	None
02-355B	Idler Gear Assembly: Idler Gear Assembly	X	X		Unlimited Life	Implement nut locking procedure and additional maintenance requirements.
02-355C	Idler Gear Assembly: Gaskets & Bolting			X		
02-359	Air Start Valves: Air Start Valve	X	X		Unlimited Life	Additional maintenance requirements.*

*Only a summary is noted here. Results of the reviews on each of the generic components were submitted in separate reports to the NRC.

TABLE A.1. (contd)

Part Number	Description	DR Req'd	QR Req'd	No Rev'w	Acceptability	Recommended Action
02-360A	Cylinder Head	X	X		Unlimited Life	Additional maintenance requirements.*
02-360B	Intake & Exhaust Valves	X	X		Unlimited Life	Additional maintenance requirements.
02-360C	Cylinder Head Valves: Bolting and Gaskets	X	X		Unlimited Life	None
02-360D	Valve Springs and Retainers	X	X		Unlimited Life	None
02-361	Indicating Cocks			X		
02-362A	Subcover	X	X		Unlimited Life	None
02-362B	Cylinder Head Covers: Gaskets and Bolting			X		
02-365A	Fuel Injection Pump	X			Unlimited Life	Additional inspection and maintenance requirements.
02-365B	Fuel Injection Nozzle Assembly Tubing	X			Unlimited Life	Additional maintenance requirements.
02-365C	Fuel Oil Injection	X	X		Unlimited Life	Additional testing and maintenance requirements.
02-365D	Fuel Injection Equipment: Supports	X	X		Unlimited Life	None
02-371A	Fuel Pump Linkage: Fuel Pump Control Shaft	X	X		Unlimited Life	Additional maintenance requirements.
02-371B	Fuel Pump Linkage: Linkage Assembly and Bearing	X	X		Unlimited Life	Additional maintenance requirements.
02-373A	Gear Case Opening Cover: Cover			X		
02-373B	Gear Case Opening Cover: Gaskets and Bolting			X		
02-375	Air Intake Manifold	X	X		Modifications	Installation of missing U-bolt nuts. Additional installation requirements.
02-380A	Exhaust Manifold Piping	X	X		Modifications	Replace slip joints with slip on flanges. Additional maintenance requirements.

*Only a summary is noted here. Results of the reviews on each of the generic components were submitted in separate reports to the NRC.

TABLE A.1. (contd)

Part Number	Description	DR Req'd	QR Req'd	No Rev'w	Acceptability	Recommended Action
02-380B	Exhaust Manifold Gaskets and Bolting	X	X		Unlimited Life	None
02-385A	Cylinder Block Covers: Covers and Relief Valves			X		
02-385B	Cylinder Block and Crankcase Covers: Gaskets and Bolting	X	X		Unlimited Life	None
02-386A	Crankcase Covers: Crankcase Cover Assembly			X		
02-386B	Crankcase Covers: Crankcase Gaskets and Mounting Hardware	X	X		Unlimited Life	None
02-387A	Crankcase Ventilator: Crankcase Vacuum Fan			X		
02-387B	Crankcase Ventilator: Oil Separator			X		
02-387C	Crankcase Ventilator: Fittings, Bolting, Supports			X		
02-387D	Crankcase Ventilator: Crankcase and Fluid Manometer			X		
02-390A	Intake & Intermediate and Exhaust Rocker Shaft Assembly	X	X		Unlimited Life	None
02-390B	Rocker Arms and Pushrods: Exhaust Rocker Shaft Assembly	X	X		Unlimited Life	None
02-390C	Main and Connector Pushrods	X	X		Unlimited Life	Additional procurement requirement.*
02-390D	Rocker Arms and Pushrods: Pushrods Connector	X	X		Unlimited Life	Additional procurement requirement.*
02-390E	Rocker Arms and Pushrods: Bushings	X			Unlimited Life	Additional maintenance requirements.
02-390F	Rocker Arms and Pushrods: Lifters	X	X		Unlimited Life	Replace worn lifters at refueling outages.
02-390G	Rocker Arms and Pushrods: Miscellaneous Bolts and Studs	X	X		Unlimited Life	Additional maintenance requirements.*
02-395A	Gear Case Covers: Cover			X		

*Only a summary is noted here. Results of the reviews on each of the generic components were submitted in separate reports to the NRC.

TABLE A.1. (contd)

Part Number	Description	DR Req'd	QR Req'd	No Rev'w	Acceptability	Recommended Action
02-395B	Gear Case Covers: Gaskets and Bolting			X		
02-410A	Overspeed Trip: Governor	X	X		Unlimited Life	Additional maintenance requirements.
02-410B	Overspeed Trip: Governor and Accessory Drive	X	X		Unlimited Life	None
02-410C	Overspeed Trip: Coupling	X	X		Modifications	Replace L-110 Lovejoy coupling and implement additional maintenance requirements.
02-410D	Overspeed Trip Vent Valve	X	X		Unlimited Life	Additional maintenance.
02-411A	Govenor Drive: Governor and Tachometer Drive	X	X		Unlimited Life	None
02-411B	Governor Drive : Couplings, Pins & Keys	X	X		Unlimited Life	Additional maintenance requirements.
02-413A	Governor Linkage	X	X		Unlimited Life	Additional maintenance requirements.
02-413B	Fuel Pump Linkage	X			Unlimited Life	None
02-415A	Governor Assembly: Woodward Governor	X	X		Unlimited Life	Additional maintenance and operation requirements. Additional setting procedures.
02-415B	Governor Assembly-Booster Servometer	X			Unlimited Life	None
02-415C	Governor Assembly Heat Exchanger	X	X		Unlimited Life	None
02-420	Engine Driven Lube Oil Pump	X	X		Unlimited Life	None
02-425A	Engine Driven Jacket Water Pump	X	X		Unlimited Life	Additional maintenance requirements.*
02-425B	Jacket Water Pump: Cover Plate			X		
02-435A	Jacket Water Fittings: Pipe & Fittings	X	X		Modifications	Modification of support.
02-435B	Jacket Water Fittings: Supports	X	X		Modifications	Modification of support.
02-435C	Jacket Water Inlet Fittings: Valves	X	X		Unlimited Life	None

*Only a summary is noted here. Results of the reviews on each of the generic components were submitted in separate reports to the NRC.

TABLE A.1. (contd)

Part Number	Description	DR Req'd	QR Req'd	No Rev'w	Acceptability	Recommended Action
02-436A	Intercooler Piping and Piping Couplings, Gaskets and Bolting	X	X		Unlimited Life	None
02-436B	Intercooler Piping: Coupling, Gaskets, Bolting	X	X		Unlimited Life	None
02-437	Turbo Water Piping: Pipe & Fittings	X	X		Unlimited Life	None
02-441A	Starting Air Manifold: Piping, Tubing and Fitting	X	X		Modifications	Addition and modification of supports.
02-441B	Starting Air Manifold Valves, Strainer, Filters	X	X		Unlimited Life	Additional maintenance requirements.
02-441C	Starting Air Manifold: Supports	X	X		Modifications	Replacement and modification of supports. Install spacers on four supports.
02-445	Fuel Oil Booster Pump	X	X		Unlimited Life	None
02-450A	Fuel Oil Header: Piping & Tubing	X	X		Modifications	Modification of supports.
02-450B	Fuel Oil Header: Fuel Oil Tubing Supports	X	X		Modifications	Modification of supports.
02-455A	Fuel Oil Filters & Strainers: Fuel Oil Filters	X	X		Unlimited Life	None
02-455B	Fuel Oil Strainer	X			Unlimited Life	Additional maintenance requirement. Evaluate need to relax strainer size requirement.
02-455C	Fuel Oil Filters & Strainer: Mounting Hardware	X	X		Unlimited Life	None
02-465A	Lube Oil Lines External: Tubing, Fittings, Couplings	X	X		Modifications	Addition of supports. Additional installation requirements.
02-465B	Lube Oil Lines - External: Supports	X	X		Modifications	Modification of a support.
02-465C	Lube Oil Lines External: Valves	X	X		Unlimited Life	None
02-467A	Turbocharger: Lube Oil Fittings - Pipe, Tubing, Fittings & Flexible Coupling	X	X		Modifications	Replace Dresser couplings with slip-on flanges. Additional support requirements.
02-467B	Turbocharger: Lube Oil Fittings - Supports	X	X		Modifications	Modification of supports.
02-475A	Turbocharger: Bracket	X	X		Unlimited Life	Additional inspections recommended.

TABLE A.1. (contd)

Part Number	Description	DR Req'd	QR Req'd	No Rev'w	Acceptability	Recommended Action
02-475B	Air Butterfly Valve	X	X		Modifications	Addition of grease fittings to valve shaft. Additional maintenance requirements.
02-475C	Turbocharger: Bracket - Bolting & Gaskets	X	X		Unlimited Life	Additional inspections recommended.
02-495A	Turbocharger: Air Outlet Adapter - Adapter			X		
02-495B	Turbocharger: Air Outlet Adapter - Mounting Hardware			X		
02-500A	Control Panel Assembly: Cabinet/System	X	X		Unlimited Life	None
02-500B	Control Panel Assembly: Annunciators			X		
02-500C	Control Panel Assembly: Circuit Breaker/Contact Blocks			X		
02-500D	Control Panel Assembly: Pressure Gauges			X		
02-500E	Control Panel Assembly: Hourmeter			X		
02-500F	Control Panel Assembly: Accumulator	X	X		Unlimited Life	None
02-500G	Control Panel Valves	X	X		Unlimited Life	Additional maintenance requirements.
02-500H	Control Panel Assembly: Pressure Switch	X	X		Unlimited Life	None
02-500I	Control Panel Assembly: Pyrometers			X		
02-500J	Control Panel Assembly: Relays	X	X		Unlimited Life	None
02-500K	Control Panel Assembly: Solenoid Valves	X	X		Unlimited Life	None
02-500L	Control Panel Assembly: Tachometer			X		
02-500M	Miscellaneous Equipment: Piping, Tubing, Fittings		X		Unlimited Life	None
02-500N	Control Panel Assembly: Terminal Boards/Switches/Wiring		X		Unlimited Life	None
02-503	Thermometer			X		

TABLE A.1. (contd)

Part Number	Description	DR Req'd	QR Req'd	No Rev'w	Acceptability	Recommended Action
02-520	Instruction Plate: Nameplate			X		
02-525A	Barring Device - Pneumatic: Barring Device Assembly			X		
02-525B	Barring Device - Pneumatic: Regulator Valve/Shut Off Valve			X		
02-525C	Barring Device - Pneumatic: Misc. Fittings, Hose, Filters, Tubing			X		
02-525D	Barring Device - Pneumatic: Mounting Bracket/Supports			X		
02-530A	Platform - Front & Side: Side Platform Assembly			X		
02-530B	Platform - Front & Side: Front Platform Assembly			X		
02-530C	Platform - Front & Side: Platform - Bracing (with Attachments)			X		
02-531A	Platform Ladder Front: Platform Assembly			X		
02-531B	Platform Ladder Front: Bracing			X		
02-540A	Lube Oil Sump with Strainer Assembly and Mounting Hardware		X		Unlimited Life	None
02-540B	Lube Oil Sump Tank: Misc. Fittings, Gaskets, Pipe & Bolting Material, Valve	X	X		Unlimited Life	None
02-540C	Lube Oil Sump Tank: Mounting Hardware	X	X		Unlimited Life	None
02-550	Foundation Bolts: Anchors, Bolts, Misc. Hardware	X	X		Unlimited Life	Additional maintenance requirements.
02-590	Special Tools: Asst. Engine Assembly Tools			X		
02-630A	Pyrometer Conduit Assembly: Conduit	X	X		Unlimited Life	None
02-630B	Pyrometer Conduit Assembly: Conduit Fittings	X	X		Unlimited Life	None
02-630C	Pyrometer Conduit Assembly: Support	X	X		Modifications	Repair, replace, and add conduit supports.

TABLE A.1. (contd)

Part Number	Description	DR Req'd	QR Req'd	No Rev'w	Acceptability	Recommended Action
02-630D	Pyrometer Conduit Assembly: Thermocouples	X			Unlimited Life	Additional maintenance recommendations.
02-630E	Pyrometer Conduit Assembly: Gaskets			X		
02-688A	Engine & Aux Module Wiring Material - Conduit & Fittings; Pyrometer Conduit Assembly - Conduit, Fitting, Supports	X	X		Unlimited Life	None
02-688B	Engine & Aux. Module Wiring Material: Wiring & Terminations	X	X		Unlimited Life	None
02-688C	Engine & Aux. Module Wiring Material: Boxes & Terminals		X		Unlimited Life	None
02-689	Off Engine Alarm Sensors: Wiring	X	X		Unlimited Life	None
02-690	On Engine Alarm Sensors	X	X		Unlimited Life	None
02-691	Off Engine Alarm Sensors	X	X		Unlimited Life	None
02-695A	Engine Shut Down Equipment: Tubing/Fittings & Supports	X	X		Modifications	Addition and modification of supports.
02-695B	Engine Shut Down Equipment: Valves, Regulator, Orifices	X	X		Unlimited Life	Additional maintenance requirements.
02-695C	Engine Shutdown: Trip Switches	X	X		Unlimited Life	None
02-700A	Jacket Water Stand Pipe: Pipe, Fittings, Gaskets	X	X		Modifications	Addition of a support.
02-700B	Jacket Water Stand Pipe: Valves	X	X		Unlimited Life	Additional maintenance requirements.
02-700C	Jacket Water Stand Pipe: Supports	X	X		Unlimited Life	None
02-700D	Jacket Water Stand Pipe: Gauges			X		
02-700E	Jacket Water Stand Pipe: Switches	X	X		Unlimited Life	None

*Only a summary is noted here. Results of the reviews on each of the generic components were submitted in separate reports to the NRC.

TABLE A.1. (contd)

Part Number	Description	DR Req'd	QR Req'd	No Rev'w	Acceptability	Recommended Action
02-700F	Jacket Water Stand Pipe & Misc. Bolting Material	X	X		Unlimited Life	None
02-717A	Aux Sub Base & Oil & Water Piping: Aux Sub Base	X	X		Unlimited Life	None
02-717B	Aux Sub Base & Oil & Water Piping: Jacket Water Valves	X	X		Unlimited Life	Additional maintenance requirements.
02-717C	Aux Sub Base & Oil & Water Piping: Jacket Water Piping, Couplings, Fittings, Orifices, Y Strainers	X	X		Modifications	Replace 3 Dresser couplings with slip on flanges. Additional nuts required on 2 Dresser couplings. Addition and modification of supports. Additional installation requirements.
02-717D	Aux Sub Base & Oil & Water Piping: Jacket Water Gaskets & Bolting		X		Unlimited Life	None
02-717E	Aux Sub Base & Oil & Water Piping: Jacket Water Supports	X	X		Modifications	Addition and modification of supports.
02-717F	Aux Sub Base & Oil & Water Piping & Tubing: Pipe Tubing and Fittings	X	X		Modifications	Addition and modification of supports. Addition of a Dresser coupling. Additional nuts required on 2 Dresser couplings.
02-717G	Aux Sub Base & Oil & Water Piping: Lube Oil-Valves	X	X		Modifications	Reorientation of valve in pipe line. Additional maintenance requirements.
02-717H	Aux Sub Base & Oil & Water Piping: Lube Oil-Gaskets and Bolting	X	X		Unlimited Life	None
02-717I	Aux Sub Base Lube Oil Piping: Supports	X	X		Modifications	Addition, replacement and modification of supports.
02-717J	Aux Sub Base & Oil & Water Piping: Fuel Oil-Piping and Fittings	X	X		Unlimited Life	None
02-717K	Aux Sub Base & Oil & Water Piping: Fuel Oil-Valves	X	X		Unlimited Life	Additional maintenance requirements.
02-717L	Aux Sub Base & Oil & Water Piping: Fuel Oil-Gaskets & Bolting	X	X		Unlimited Life	None

TABLE A.1. (contd)

Part Number	Description	DR Req'd	QR Req'd	No Rev'w	Acceptability	Recommended Action
02-717M	Aux Sub Base & Oil & Water Piping: Fuel Oil-Supports	X	X		Modifications	Replace missing U-bolt on a support.
02-805A	Intake Air Silencer		X		Unlimited Life	None
02-805B	Intake Air Filter	X	X		Unlimited Life	Additional maintenance requirements.
02-805C	Exhaust Silencer			X		
02-805D	Flex Connections	X	X		Unlimited Life	None
02-810A	Miscellaneous Equipment Auxiliary Jacket Water Pump		X		Unlimited Life	None
02-810B	Jacket Water Standby Heater Pump		X		Unlimited Life	None
02-810C	Jacket Water Heat Exchanger	X	X		Unlimited Life	Additional maintenance requirements.
02-810D	Jacket Water Thermostatic Valve	X	X		Unlimited Life	Additional maintenance requirements.
02-810E	Misc. Equipment: Jacket Water Standpipe Heater	X	X		Unlimited Life	None
02-820A	Misc. Equipment: Lube Oil Sump Tank Heater	X	X		Unlimited Life	None
02-820B	Miscellaneous Equipment: Aux. Lube Oil Pump		X		Unlimited Life	None
02-820C	Prelube Oil Pump	X	X		Unlimited Life	Additional inspections recommended.
02-820D	Lube Oil Keepwarm Strainer	X	X		Unlimited Life	Additional maintenance requirements.
02-820E	Oil Prelube Filter	X	X		Unlimited Life	Additional maintenance requirements.
02-820F	Full Flow Lube Oil Filter	X	X		Unlimited Life	Additional maintenance requirements.
02-820G	Lube Oil Heat Exchanger	X	X		Unlimited Life	Additional maintenance requirements.
02-820H	Lube Oil Full Pressure Strainer	X	X		Unlimited Life	Additional maintenance requirements.
02-825A	Fuel Oil Day Tank	X	X		Unlimited Life	None
02-825B	Miscellaneous Equipment: Fuel Oil Transfer Pump		X		Unlimited Life	None

TABLE A.1. (contd)

Part Number	Description	DR Req'd	QR Req'd	No Rev'w	Acceptability	Recommended Action
02-825C	Fuel Oil System: Fuel Oil Drip Waste Pump			X		
02-825D	Fuel Oil Booster Pump: D.C. Motor Driven			X		
02-825E	Fuel Oil System: Fuel Oil Duplex Strainer	X	X		Unlimited Life	None
02-825F	Fuel Oil System: Fuel Oil Valves, Bolting			X		
02-835A	Air Start System: Starting Air Skid Base	X	X		Unlimited Life	None
02-835B	Starting Air Compressor			X		
02-835C	Misc. Equipment: After Cooler			X		
02-835D	Starting Air Tank Relief Valve	X	X		Unlimited Life	None
02-835E	Air Start System: Starting Air Piping, Fittings, Tubing			X		
02-835F	Starting Air Float Trap	X			Unlimited Life	Additional maintenance requirements.
02-835G	Misc. Equipment: After Cooler Bolting			X		
02-835H	Misc. Equipment: After Cooler Support			X		
02-835I	Air Dryer			X		
02-835J	Starting Air Tank	X	X		Unlimited Life	None
02-835K	Air Start System: Starting Air Pressure Gauge			X		
10-300	Component Failure: Human Error			X		
10-400	Component Failures: Cause Unknown			X		
10-500	New Procedures			X		

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L. Wechsler
A. Wendel

5 Senior Review Panel

F. Albaugh
S. Bush
C. Hill
W. Richmond
L. Williams

22 Project Team

J. Alzheimer
A. Currie
D. Dingee
R. Dodge
W. Gintner
W. Laity (15)
J. Nesbitt
F. Zaloudek

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