PDR-016

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

OCT 30 1984

Ms. Nina Bell
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1346 Connecticut Avenue, NW
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IN RESPONSE REFER
TO FOIA-84-275

Dear Ms. Bell:

This supplements our five previous letters to you concerning your letter dated April 10, 1984, in which you requested, pursuant to the Freedom of Information Act, documents relating to:

1. The TDI diesel generators at the Shearon Harris nuclear plant; and

2. All lists of problems and defects which have occurred with TDI generators being used or tested, or which have not yet been used for nuclear facilities and in other applications (e.g. marine).

The enclosed Appendices A and B list some recently located additional documents subject to your request.

The documents listed on Appendix A are being placed in the NRC Public Document Room (PDR) in file folder FOIA-84-275 under your name.

The documents listed on Appendix B are already on file in the PDR, and you may obtain access to them by referencing the pertinent accession numbers.

Sincerely,

J. M. Felton, Director
Division of Rules and Records
Office of Administration

Enclosures: As stated

Re: 84-275

APPENDIX A

1. Memo from R. Caruso to Enclosure 1, re: Report of Meeting with Representatives of the Transamerica Delaval Inc. (TDI) Emergency Diesel Generator Owners Group, dated 2/2/84

2. Memo from J. A. Olshinski to J. P. O'Reilly, re: NRC/MP&L Meeting on January 27, 1984, dated 2/2/84

3. Memo from J. A. Olshinski to J. P. O'Reilly, re: Transamerica Delaval Inc. (TDI) Owners Group Meeting w/enclosure, dated 2/2/84

4. Memo from G. W. Kreighton to E. E. Utley, re: Request for Additional Information Regarding Transamerica Delaval Emergency Diesel Generators - Shearon Harris Unit 1, dated 2/6/84

5. Memo from M. Miller to Enclosure 1, re: Report of February 16, 1984 Meeting between NRC and Representatives of Transamerica Delaval Inc. (TDI) Owners Group, dated 2/27/84

6. Memo from C. Berlinger to W. Muselar, re: Request to Transamerica Delaval Inc. Owners Group for Additional Information, dated 2/28/84

7. Memo from C. Berlinger to J. P. McGaughy, re: Preliminary Assessment of Two Reports Submitted to the NRC by the Transamerica Delaval Inc. (TDI) Owners Group, dated 4/11/84

8. Memo from C. L. Ray, Jr. to H. R. Denton, re: TDI Diesel Generator Owners Group Monthly Status Report, dated 5/25/84

9. Proposed Staff Actions to Improve and Maintain Diesel Generator Reliability, Generic Letter 84-15, dated 7/2/84

APPENDIX A (cont'd)

10. Memo from M. Miller to Enclosure 1, re: Summaries and transcripts of NRC/Transamerica Delaval Inc. (TDI) Owner's Group meetings, dated 6/26/84

11. NRC Inspection Report No. 50-400/84-23 dated 8/9/84

12. NRC Inspection Report No. 50-400/84-24 dated 8/31/84

APPENDIX B

1. NRC Inspection Report No. 50-400/84-17 - DCS Accession #8407270402

2. Memo from C. Berlinger to J. P. McGaughy, re: Preliminary Review of Report on Investigation of Types F and AF Distow Skirts, FaAA-84-2-14, dated 2/27/84 - DCS Accession #8404120045

3. Memo from C. Berlinger to J. P. McGaughy, re: Request for Additional Information Regarding Transamerica Delaval Inc. (TDI) Diesel Generators, dated 3/19/84 - DCS Accession #8404040290

4. Memo from M. Miller to Enclosure, re: Report of March 22, 1984, Meeting with Representatives of Transamerica Delaval Inc. (TDI) Diesel Generator Owners Group, dated 4/10/84 - DCS Accession #8404110307

84-275

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

February 2, 1984

Docket Nos: See Enclosure 1

APPLICANT: See Enclosure 1

FACILITY: See Enclosure 1

SUBJECT: Report of Meeting with Representatives of the Transamerica Delaval, Inc. (TDI) Emergency Diesel Generator Owners' Group

On January 26, 1984, members of the NRC staff met with representatives of the TDI Owners' Group to discuss problems related to Emergency Diesel Generators manufactured by TDI. A list of attendees is included in Enclosure 2. Enclosure 3 includes copies of the handouts and slides used during the meeting. Enclosure 4 is a transcript of the meeting.

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Enclosure 4

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

A Meeting on TDI DIESEL GENERATORS

Phillips Building
Bethesda, Maryland
Thursday, January 26, 1984

A meeting on TDI Diesel Generators convened at 3:04 p.m., Harold Denton presided.

APPEARANCES:

(Attendance List will be Generated.)

MR. DENTON: Good afternoon. My name is Harold Denton. What we are going to discuss today is the results of the staff review of the reliability of the Delaval diesel.

We started looking intensively in this area when problems began to develop at San Onofre, Grand Gulf, and at Shoreham. Since that time, our review has expanded.

We are prepared today to discuss with you in detail the results of all the information that has come to our attention regarding the operating performance of these diesels.

We also have with us today the Regional Administrator from Region IV, John Collins, who conducts our vendor inspection program. He will describe the results of his vendor inspections at the factory of Delaval Diesels.

I understand that the Owner's Group has been informed of the utilities who own these diesels, and they are represented today by Jim McGaughy, who is the Chairman of the Owner's Group. I understand that the Chief Executive of Delaval Diesel Corporation is also present, and that his representatives will be making a presentation.

Let me discuss a few ground rules to begin with, to make the meeting go smoother. We are taking a transcript of this meeting. The issue is in contention, as you know, at several proceedings. And this makes it easier for us to provide the Hearing Boards a complete and accurate record of what information is made available today. Because of this transcript, it's very important that anyone who has questions or comments be sure to identify themselves for the record when they ask questions.

The way I would like to walk through this process is to have the staff first describe in some detail the information that has become available in the last few months on the performance of these diesels in the field. This is mainly at nuclear power plants, but we also collected data from some non-nuclear sources.

Then, we will cover the vendor inspection, as I mentioned. Then, we turn the meeting over to the utility Owner's Group, who I understand is prepared to describe their remedial program to try to establish the reliability of these diesels.

I understand, Jim, that you may have an opening -- opening remarks to say before we begin. Why don't you do that now?

MR. McGAUGHY: Good afternoon. My name is Jim McGaughy. I am Vice-President of Mississippi Power and Light Company. I am speaking to you today as Chairman of the Delaval Diesel Owner's Group.

The issues that will be presented here, we feel the problems that have been found in our pre-operational testing program and our subsequent research and reported to the NRC, as they've been found, using the proper prescribed methods. For some time, all the owner's of these engines have bound together putting the best minds available in the world on these issues in the one effort to study and correct these issues.

Our goals and the goals of the NRC are the same. We are committed to provide our plant to reliable emergency backup power supplies. We feel this comprehensive program we have in place, in place now, working now, will do just that.

We are here today to tell you about what it is that we have been doing. The elements of our program are four. The first element is resolve the known problems, both generic problems and problems in the specific engines themselves, to design and find fixes to these problems.

In addition, we will take -- and are in the process of taking each engine from the ground up, reviewing its design, its construction, its procurement and doing a quality revalidation on each and every engine. From the results of the quality revalidation, then we go into testing, and the testing involves non-destructive testing, destructive testing, operational testing of components, operational testing of the engines. This work is in progress now.

And also then we will, through this group, respond to the questions, of course, that the NRC will put to us. The participants in our program are as follows. We have the eleven owners, and I will have a list of those for you later. Eleven utilities. FaAA Associates, who are renown in doing failure analysis work. We have the wholehearted support of Delaval in this effort, both in gathering of information and gathering of design data, and in review of this data. Stone and Webster Engineering is supporting this effort. And also several diesel generator consultants from around the world.

The organization the Owner's Group has set up has me as Chairman, Mr. Joe George of Texas Utilities as Vice-Chairman. Executive Committee made up of the eleven utilities. The Technical Director of the program is Mr. Bill Museler of LILCO. We have taken the program that LILCO has started on their site, adding to it. The work is being done at the LILCO site.

As you see, in resolving the known failures and determining solutions to those problems, FaAA is taking the lead; that is their speciality. In terms of design review and quality revalidation, we have FaAA, Stone and Webster, our various consultations, and we have engineers from each utility working in this effort. The testing program definition and carrying out the testing program will be done, of course, by the utilities who own the engines and operate them, and by FaAA who will assist us in that effort.

To give you an idea of the extent of this program, I would like to put this chart up. This is the organization that is in place. We have over a hundred and twenty people full-time working on this effort, working on this effort now. This is in progress. We are confident that when we complete this program, that we will have reliable engines to provide backup power supplies for these plants.

Thank you.

MR. DENTON: As those of you know, who own these diesels, this is a very important safety issue for the NRC. There are about fifty-seven engines made by Transamerica Delaval that are in this, owned by the sixteen utilities that are on our list. None of the Delaval diesels are at operating plants, which means it's not an imminent safety problem today, but certainly it has profound implications for schedules for some of the utilities if the problem is not adequately addressed.

I did want to mention my perspective on the safety side to be sure it's well understood. The only plants that are operating that have Delaval diesels are San Onofre Unit 1. That plant is shut down for a seismic modification. Grand Gulf, which is limited to a five percent power license and is presently shut down. And, Rancho Seco, which is using other diesels, but I understand has ordered, or has in place, several Delaval diesels which they have intended to install.

We view this as a very serious problem for the industry. It is unique to have a problem in what I will call a convention component of American technology. You wouldn't think that diesel generators would get on the critical path of the nuclear power reactors, but that's very likely what has happened.

And just so there is no doubt about where the staff stands on this issue, we are not prepared to go forth and recommend the issuance of new licenses on any plant that has Delaval diesels until the issues that are raised here today are adequately addressed. It sounds like we have a very ambitious program. What I want to do is make sure you have all the information we have.

And if we come to an understanding about the factual basis that we are working with, so we can move to a discussion of the information we have been able to gather, and if everyone would hold their questions to the extent they can, we can get through the presentations faster.

We will provide ample opportunity for discussion after we have gotten the factual basis on the table. Then, we will turn to a detailed presentation of your program. And I plan to provide a break somewhere in the meeting. But we will probably go until about six o'clock.

The first presentation will be made by Frank Miraglia and assisted by Carl Berlinger. Carl Berlinger is a Senior Manager on the NRC staff. We designated him as the person responsible for ultimately reviewing your program and making sure that it is an acceptable, adequate program.

So, Frank, why don't I turn over to you to cover what we know about the operating experience.

MR. MIRAGLIA: My name is Frank Miraglia. I am the Assistant Director of the Safety Assessment Division of Licensing.

The first view graph is a list -- the first view graph indicates the fifty-seven Delaval diesels that have been procured for use at sixteen different nuclear power plant sites. May I have the second view graph?

We are going to discuss the U.S. experience with these diesels in the operating stations to date.

The next slide is a brief summary of the operating experience with San Onofre 1 station. The information on this view-graph is in a very summarized fashion. We have a more detailed handout that will be available at the end of the meeting that has additional details about the operating experience and chronology with some of these machines at the various nuclear power stations.

There are two Delaval diesels at San Onofre 1. They were installed in 1976. They are Delaval V-20 engines. They were declared operational in 1977. The operating time on each engine at San Onofre is approximately 450 hours. These are actually the first Delaval diesels to enter nuclear service.

Problems to date are indicated on the slide. They've had turbocharger thrust bearing problems. This event resulted in a Part 21 report, was issued and problem was considered to be of a generic nature.

They've had a lube oil leak and fire, which was a result of a fuel line failure, test line off a lube oil line which failed because of vibration. And it was a small fire.

The pistons have been modified at San Onofre 1 to correct a problem that is noted at Grand Gulf and resulted in a Part 21 notification there, to prevent crown separation.

They've had an unqualified instrument cable, which also was replaced in conformance with reported Part 21 occurrence. And just recently in another Part 21 report, there is potentially defective coupling material. That Part 21 report was filed earlier this month.

The next slide is a summary of the experience on the -- of the Grand Gulf diesels. They have Delaval diesels. They are the V-16. The operational hours on the diesels are 1100 hours on the Division I diesels, and seven hundred hours on the Division II diesels.

These are the first V-16 Delaval diesels to enter nuclear service. The problems to date are the -- Number one is the pistol crown separation. That was a generic problem and identified this particular problem as a Part 21 for the Delaval diesels.

They have experienced piston skirt cracks, and piston skirts have been replaced on the Division II diesels.

They've had a fuel line failure, which resulted in a fire. And the fuel line failure was due to fatigue. They have experienced cylinder head cracking on these diesels. The heads have been replaced.

In addition to those, they've had the turbo-charger problems. I believe three different instances of turbocharger problems. And, again, you can see commonality between this experience and the San Onofre experience.

They have experienced push rod cracking problems. In addition, they've had the generator short due to an engine fastener. This was a crankcase capscrew failed and had lodged in the generator and shorted the generator out.

In addition, Grand Gulf has also experienced problems with their air starting valves which has resulted in failure of the generators to start.

This summarizes the experience with the San Onofre and the Grand Gulf units. I would like to have Ralph Caruso summarize for you the experience to date on the Shoreham machines and also to present a brief summary of the information that we have been able to gather from non-nuclear marine experience with similar type diesels.

Ralph Caruso.

MR. CARUSO: The engines installed at Shoreham are Model DSR-48, straight-8 engines. They are rated at 3500 kilowatts and ~~have~~ had approximately 700 hours roughly RC on each engine at the time of a major failure of crankshaft in August of 1983.

Those engines were the first straight-8 engines to be installed in the United States in service. Shoreham has had a number of minor problems and one major problem.

To date, they've had problems with jacket water pump propellors. This problem occurred twice. Two fuel oil lines have ruptured due to manufacturing defects. Those two ruptures resulted in Part 21 reports being issued for San Onofre and Grand Gulf.

In August they had the failure of the crankshaft in the Number 102 diesel generator. Subsequent inspections of Number 101 and 103 engines revealed cracks in the crankshafts of those engines, and in approximately the same location as the failure of the 102 engine.

Upon disassembly of the engine to repair the crankshaft problems, connecting rod bearing failures were discovered, not just on the engine with the failed crankshaft but also on another engine. Subsequent inspection revealed problems with piston skirts, with cracks in the piston skirts. Those piston skirts have been replaced at Shoreham.

And, in addition, over the life of the plant they have experienced several problems with different types of fasteners used to attach critical components together in the engine.

The staff has received a considerable amount of information regarding marine experience from three different operators of marine engines. The Marine engines we are talking about, ~~or~~ are the V-16 and V-12 engines. They are very similar, if not identical, to engines that are being installed in nuclear power plants in the United States.

The operating experience for these engines is varied at this time, with engine operating hours varying from 3000 to 30,000 hours. To date, all three operators have reported cylinder head cracking to various different extents.

Two operators have reported piston cracking. One operator reported the complete failure of two pistons.

Problems have also been noted with excessive bearing wear, turbocharger instability, and turbocharger vibration. Cracks have been noted in push rods. ~~valves~~. RC Cracks have been noted in connecting rods.

In addition, cylinder blocks have been replaced by one of the operators.

This is a summary of the marine experience to date.

MR. DENTON: We have given you a very quick summary, but there is extensive information available in what we will hand out later in the presentation.

And just because we have gone through it quickly, I don't want you to think that this is all there is. There is really quite a bit of poor operating history with this piece of equipment in the time that we have been able to assemble it.

I think some of the reasons for this poor performance will be obvious when you hear from our next speaker, John Collins, who I mentioned heads up the vendor inspection program. John.

MR. COLLINS: Thank you, Harold. Now, we are passing out the view-graphs which cover a summary of the major findings that we've had of the inspection.

Since 1979, we have made nine inspections of Delaval. Seven of those inspection reports are identified in handout material. They are available in the PDR. If you would like copies and you cannot get copies, contact myself in Arlington or Ian Barnes of our Vendor Branch, we will be very happy to see that copies of these reports are sent to you.

The remaining two reports have been forwarded to the Company for proprietary review. That review period should be up tomorrow. If there are not any proprietary problems, they will be placed in the PDR and they will be available, too. So, if you want to contact me, my number in Arlington is Area Code 817-860-8225. Or, Mr. Barnes, same area code, 860-8176.

We have -- as I hope everybody has the slides now, our finding of deficiencies covered just about every subject. They included areas on manufacturing process control, control of special processes, procurement control, material identity and control, design and document control, equipment calibration, lack of internal audits or improper or not sufficient disposition of audit findings, and then deficiencies in QA records.

At this time, I am going to ask Ian Barnes, who is the Chief of the Reactor Section for the Vendor Program to go through some of the highlights of the inspection findings with you. We are not going to read them to you. You have them, but I think it's important we at least identify some of them.

The other handout material has a more complete summary of all of the findings that were made or documented in the nine reports. So, Ian, why don't you walk us through some of the significant findings?

MR. BARNES: Good afternoon. The first slide that is on now shows a categorization of the vendor program branch inspection findings by subject area. It represents a total of sixty-two non-conformances and violations that were issued as a result of the nine inspections.

As John has just indicated, a description of all of the findings in that particular slide are included in a handout that is being passed around. From this inspection history summary, we have extracted examples of inspection findings that raise concerns with regard to the adequacy of implementation and the effectiveness of the Transamerica Delaval program.

The next slide, please. The first subject I am going to address is manufacturing process control. We have put specific examples of inspection findings in a subject area, but bringing the question of implementation effectiveness, manufacturing process controls, and the performance of quality function of Transamerica Delaval.

As you will note from this slide, instances were noted where route sheets were not available to the Vendor Branch review. For example, the first item on the slide, jacket water pump. Reworked operations for ninety-two pistons that were supplied to Shoreham and Grand Gulf, that's the fifth item. Replacements of cylinder head assemblies for Shoreham, that's the final item on the slide.

Route sheets from Transamerica Delaval provide the primary basis for verifying that the inspection operations have been performed. The absense of those route sheets did not allow us to verify that required inspections of manufacturing operations had, in fact, been accomplished.

Examples of findings which address the performance of the quality control function is shown in the second, third and fourth items, i.e. there was no evidence of acceptance of certain operations on components for jacket water pumps pertaining to modification efforts.

As Ralph indicated earlier, there had been two successive problems involving jacket water pump problems at Shoreham. And, so evidence of sign-off to installation of rocker arm hold down bolts were found subsequent at Shoreham, were found subsequent to be missing.

In regard to San Onofre, piston reworked, with the date of sign-off for manufacturer operations occurring actually two to three weeks after the pistons had been returned to San Onofre.

If you look, in regard to the seventh item on this list, is the apparent use as indicated by the route sheets of unqualified personnel performing non-descriptive examinations on SNPs replacement cylinder head.

The eighth item, which is an absence of any documented provisions for control of installation of fuel oil line clamps in regard to Shearon Harris. We believe that's generic to all of the engines, in that one of the fuel oil line failures at Grand Gulf has been attributed in part to the absence of required line clamp. We believe this finding is quite significant.

It has been mentioned earlier about cracking problems in piston skirts. Review of engineering drawings for the various designs of piston skirts show, in fact, that there was an engineering requirement to perform stress relief heat treatment after normalizing of the castings. The corrective action that, in part, is being carried out for piston skirts is to perform stress relief. There was an initial requirement always in effect to do that very thing.

The next slide. This slide shows a few examples of inspection findings in regard to procurement document control deficiencies, use of vendors, the materials that without performing any service or audits of those vendors to establish adequacy of their own programs, and inadequate receiving inspection.

In the more comprehensive handout that is being distributed, you will find additional examples of inadequate receiving inspection and using other vendors without performing required service or audits.

Next slide. In the area of material identity and control, an inspection of this subject showed eleven discrepancies were observed in a smaple of forty-five, I believe, in material identity between that recorded at the time of the misuse of the material to a given job and the identity of the material that was recorded on the finished engine.

Next slide. We have included the next slide to show examples of the failure of the quality issuance function to comply with both QA program requirements for corrective action and non-conformance conditions to be identified and the specific instance of failure to comply with corrective action commitments made to the NRC in regard to the performance of their ASME weld shop. In the same context, their ASME weld shop, recurring examples were noted during successive inspections for failure to enforce program commitments with respect to control of welding electrodes in regard to that console moisture.

Next slide. The next slide is an additional example of the failure of the QA function to comply with program requirements for audits of their manufacturing activities.

The final slide, John. We have included this to illustrate that we have certain concerns in regard to the adequacy of the Delaval evaluation and reporting practices in regard to 10 CFR Part 21.

MR. COLLINS: As we indicated at the beginning, we have summarized in these slides the findings. But, as I also indicated, I think there is a lot more that's of interest. If you carefully review the findings that were handed to you that were documented in the handout to you, one thing it says to me, in my opinion, is that not only has there been problems at the manufacturing shop but also, in my opinion, calls into question the adequacy of the vendor programs or surveillance programs that are being conducted by the utilities. Had some of these been identified up front by utilities on-site inspection programs, or receiving inspection programs, or procurement programs, I think they could have been identified even sooner than now.

So, it really calls into question your own programs. Darrell.

MR. EISENHUT: Well, let's see, we went through the two aspects in such a short summary fashion, the operating experience and the inspection findings, that one might draw connections that they infer, or might leave it to the operating experience, these were meant to be short summaries. We certainly are going to be, on the staff, undertaking a more detailed look at all these aspects, in both the experience, the inspection results.

As mentioned earlier, Carl Berlinger is heading a major review effort. But I guess you have to sit back and say: Where does this leave us right now?

And right now, our preliminary conclusion -- and that conclusion is based on these limited looks -- is that certainly our level of confidence in the overall reliability of TDI diesels in general is significantly reduced. We've got to say that from the front end.

And, secondly, as Harold Denton mentioned in the beginning, is that before we undertake the licensing of any plants with TDI diesels at this time, these issues clearly are going to have to be addressed. These issues are clearly the quality aspect from both the design, the construction, the operating experience is going to have to be factored in, and the overall ability of these diesels to reliably perform their function is going to have to be demonstrated.

That's basically where we are today. As we said early, and Jim McGaughy pointed out, there is a major industry undertaking, a major program has been laid out, that we hope is going to address all of these issues. And, obviously they are going to have to address them to the staff's satisfaction.

With that as a short summary, I guess I would like to open it up to the staff presentation for any questions before we go to the second part this afternoon on either piece, the operating experience piece, or on the inspection results found today. Any questions? (No reply.) Can't get off that easy.

Well, if there are no questions, why don't I suggest it would probably be easier, Jim, on your presentation if we took a short break now rather than start into it.

MR. BECK: Darrell, one question.

MR. EISENHUT: Excuse me. Could you identify yourself?

MR. BECK: Larry Beck, Cleveland Electric. Does the staff have any experience, vendor experience, for the plant period in 1979?

MR. EISENHUT: No. I think the first inspection report is, in fact, March 1979.

MR. BECK: Most of our diesels that were manufactured and built were before that.

MR. EISENHUT: No. I understand that. That's why we have to do a detailed review and a detailed look at what that experience tells you about the diesels that were built earlier.

I want to caution you in two areas, though. When you look at that, one aspect was documentation review. And the documentation is required to be there, regardless of when they were actually manufactured. And the second piece is that a number of these findings relate to the reword of the diesels.

So, we clearly are factoring that into consideration. Any other questions? If not, why don't I suggest we take a short ten-minute break and then return and turn it then over to the Owner's Group for their presentation.

(Whereupon, a recess is taken at 3:41 p.m., to reconvene at 3:51 p.m., this same day.)

MR. DENTON: Let us resume. I would like to have Carl Berlinger stand up in case there are those of you who haven't met him in his corp performance role.

Carl is a person we have assigned to review the utility proposal in this area, and he will be the person you will be dealing with mainly. We have a number of NRC staffers in the room that you should know are here. We have representatives from the Probability Assessment Branch, the AELD, mechanical engineering. So, we are represented here in various skills. And I expect the NRC representatives to ask questions during your presentation. We will try to hold our questions to the extent we can.

I think what we have done this morning is provide you with a basis on our opinion on the reliability of these diesels. I take it from the lack of questions that not much of this information comes as a surprise to you, and that your program is designed to cope with these kinds of problems.

Why don't I turn it over to Mr. McGaughy to describe them further in detail, what utility is playing who collectively.

MR. McGAUGHY: Thank you for the opportunity to review your findings with you. Most of these we have known of, or some we have not known of, all of which we will factor into our program.

I would like to briefly describe what it is that we are going to talk to you about. I've already talked to you about the formation; our charter is to do everything that's required to make these units reliable backup power supplies.

Mr. Bill Museler, who is the program technical manager, will talk about the program description in some more detail.

Mr. Wells, who is of FaAA, will give you some background and some detailed descriptions of some of the analytical work that has been ongoing.

Mr. Seaman will talk about the design review, the quality revalidation program.

Transamerica Delaval, Mr. Clint Matthews and Mr. Bixby, will tell you a few things about what they are doing in their commitment to this program.

Then we will review the schedule with you. So, without further ado, Bill.

MR. MUSELER: Good afternoon. My remarks will be brief to introduce the three next speakers who will focus on some of the detailed elements of the program.

However --

MR. McGAUGHY: Excuse me. There is one other thing I forgot to say. Some of you will have questions. Don't ask them. We've got a limited amount of time. Make note on your handout if you have one. And when we get through, we will answer you.

MR. MUSELER: I am going to attempt to put the Owner's Group program in perspective and focus on some of the concepts that the technical folks who put the program together included in the program; then, review briefly the elements of the program again, and go into a little bit of detail as to the resources that we have dedicated to this program.

When we first focused on the need to produce a rather comprehensive program, rather than dealing with the problems as they came up one after another, we decided early on that we would focus on a component basis to ensure that the components and, therefore, the entire engines of these eleven plants, when we get done, are sufficiently reliable to provide backup power for our nuclear plants.

We also decided that all components on the engines would be looked at and considered for potential review.

In assembling our data base for this, we utilized both the data available through the NRC, through our own contacts, through industry organizations such as INPO and AIF, as well as what information we could gather from the commercial field, both stationary units and from marine applications.

As Jim said, the Owner's Group has been together more or less since October and has been a formal entity since that point in time. So, we also decided early on that a unified team approach would be needed in order to ensure that we captured all of the available data and addressed all of the problems or concerns that might be applicable to these engines.

We also decided that we needed to do more than just approach quality assurance from the standard quality assurance program aspects. And by that, I mean we have decided that as part of the design review and quality re-validation effort, the quality engineers and indeed the specialists are evaluating the need to perform either inspections or evaluations of components on the basis of their function and their real requirements as opposed to just doing quality assurance program review.

So not only our quality assurance engineers are involved in picking attributes that need to be checked from a quality standpoint, but the design engineers are also involved in picking those attributes and decide what needs to be checked or inspected to ensure adequate reliability.

The last two items, clearly, we anticipated and, in fact, in the early stages it's turning out to be true, that additional testing will be required, both engine testing and component testing, and additional inspections of components will be required in some cases.

To review the basic elements of the program, when we evaluated the data base and looked at the concepts, we decided what would be needed in order to form a viable program and we broke it down into these four major areas. The resolution of known problems, whether those problems come from our own engines or if they come from an outside experience, if those problems are applicable to our engines we are going to ensure that either that's corrected or that the applicability does not result in any detriment to our engines. An overall design review and quality revalidation of each engine is part of the program. And, Mr. Seaman will expound in quite some depth on the individual elements of that program.

Additional testing and inspection clearly are part of the Owner's Group program, and a significant amount of that testing and inspection is already underway.

Finally, responses to NRC questions are being handled generically by the Owner's Group. For those questions which are clearly best handled generically, and individual responses from the individual utilities to the balance of the NRC questions, will also be provided.

I am going to focus now briefly on the resources that we have devoted to this program and that are in place in order to accomplish the activities that will be laid out by the following speakers. All eleven utilities are participating in the program; and, in fact, are providing utility engineering manpower to the program. I think Jim McGaughy pointed out that we think this effort needed to be managed both at the overall level and also at the lower level by ourselves because of the immediacy and because of the importance of this particular Owner's Group situation.

Right now at Shoreham there are approximately twelve utility engineers and over thirty other consultant and contracting personnel working full-time on it. And the overall number of people working on the entire Owner's Group program approaches one hundred and twenty. And, Craig will outline where those people are a little later.

MR. DENTON: I don't want to start a pattern of questions yet, but we have different counts on the number of utilities. Maybe it's due to cancelled units.

Are all the utilities that own these diesels members of your Owner's Group, or is there someone that is not a member?

MR. MUSELER: It's two cancelled units. TVA and WHOOPS are not members.

Failure Analysis Associates is involved in several aspects of the program, both in the design review area naturally, and in the resolution of the known problems where they have the lead responsibility.

Transamerica Delaval has been assisting the Owner's Group, both in terms of providing the necessary design documentation and also in providing a review function of what we are doing in addition to the diesel generator consultants that we have providing an overview to the effort.

Stone and Webster Engineering Corporation plays a major part in the quality revalidation role. And they constitute the largest block of personnel at the Shoreham site working on the program.

Finally, we have employed a number of special diesel generator consultants, and I'm going to just cover the credentials of just a few of these additional consultants along with Failure Analysis Associates.

Dr. Pischinger is a renowned diesel generator expert from Germany. He is currently Director of the Institute for Applied Thermodynamics at Aachen University, and also Vice-President of a diesel generator analysis consulting firm. His overall experience in the diesel generator field is over thirty years. Formerly, he was head of Research and Development for K.H.D.AG, a major diesel engine manufacturer in West Germany. And also head of the Research Department for the Institute for Internal Combustion Engines in Graz, which is in Austria.

Dr. Pischinger has authored numerous papers on the subject of diesel generator design and testing, and has also authored several textbooks on the same subject.

I note that we visited Dr. Pischinger in Germany. He has been involved directly in the component selection process through his representatives and by telephone, and he has also visited the Shoreham site and reviewed Shoreham's diesel engines when they were apart and available for inspection.

Paul Tholen is a consultant to Dr. Pischinger, and he is currently resident on the Shoreham site, is a full-time member of the Owner's Group.

He formerly held Dr. Pischinger's position as Director of R&D for K.H.D., and he was responsible for a number of developments in the diesel generator field, notably highly-turbocharged diesels in the 1950s.

Some of his publications are listed there on the slide.

Dr. Clifford Wells will be speaking to you next, is in charge of the overall effort of failure analysis which encompasses the resolution of known problems as well as participation in design review effort.

Currently, he is Vice-President of FaAA, responsible for fatique and reliability analysis and NDE evaluation.

Formerly, he was the Director of Engineering Mechanics for SRI, Assistant Materials Engineering Manager for Pratt & Whitney Aircraft Engine Division.

He has previously been Chairman of the Executive Committee of the Materials Division of ASME, and is currently the editor of "Fatique of Engineering Materials and Structures".

Gary Rogers is responsible for FaAA, for the design review part of the DRQR program. He is Director of FaAA's Phoenix Office, where he is responsible for reciprocating and turbo machinery design, vibrations analysis and field testing.

Gary Rogers has been responsible for the strain gage testing of the Shoreham crankshafts, both the old 13x11 crankshaft and the new 13x12 crankshaft. He was in charge of the investigation of the Arkansas Nuclear-1 diesel main bearing and generator shaft failure, and he has also been involved in other failure analyses of problems at other nuclear plants.

Formerly, he was at Garrett Corporation, responsible for gas turbine engine design and development, and design analysis of driveshaft torsional instability.

I think it's worthy of note that while at Garrett, Mr. Rogers was a member of the Materials Review Board whose function is very similar to the design, review and quality revalidation effort that we currently have underway for our diesel engines.

The final brief resume I would like to review with you is Dr. Lee Swanger, who is with FaAA. His current position with FaAA is Managing Engineer for Palo Alto's Experimental Laboratories and metallurgical analyses for FaAA.

Formerly, he was Director of R&D for Imperial Clevite, which is a major bearing manufacturer. And he was responsible for component development, analysis of bearing failures, and manufacture process development.

Dr. Swanger also has a number of publications to his credit, which are listed here, and one U.S. Patent on "Bearing Material and Method of Making".

The last item I would like to review with you before the next speaker goes into this program in considerably greater depth is what we intend the output of the program to be and what we plan to submit to the NRC for your review.

First is specific reports on everyone of the known problem areas. And we will talk near the end of the program about how many that constitutes, whether the problem is generic or engine-specific. So that we will attempt, where time permits, to have all engines addressed in a single report and where time requires us to sequence it, we will issue a series of reports addressing those engines that need to be addressed first. But all problems will be addressed for all engines.

Second, an engine-specific design review and quality revalidation report will be one of the outputs of this program. Mr. Seaman will show you our tentative schedule for those reports.

The preoperational test reports that come out of those plants that have yet to perform. Preops on the diesels will naturally be part of the package. And we expect that that will come through I&E.

Special test reports, as required. For example, a test report on the instrument, the crankshaft run of the Shoreham R-48 engine will be a special report. And various other reports on specific aspects of the program, as required, will also be prepared and filed.

Finally, responses to NRC questions. We already mentioned we will respond generically to the appropriate questions posed by the NRC, and will respond specifically on a plant-specific basis where applicable.

Dr. Wells of FaAA, Failure Analysis Associates, is now going to cover the status of three of the major known problem areas, crankshafts, bearings and pistons.

Dr. Wells.

DR. WELLS: Let me start out by bringing you up to date on the resolution of the DSR-48 crankshaft failure problem. As I'm sure you know by now, five cracks were experienced in the three crankshafts at the time that our firm was brought into the investigation of the diesel engine problems.

We first identified the cause as tortional fatique. First of all, by conducting an analysis according to an industry accepted practice called the Holzer analysis. The Holzer analysis is actually a rule of thumb that has been adopted by the Diesel Engine Manufacturers Association to come up with a reference value, or relative figure, for torque and tortional stresses in the design of diesel engine crankshafts.

We went beyond that analysis by conducting our own complete dynamic analysis, given the exhortation of all key factors influencing the response of the engine. We call this a modal superposition analysis, because it takes into account all the possible modes of crankshaft response and allows us to calculate the variation of torque at each of the locations of the engine, which are critical which were found to have cracks during the investigation of the Shoreham engines.

With those torques at hand, we next modeled the detailed geometry of a typical flow of the engine in order to get the detailed stress distributions. From those stress distributions that gave us the complete oscillating history of stresses and all components of stresses, we were able to determine the endurance limit for that material under those machining practices that led to the design of the shafts and concluded, in fact, that these oscillating stresses were well in the range of the endurance limit for the particular material.

Next, we instrumented one of the DSR-48 crankshafts to determine whether our analysis was correct and also to come up with a complete understanding of this distribution of torque and stress in the crankshaft. This test verified, in fact, the predicted amplitude of the stresses, even including some of the fine details, as you will see in a moment some of these stress responses are quite complex.

Therefore, we concluded that we had a very complete understanding of the problem of tortional vibration in the engine. From that understanding, we next applied the same analytical procedures to the new crankshafts which had a one inch larger crankpin diameter; that is, the change was made from 11 inch to 12 inch diameter. And, of course, required replacement of connecting rods with a larger diameter bearing.

Following that prediction, we just recently completed a test, instrumented test, of the new crankshaft. This was done by three different methods. We measured the tortional oscillation of the free end of the crankshaft. We measured the variations of the output torque at a location just forward of the fly wheel. And we also put strain gages on the two throws that we found from the original test represented the locations of the maximum stresses, and as accurately as we could the locations of the cracks that initiated in the original shafts.

Next slide, please Just to indicate some of the features of this analysis -- and, incidently, the results have only been obtained recently and are still undergoing evaluation. We do not yet have complete records of all the stresses at all the locations.

So, here, then, is a preliminary comparison between what we predicted last fall in our November presentation to the Commission and what was actually measured in the last few days. And you can see, I think, quite excellent agreement between what was calculated and what was actually measured considering the output torque that is experienced at the fly wheel of the engine. Just point to these -- some of these distinguished features. You see here that some of these fine features of this irregular cycle which, of course, is repeated every two revolutions of the engine are, in fact, matched by the measured values.

There is a slight difference in amplitude. You will see here that the amplitude of torque is somewhat higher, about ten percent, than was predicted. But we feel that understanding is not far away. And we are confident, then, that we have a very accurate understanding of the performance of the new crankshaft.

Next, please. We turn now to the bearing analysis. You recall that there were several bearings found that failed during the disassembly of the engines at Shoreham. We did a complete stress analysis of the bearing and applied fracture mechanics and fatigue life initiation analysis to the material, which happens to be a cast aluminum alloy. And you can see here the design feature that we concluded was responsible for the failure of the bearings.

That is to say, the bearing shell was inadequately supported by the connecting rod. In the original 11-inch connecting rod design that you see on the left hand side of this figure, you can see that the one-quarter inch chamfer leaves an exposed edge of that bearing which is subject to a high oil film pressure and, therefore, bending stresses are produced each time the oil pressure is applied on the underside of the bearing shell, and the bearing shell bends.

That particular detail has been eliminated with the new connecting rods. Now, the chamfers are reduced to a sixteenth of an inch. And, a comparison of the stresses that we predict in this case, first of all, the one-inch larger crankpin diameter from 11 to 12 inches reduces the oil film pressure. Also, because the shaft is stiffer and oscillates less under tortional vibration the yaw, the angular variation of the center line of the crankpin relative to the center line of the connecting rod bearing, is reduced substantially by these figures.

The maximum calculated stress is reduced a factor of two. Therefore, given the quality of the material of the casting which we characterize as a typical seven-tenths millimeter diameter, we predicted that the 11-inch bearing shell would fail in a very short time, 250 hours; however, we predict with the same analysis that the new shell will be good for essentially the life of the engine.

Next, please. We concluded, then, that we have identified the cause since this chamfers situation does not exist in any of the other engines of which we are aware, the problem is unique to the Shoreham engine; and, in fact, the original connecting rods are no longer in service.

Through analysis, inspection of the bearing shells, and testing the mechanical properties of the bearing material, we have concluded that the new design is completely adequate. And we will essentially take the same approaches as appropriate to confirming the adequacy of the other bearings, particularly for the V engines.

Next, please. Now, to address the problem of piston skirt cracking which is only in its preliminary stages of analysis -- and this is really a progress report, I have no final conclusions to present to you. But the original Shoreham pistons had a configuration that resulted from a spot-facing rework of the first AF series of piston skirts delivered for nuclear diesel engine application.

That rework led to a configuration which is schematically illustrated by this cross-section and this shaded plant view. You can see the area that is involved. That essentially provides a reinforcement for attaching the piston crown to the top part of the skirt and distributes the load from the gas pressure in the cylinders through the piston crown, forces this top of the skirt down, distributes the load through the wall of the skirt, and through this reinforced section here into the wrist end and from the wrist pin of the skirt through the connecting rod and the connecting rod into the crankshaft, and off we go.

The failure location was in the intersection between the reinforced boss and this heavy section. In other words, cracks would initiate essentially in this location. And cracks were found in virtually all of the AF modified piston skirts at Shoreham and, in fact, cracks were observed in similar piston skirts in the Grand Gulf plant.

On finding this indication of cracking in this design, LILCO determined that they should replace all the skirts with a model called by TDI, the AE type, which is the latest type currently in production. This type, as you can appreciate, is stronger by reason of a much thicker boss area. This reinforcement lowers the stress in the critical area. You can see from this cross-section.

In addition to that improvement, the boss area has been widened to this contour. More cross-sectional area has been added in the wrist pin reinforcement area and early changes made that enhanced the ability to transfer load from the crown to the skirt.

We are currently attempting to analyze that load distribution between the crown and the skirt and the resulting detail stresses. The problem is somewhat complex, because in the attachment of a crown to the skirt there are two load paths. There is a path represented by the contact circle where the crown is bolted to the underside of this skirt, mounted through this boss. It's a nut here, of course, not shown in this picture, and that clamps the crown down on to the top of the skirt.

There is a gap on cold assembly of between seven and eleven mils. But by the first application of pressure to the top of the crown results in loading only this inner ring. Upon applying more pressure, this gap begins to close down and eventually does transfer a significant amount of present loading from the crown into the skirt at this outer diameter.

The stresses produced in this critical area, which is subject to fatique, depend critically upon this distribution of load. Therefore, we have modeled the structure of the piston skirt -- and this latticework here represents the degree of detail necessary in coming up with a structural model to be subject to detailed stress analysis. And there are many, many elements.

All you see here are the surface elements. And we are currently analyzing the detail stress distribution in the vicinity of the cracks.

The AN skirt configuration is involved in several of these skirts in nuclear application. And it is essentially the same as the AF configuration. The main difference being primarily that it is produced by casting rather than by free-machine, the original design of the AF skirt.

There are three -- and so far as we know, only three -- basic types of geometries required. We are currently doing the detailed analysis of the original Shoreham and the new AE version, and we will be doing the AN. These analytical models are still under development.

Because of the complexity of the stress analysis and the difficulties of determining the precise load distribution between the crown and the skirt, we plan to assist TDI in planning and conducting a strain gage test to determine the -- experimentally the actual magnitude of stresses. We have engaged a major manufacturer of pistons in West Germany to provide a complete three-dimensional stress analysis of the entire assembly of piston, crown, skirt, wrist-pin, including site loading and everything else involved that can be anticipated.

In addition, we have begun to obtain operating experience with the new AE piston skirts. We first were able to look at two AE skirts that had been engine-run for about 700 hours by TDI in a development engine and subject to apparently more severe conditions than experienced in nuclear standby operations. And we were unable to find any significant linear defects that suggest any fatique initiation in the regions for concern.

We have just begun to take information from an engine, a V-16 engine, in operation in Kodiak Island, Alaska. So, far we've looked at one skirt that has been operated in excess of 9,000 hours and have found that there are no indications in that skirt of fatique, cracking. That skirt is now on its way to our laboratory in Palo Alto and will be given a detailed metallurgical examination. And we anticipate having the opportunity to look at additional skirts.

Thank you.

MR. SEAMAN: My name is Craig Seaman. I will explain for you in a little bit more detail our diesel generator design review and quality revalidation program.

As you can see from the utilization chart, the program is broken up into three major groups. The design review group, the component selection group, and the quality revalidation group. The design review group is made up of a number of task leaders who are engineers who specialize in the various components we are going to be looking at.

Associated with them are our diesel consultants, the Germans as well as Failure Analysis people, Karl Schmidt who we are using for some of our piston reviews, and other consultants as necessary who will be consulting with the task leaders.

In addition, the design review group also has Owner's representatives, people from the various utilities who are both site engineers familiar with the unique experiences that we've seen at the various sites, and design specialists, valve specialists, various component type specialists from utilities, and the representative from Transamerica Delaval.

The component selection group is really made up of two sub-sections. One is the component selection group -- component selection committee, rather, who will go through the detailed component list for each engine design, and includes representatives from Failure Analysis Associates, Stone and Webster, our diesel consultants and Owner's representatives, and representatives from Transamerica Delaval as part of the component selection process.

We have set up a group of Owner's representatives who will be assembling the various site experience data to be used during the component selection process, which I will explain in a little bit more detail in a minute.

In the quality group area, again you can see that we have representatives of Failure Analysis, Stone and Webster and Owner's, who will be overseeing the entire program. And, again the quality group is divided into three sub-sections. The documentation review task leader. This individual is responsible for assemblying various site and Transamerica Delaval documentation by component so that that information is available, both to design group and the quality group for review purposes.

A quality engineering group, who will assist in an engineering capacity, both the documentation group and the last group that I will talk about, which is the field inspection group. Now, these people are the people that will go out into the engines and actually conduct inspections and tests on the engines as specified by the group.

MR. DENTON: What's your confidence in the ultimate success? It's a very impressive group you've put together here.

Do you have a group on just replacing the engine with one of the different design? Why didn't you go that route versus this route?

MR. SEAMAN: We don't have a group to consider replacement of design.

ATTENDEE: Replacement of engine is a very long term project. This is something we can do over a period of months as opposed to period of years. We are -- we feel confident that this program will be successful, and we will not know until we get further into it.

MR. COLLINS: Could you put that back again? It isn't clear to me. Maybe you could talk a little more about the task of what these people will be looking at in field inspection.

MR. SEAMAN: Okay. As I go through my presentation, I will be describing each of the functions of the program and in a lot more detail. So, hopefully that will become clearer in a minute.

The next thing I would like to discuss is the program description itself. Basically, the program is conducted in five phases. The first phase is to assemble experience data. The second phase is component selection. The third phase is preparation of task descriptions. The fourth phase is implementation of task descriptions. And, then, finally we will prepare a final report for each engine.

I will be discussing each of these in more detail in just a minute. If we look at the flow chart, that explains how the program will be conducted. Again, our first task is to identify the engine components. And, then we actually break into two sub-groups which will be assemblying, and have been assemblying, experience data.

One of which is the site data from the various sites, including the R-48s, the V-16s, V-12 and V-20 engines. And the other group will be assembling industry data, which again I will be discussing in a little bit more detail. But basically we are going after nuclear industry experience, as well as Transamerica Delaval marine experience and Transamerica Delaval stationary engine experience.

Next step is to select the components for review. After that, again we break into two phases, the design review phase and the quality revalidation phase. Common to both of them is the preparation of the detailed task descriptions. And, then the design review group will perform calculations and evaluations and reviews, as described on the task descriptions. Likewise, the quality revalidation group will perform inspections, tests and/or review documentation as appropriate, in accordance with task descriptions that have been established in the quality revalidation group.

And, then, finally is preparing and issuing the final report for each engine.

I would like to discuss in a little bit more detail now how we are assemblying this experience data and the type of documents that we are going after. Again, this is basically being done with two groups. One is utility representatives, Owner's representatives, that are being supplied at the Shoreham site who are assembling site experience data at the specific power plant sites.

Now, the types of data that they are looking for are maintenance records, operating loss, any design changes and improvements that each individual site has recommended and implemented, and any failures that have occurred at any of the sites.

With respect to industry data, again what we are doing is in the area of nuclear. We have, as Mr. Museler pointed out, earlier gone to 10 CFR 21 reports, any information we can gather from INPO or other industry sources that are associated with nuclear diesel engine. And we are not limiting this to Transamerica Delaval engines. The reason is that there are many components on these engines that are shared among manufacturers, and we want to make sure we understand what the historical operating experience is on any one of these shared components.

In a non-nuclear area, as I mentioned earlier, we are doing our best to assemble marine data. Transamerica Delaval is being very helpful in this area. And, again, also any non-marine data, stationary diesel engine experience is also being assemblied.

All this data is being summarized in a computor report that we are using. It's used during the selection process which I will be discussing in a moment to make sure that the people that are selecting components are aware of industry experience, and also to be sure that the design review and quality revalidation groups are also well aware of this experience when they conduct their reviews.

MR. DENTON: Can you give me a feel for how many diesels there are in a non-nuclear data field? If you are aware of the fifty-seven or so that have been sold to utilities, how many are there of a similar design or use in the non-nuclear field?

MR. SEAMAN: Gross numbers, I couldn't recall again off the top of my head. What we are looking for is experience data from the marine industry, anybody we can contact that has marine engines. Again, we are using Transamerica Delaval to help us out with that, to let us know what type of experiences they are aware of. We do have a listing of all Transamerica Delaval engines that have been manufactured, going way back in time.

And so we do know what engines are where, for specific design types. So, we are contacting those people to get what data we can from them.

ATTENDEE: Harold, to give you a feel for that, in the case of cylinder heads, which was an early issue on Shoreham, the data base on cylinder heads is several hundred cylinder heads which accounts for fifty or sixty engines at least. So, that's the order of magnitude for that component. For different components, the number of engines that we have data on is different, because the recording on the non-nuclear engines is on an exception basis. It's only when something really goes wrong.

But that's the order of magnitude.

MR. SEAMAN: Okay. Component selection.

MR. QUIDLE: I have a question. I'm Tom Quidle, AEOD. Do you know now, or is your program going to find out, what components of the Delaval engine might be common to other engines?

Do you know that already?

MR. SEAMAN: Absolutely. As I go through the component selection process, I will describe that in a little bit more detail, which is the next item.

The common data base we are using to select our component selection organization is the Transamerica Delaval parts list. That is the base document for our review. And each site is taking the Transamerica Delaval parts list and bringing it to Shoreham to be broken into components.

One of the first things we will do is identify common parts among the various utilities. And there are quite a number of them. And, again, that's part of the component selection process.

The selection committee itself is made up of an Owner's representative, Stone and Webster, Failure Analysis, a representative from Transamerica Delaval, and one of our diesel generator specialists, who is at the Shoreham site right now.

The next thing that the selection committee will do is take the component list and the experience data and review these components and specify either a design review to be performed and/or a quality revalidation, or both. In general, the way the selection occurs is that the importance of the part to the engine is the overriding criteria; however, experience data is also factored into it to make sure that everybody else is well aware of any problems that have occurred with a specific component.

MR. COLLINS: Could I just touch on that a minute? What kind of criteria are you using for your selection of components?

If you take the experience data, the fact you may not have many hours on it may show you to have good experience. And I don't think you can really take much comfort in that.

MR. SEAMAN: In answer to your question, again the prime consideration for picking apart for review is the function of that part in the engine. In other words, if a part is important for the operation of the engine, regardless of experience data, good or bad, that part would be selected for review. The experience data comes more into play in the next item where we outline minimum review requirements.

ATTENDEE: Let me just jump ahead to address this. If you look at Item E there, there are 217 groups of components on Shoreham, of which a total of 166 were selected. The number of components with known problems is much, much less than that, so that the number of components being looked at is far greater than the number of components with known problems.

MR. DENTON: Well, let's ask. Why not look at all components?

MR. SEAMAN: That's exactly what we are doing as part of the selection process. We are looking at every component on the engine, and picking those parts that serve a purpose to the operation of the engine and specify a design review and/or quality review on that part.

The types of components that we have eliminated from the process would be things like maintenance platforms, things along that line, nameplates. So, we are, in essence, reviewing any part that has an operability type function on the engine.

Okay. Again, the experience data is utilized to specify the minimum review requirements. In other words, we will always be reviewing the primary attribute of that component to make sure that that is reviewed by our engineers and/or quality people. But we also want to make sure that we are well aware of any experience data that would indicate we have to do something special on that component. That's really where the experience data comes into play.

Okay. As Mr. Museler pointed out, for the Shoreham case, specifically we identified 217 total components. We specified a design review to be conducted on 152 of those, a quality revalidation to be conducted on 133, and the total components that were subjected to either a design review or quality revalidation is 166.

So, again we are reviewing a very large percentage of the components.

The next step in the process is the preparation of task descriptions. And the first thing we do in this area is we assign a task leader. Generally, he is an engineering or quality specialist with respect to that specific component. And this individual is responsible for preparation of the task description, as well as implementation of the actual review and/or revalidation.

In the quality revalidation area, typically the task descriptions call for NDE to be performed, or destructive examinations to be performed. In general, they will identify sample size, if that's appropriate. And also specify the procedures that will be utilized to conduct a review, i.e. NDE procedures or any destructive examination procedures that should be employed.

The design review task descriptions in general try to find industry standards wherever they would be appropriate to spell out the requirements for the design review. They will detail the methodology and any information that is required from, let's say, Transamerica Delaval in terms of engine parameters. And, where we can't find industry standards that would be appropriate for a specific component we would specify a unique analysis such as finite element modeling, or something along those lines.

The other thing we are doing are evaluations that are recommended to us by our diesel generator consultants. The diesel generator consultants work very closely with the task leaders in the design area to make sure we cover all the bases with respect to design.

The task descriptions are after preparation through the task leaders, are subject to review by the Owner's representatives, Transamerica Delaval, and the Group Chairperson and program manager.

MR. EISENHUT: Quick question. When you said upon the selection of components it's going to be a sample size, is that -- what's the basis? Is it statistical based or how are you going to do it?

MR. SEAMAN: Well, it's not always the sample size. It really depends on the specific review they are talking about. In some cases, it will be all parts. And in some cases it will be a sample. Again, that's based on a lot of factors that are used by the task leaders, such as experience data and the amount or numbers of components like that that are available in the engine.

ATTENDEE: I have a question. If a particular component has failed in one engine, would it be considered as a component for design review on an engine which it hasn't been?

MR. SEAMAN: Absolutely. Any component that's typical of any of the engines that has failed. To give you a typical way we would handle that, we would subject it to a design review to find out why it failed, in addition to checking its primary operational attribute.

And we would also have the quality group do some specific examination so we could assure ourselves that we don't have a similar failure.

ATTENDEE: Since crankshafts in all the different engines will be analyzed?

MR. SEAMAN: That's correct. And I think Mr. Museler maybe touched on that earlier. And maybe he will in a few minutes also.

Once the task descriptions are reviewed and approved, it's up to the various task leaders to actually implement the reviews or revalidations that are called for. Again, in the quality revalidation area, we will use where possible spare and/or replacement parts. Where that isn't possible, we will actually go into the engine and conduct inspections and tests on the engine. The results, of course, will be documented and analyzed.

And, if necessary, those results will be forwarded to the design review group for analysis.

Design reviews, or the first aspect that is checked on all design reviews is the experience data. If we have some experience data on the component, everyone of those pieces of data will be reviewed by designers to make sure that that particular situation and particular experience is addressed for that component. Calculations will, of course, be performed as called for.

Evaluations will also be performed by our consultants. And any feedback that the design group would -- for instance, if they were to find there is a particular attribute that was particularly critical for that component that ought to have some sort of non-destructive test performed as a result, that information would be fed back to the quality group so that the proper inspection would be performed.

And, finally the task leaders are responsible to identify any results and/or recommendations that would be the result of their reviews. This final package would be reviewed by the Owner's representatives, by Transamerica Delaval and the Group Chairperson and program manager.

Typically, we would expect things to fall into one of three categories as a result of our reviews. And that would be the component is acceptable as designed and fabricated. We would possibly want to increase inspection and/or maintenance frequency, or possibly upgrade or replace the part.

ATTENDEE: I have a question back here. Will someone be defining maintenance and maintenance programs for components under this list?

MR. SEAMAN: That's exactly correct. Where that's appropriate, if increased maintenance or inspection is warranted, that will be specified by the group.

ATTENDEE: In this design, will they also be considering potential failures to the standby diesels sitting around the plant for a number of years? Have a lot of maintenance people running in policing it or not policing it. That sort of thing. Will there be any of those postulated?

MR. SEAMAN: Well, maintenance type activities will be addressed by both design group and the quality group. If there is an appropriate maintenance type item like greasing or fitting, for example, that might be something that the quality group would be asked to check on that engine to be sure that it has been done.

In the area of design review, we will also be reviewing maintenance programs to make sure that the proper maintenance programs are in effect.

ATTENDEE: Primarily, my question was relating to just setting up specific maintenance periods. But my concern to us is the alternate standby people looking at a potential for maintenance --

ATTENDEE: Excuse me. Could we hold the questions until the end and we will have someone else who can address that? If you will hold it until the question time period.

MR. SEAMAN: Okay. With respect to the final report, I will just go through this very briefly. It will contain an executive summary, a description of the program, the methodology that we used for selecting components, as well as a summary list of the components and classification, the methodology that was used both by the design and quality groups, tabulation and discussion of any deviations and/or recommendations that we have, and any corrective actions that are recommended as a result of the design review or quality revalidation.

This slide illustrates the present schedule and current status for the lead R-48 engine which is Shoreham. As you can see, the actual review commenced in late October and assemblage of experience data is essentially completed. We have also gone through our component selection process for Shoreham, and are well along with the preparation and actually started implementation of the task descriptions.

Regarding the lead V-engine plant which is the Grand Gulf V-16 engine, we have Grand Gulf representatives at Shoreham who are presently assembling their experience data. As you can see, we are expecting to get a final report out in May on the V-16 engine.

ATTENDEE: Did you mean Grand Gulf? You said Shoreham.

MR. EISENHUT: They are at Shoreham.

ATTENDEE: The work is being done at Shoreham.

MR. SEAMAN: Okay. Again, this slide is fairly self-explanatory. It's the overall schedule for all plants for the DRQR program. And I know Mr. Museler will be touching on this in a couple of minutes in a little bit more detail. So, I won't go into more detail than just show you this. And that's it.

MR. MUSELER: Mr. Clint Matthews of TDI and Mr. Don Bixby of TDI would like to take a few minutes to give us their perspective on the program.

MR. MATTHEWS: Thank you. I am Clint Matthews, General Manager of the Transamerica Delaval Engine Compressor Division. And I will talk a little about Transamerica Delaval's activities.

Our first activities were directed towards correction of the problems. This is the mechanical problems, broken parts. In the case of the crankshaft and bearing problems that occurred at Shoreham, we sent technical people to investigate the failure and to advise means of repair, followed up with a team of factory mechanics to Shoreham to work around the clock on the crankshaft replacement.

In order to provide the parts needed, we interrupted factory production of two other engines to provide the replacement crankshafts and connecting rods and other material and expedited production of a third set so that all three Shoreham engines could be changed to the new stronger crankshafts.

We have continually provided, and are providing, dimensional information, material properties, and operating parameters, as well as field history, to aid in the analysis of failures.

We conducted a static strain gage test on an 11x13 crankshaft similar to Shoreham -- not identical, but similar to Shoreham -- to enable analysis of tortion-induced stresses and force-induced stresses to separate the two. This was an aid to the other work that was being done at Shoreham by Failure Analysis and others.

We conducted an analysis of one of the failed bearings from Shoreham. And we are currently proposing a static strain gage testing of the 12x13 crankshaft, again to enable analysis of tortion-induced stresses and force-induced stresses.

On piston cracks, as soon as we heard of these occurring at Shoreham, we sent technical people to investigate the indications and cracks, provided replacement of stronger piston skirts to Shoreham. Those were identified earlier as the AE piston skirt. We have provided, and are providing, field operating history and factory test history of pistons to support the AE design and the other designs.

We are currently providing a factory strain gage test which will provide information to aid Failure Analysis Associates, independent analysis of the stresses in the piston skirts. As Cliff Wells told you, the distribution of loads in the piston is a very difficult thing to do analytically, so we are helping by doing some measurements, direct measurement of that distribution of load.

Transamerica Delaval's support of the Owner's Group program. First of all, we encouraged the formation of the Owner's Group, because it provides, as we see it, the best way to separate generic concerns that might be a concern to all groups, from specific concerns, as the most efficient, the most effective way, of pinpointing what actual problems are in dealing with those problems. The Owner's Group was formed, and we had a meeting on November 30th in Oakland, primarily directed towards generic problems, also addressing some specific problems. As a result of that meeting, turned out a lengthy document providing written answers to the questions that had arisen among the Owner's Group.

We have provided blueprints and other information -- by other information, technical information such as specification sheets, operating history, quality documentation, test records and so forth -- to assist the Owner's Group in design review, quality review, quality revalidation program. We have supported it in that way, and will continue support of it in that way.

We are providing full-time technical support partly at Shoreham and partly in our own operation in

Oakland, California, to the Owner's Group design review quality revalidation program.

We realize that the NRC has serious concerns about the adequacy of the Transamerica Delaval quality assurance program in view of a number of serious problems and lesser problems that have appeared at nuclear and non-nuclear plant installations, and from findings of NRC inspections of operations at our plant.

Prior to the August 1983 crankshaft failures at Shoreham, our quality program had been audited dozens of times over a ten-year program by representatives of all of you. And we had been audited seven times by NRC teams. We have incorporated many changes in our written program and in the implementation of the program as a result of the findings and recommendations of these audits.

Since August 1983, we have been audited twice by NRC, September and October. Their written report was sent to us last week and arrived on Friday. The report contains numerous findings of non-conformances, some we believe are misunderstandings. But the report raises questions which we have to address about the adequacy of our program.

We recognize the great need to take steps to reestablish confidence in our Company and in our products, and we fully recognize the responsibility we have toward public safety and toward reestablishing public confidence in our quality assurance program. To that end, we made the decision to engage the consulting services of a reputable firm to give us an independent evaluation of our current program and to assist us in correcting any deficiencies that are revealed by their study. We expect to have this underway within the next three weeks.

In the meantime, we will respond promptly to the latest NRC findings, with the need toward correcting whatever deficiencies do exist, clarifying misunderstandings and generally to cooperate to reestablish confidence.

In addition, we have been told that the NRC has referred some of their observations to the NRC Office of Investigations for further work. We have not had any direct information, and still do not know if, in fact, such investigation is taking place or what its content is.

In summary, Transamerica Delaval is fully prepared to meet, to apply all available resources to resolve whatever problems arise from NRC inspections, investigations and from the Owner's Group design review quality revalidation program. We are dedicated to quality assurance, to the support of the nuclear industry, and to clearing our tarnished image.

I would like to ask Don Bixby -- Don is the

Chairman of the Board of Transamerica Delaval and Chief Executive Officer. Don will say a few words.

MR. BIXBY: I will be brief. My name is Donald Bixby. I am at Lawrenceville, New Jersey, where we have our corporate headquarters.

We are responsible there, and run a Company that is made up of sixteen operating divisions around the world, of which the Engine and Compressor Division in Oakland is one. I am not a diesel expert. I think many of us in this room will be before we get through. But at the moment, I'm not.

But I have been attending the user meetings, and I am here today to make certain there is no question about our commitment to the users and to the NRC in giving full cooperation in this program.

We are pleased that the user group has been formed. And I'm especially pleased that it involves so many outside consultants of established reputation. It would obviously be very difficult for us on our own to be very conclusive and convincing the users and NRC that everything has been properly cared for. So, we are glad that those talented consultants are in the picture.

The main thing I want to leave with you -- and incidently, the name Transamerica Delaval may not mean much to some of you. Initially, we were the Delaval

Steam Turbine Company, and over the years we have had some transition in name. And those of you that may have served on naval vessels would know of us. And, of course, we have been a major supplier to the utilities for many products for many years.

And the thing that gives us our thrust in the marketplace has been our reliability. And, so it is absolutely essential that we restore that, that concept, and there is no question of it. And we will have to dedicate our total effort to that.

But, the main message is, we are committed to the program. You can count on us. If anyone at NRC or the user group has any moment of feeling that's not happening, I wish you would call me in Lawrenceville, New Jersey and let me know.

MR. EISENHUT: Mr. Bixby, if I could interrupt and follow up on that, a couple of quick questions, then.

Obviously, one of the things we are going to be looking at is the overall experience, manufacturing experience, the QA problems, what they mean, et cetera. I think one thing we want to do with you is take you up on that offer.

We will be asking you to -- if you can follow up on that commitment, we will be asking you to make available to us the manufacturing records, the engineering records, the operating experience, whatever you know and are aware of, we certainly intend to have a team of people following this problem, pursuing it, all aiming towards really trying to understand the problem, correct the problem, figure out what it takes to get in front of it.

MR. BIXBY: And you can count on that. And my belief is that is already happening with the user group, that many of these problems that have been identified were identified by us. We have disclosed the --

MR. EISENHUT: Part of the reason I asked that is, while I notice in your overall schedule you have operating experience, some recent reports, et cetera. There is very, very little information that has been provided to the NRC in terms of summarizing the problems, either via the owners, the particular owners, or TDI, up to this time.

So, I think it's something we will want to pursue with you.

MR. BIXBY: You can count on us.

MR. EISENHUT: Another quick question. It was Mr. Matthews that referred to your engaging an independent firm to get some of the problems -- have you identified who the firm is? Can you tell me now?

MR. BIXBY: We think we know who it is, but we would rather complete our agreement with them before they know they've got the order. But, I will tell you later.

MR. EISENHUT: Jim, I know it's a short piece of the presentation yet, but I do know it's a whole series of questions yet.

Maybe what we ought to do is take a short five minute break, if we could, if that's agreeable.

(Whereupon, a recess is taken at 5:04 p.m., to reconvene at 5:22 p.m., this same day.)

MR. MUSELER: We have two more items. One is a description of how the various parts of the program described by the previous speakers will actually get integrated into an action plan on a component, say, with all the engines. And I will attempt to do that, as well as describe to you what we currently feel is our overall schedule.

The integrated program approach will allow us to resolve the generic known problems on the lead engines, providing we have the data base of all the engines assembled as quickly as possible. And we think that's going to occur very rapidly.

The design reviews and the quality revalidations of later engines beyond the lead engines will build on the early units. And that we will see in the following slide exactly how that will progress.

Sample inspections on all the units will enable us to have an adequate universe for sampling of whichever parts we need to look at the design for. And whichever parts we need to call destructive or non-destructive inspections on.

We believe that as this program progresses, and it's moving very rapidly right now, that confidence will build very rapidly, proportional to the progress we make in each of the program areas.

Now, this is a very busy slide, but I think it's very useful to spend a little time on it, because it does put in perspective how we are approaching any given problem or any given design review for all the engines. This particular slide is on the crankshaft situation, and you can see it's broken down into groupings of engines, the three R-48s, the six V-16s, the V-12 and the V-20 engines.

For Shoreham, we performed conventional analyses on the crankshaft tortional situation. FaAA has performed refined analyses along the same manner to validate the conventional methodology, and has performed finite element analyses. They have also done this instrument test that Cliff Wells described earlier.

In order to validate those analyses, the Shoreham engines are all going to be run for 100 hours at a hundred percent power. The reason for the 100 hours is that that provides ten to seven stress cycles which gets you out beyond the endurance limit, and that will validate that these shafts are acceptable for the life of the engine.

Following those runs, and essentially following the entire preoperational test program, which has been submitted to the NRC and accepted, we are going to perform NDT inspections of the three crankshafts in the critical stress areas. We are going to run a torsiograph test on the engine, which is the conventional methodology for the industry, to insure that that torsiograph matches the conventional methodology of the crankshaft analysis. And we've already mentioned that we've done strain gage testing on both the old shafts and the new shafts.

Follow that down, River Bend, the next engine, we believe will require a conventional analysis, Holzer analysis if it's different than Shoreham. The metallurgy of the shaft, for the shafts from River Bend, and the detailed design configuration need to be checked. But if it, in fact, is identical to Shoreham, then the Holzer analysis might be applicable. In fact, I think we know enough about River Bend to know that since they have a different generator then that affects the tortional analysis, that there will be a unique analysis done for River Bend.

River Bend will run at least one engine for 100 hours at a hundred percent power in order to get beyond the endurance limit of the crankshaft, and perform NDT inspections of those crankshafts, and also perform a torsiograph test.

We get down to the third R-48 engine --

MR. EISENHUT: Excuse me. But before you go by that, what does the "None" mean in the Hardware Changes column?

MR. MUSELER: The None means that because this is a known problem. The Shoreham engine had to replace the crankshafts for obvious reasons. We believe that since the replacement crankshaft for Shoreham and the original installation for River Bend and Rancho Sacho are the same, that no replacement parts will be required.

With respect to the V-16 engines, a Holzer analysis or conventional analysis will be done by FaAA for the Randolph engine. Those engines have already been run at a hundred percent power for over 100 hours, and the crankshafts inspected. A torsiograph test will be run on the Randolph engine, on at least one engine to validate the conventional methodology.

Preliminary indications on Grand Gulf, based on factory torsiograph tests, indicate that there is agreement between the torsiograph and the conventional analyses. But FaAA is going to perform an independent conventional analysis for those shafts.

ATTENDEE: If there was not an agreement between the torsiograph and the Holzer analysis, what would you do?

MR. MUSELER: I think that would depend on what the disagreement was, the magnitude of it. For example, it could -- if the torsiograph showed that the loads on the crankshafts were much higher than predicted, for example, and validated that, but we double checked the calibration and we were sure that that's really what we were looking at, then probably one of two things would happen.

If that occurred, we probably would wind up doing more refined analyses, and we might wind up doing a strain gage instrumental test to find the actual stress in the highly stressed areas. So, it's difficult to predict the entire chain without knowing exactly what disagreement might occur.

But, clearly we would have a problem at that point and would either do additional analytical and/or testing work to find out whether we have a crankshaft problem.

Let me just say, the stresses in the V-16 based on the preliminary work that we've done are lower than they are in the revised Shoreham R-48 and lower than the other R-48s. But, if that happened, we would have to address it, depending on what the facts were.

ATTENDEE: In light of the fact that the torsiograph test that was done on the original Shoreham, the 13x11 crankshaft didn't show that there was a problem with the Shoreham crankshaft, why do you think that the torsiograph test will be able to show you if there is a problem with the V-16s or the V-20s or the V-12?

MR. MUSELER: We are going through some iterations on torsiograph testing right now. And we are not prepared to say what the validity or non-validity of the original torsiograph tests on Shoreham are.

If what you propose turned out to be true; in other words, if the original torsiograph validated the fact that they were below limits, we would have to address that in terms of how far below the limits were they.

In other words, suppose it indicated, which I think the raw data indicates, it was very close to the margin. I think being very close to the margin as opposed to be being twenty or thirty percent away from the margin is indicative of the situation, because the situation is that those shafts originally were close to being adequate, although they weren't. And, again we are not prepared at this point to say clearly what the original torsiograph on Shoreham engine means.

I think I had gotten to Grand Gulf and said that we would do a unique analysis. FaAA will do a unique analysis for Grand Gulf.

And if you follow down the other V-16s, clearly if the engine configurations are exactly identical to Grand Gulf, then the analysis would be applicable to them. If they are different, a unique analysis will have to be done for that engine. And we haven't gotten to the point where we know which ones can be piggybacked in that respect.

Torsiograph testing, we believe, is appropriate for all of the engines, because at the current time we believe that the conventional crankshaft analysis methodology is adequate to predict the behavior of the crankshaft on a microscopic level. Therefore, torsiograph testing is appropriate to validate that. If something happens to change that over the next several weeks, we would have to reevaluate that.

But right now we believe that is the case. The conventional methodology is appropriate, and we would reaffirm that for all of the engines, and check it with torsiograph testing in place in plant.

MR. COLLINS: Why wouldn't you do the NDT on the 12 and 20?

MR. MUSELER: Why wouldn't we do the NDT on the 12 and 20, I think these engines are right now -- and, again this is a preliminary order of doing things, but we haven't had a chance to really decide which engines need the first priority beyond Grand Gulf. But, if they were done in this order and we had validated that conventional analyses and the metallurgy and the fabrication had resulted in no problems with crankshafts on the three R-48s and six V-16s, we feel fairly confident that one would not need to do that, although that is --

ATTENDEE: Bill, don't you have at the start of each examination of these components an understanding of what you have in each of the machines now, what their pedigree is now so you can make some judgments as to what you can see?

MR. MUSELER: That's correct. We need to know exactly what the design configuration of each component is. We need to know its history in terms of its metallurgy and its manufacturer. That's a true statement.

And that data is being supplied by the Owner's representatives directly from the sites and then by TDI, where they have it.

ATTENDEE: So, these conclusions are predicated on someone understanding that these components are coming from at least a similar, if not the same -- if there is a distinct variation in that, you may have to do something different.

MR. MUSELER: That's also a true statement.

ATTENDEE: Another way to look at it would be if the quality assurance program, the manufacturer of all of a particular model, like the V-16s, can't be at a level of confidence, then it puts in the question of your program, because you may have to first prove that the components and the machines have been built to an adequate quality standard, and that they are consistent from unit to unit as they come off the assembly line before you can make any generalizations as to what would be adequate in the way of inspections and testing to verify the design.

MR. MUSELER: That also is a true statement. We need to verify that what came out the other end is what we are basing our analysis on.

We will be examining the metallurgy of the shafts as well as the --

ATTENDEE: As fabrication?

MR. MUSELER: Yes. This is just one other example which I believe is useful to illustrate, because it requires a different approach to the crankshafts, in our view, and that's the connecting rod bearings, the problem which we think was unique to the 11-inch bearings on Shoreham.

For Shoreham, we have done the journal orbit analysis, which is a detailed bearing manufacturer type analysis. We have done a finite element analysis, and we have done a fatigue and fracture mechanics analysis on these bearings. We've also done a considerable amount of NDT inspection and destructive testing on bearing materials.

After the same 100 hour runs -- and, in fact, after the whole preop test program at Shoreham, we are going to be sampling those bearings to make sure that they in fact are performing as adequate, performing as advertised.

And in addition to inspecting bearings throughout the program, in terms of verifying that they are performed properly, we are going to be inspecting bearings prior to operation to ensure that they have the appropriate weight size, which is the critical parameter for this particular situation. And also to verify that we do have the appropriate material.

Let me just say that there was flying back and forth in terms of material properties in these bearings early on, and we had one -- I will say -- error made in the test early on in the program. It turns out that material-wise now, we are going to be doing more material testing. But material-wise now, I don't believe that there is a material properties problem with the bearings. But there is going to be more of that testing done.

At any rate, the same basic philosophy applies in what we do for one engine, if it's applicable from a design analysis standpoint to the next engine, we would apply that; if it needs to be done differently, it would be. Clearly, the V-16 engines, which have 13-inch pins, will receive their own unique analysis on the first engine and if all the other engines are directly applicable, they will just reference that.

Inspection of bearings, however, is going to be done on a different basis than we are doing the crankshaft inspection. For example, these bearings are manufactured over a period of eight or nine years. And Dr. Swanger, whose resume you saw earlier, is the bearing expert. And he is going to design a sampling plan, both preoperational and post-operational to ensure that we have adequate coverage over this universe of bearings from over the last eight years.

That sampling plan, in terms of how many bearings for which engine, is not fully defined at the present time so I can't tell you how many bearings are involved. The idea, however, is to ensure that we have coverage over this entire period, so that when we are through we can say that what we've got, if the results are positive --

we are talking in terms of reaching the same conclusions that we have reached today, that's not to say that the different data might not tell us something else.

But if we do reach the conclusions we believe we will through this sampling plan, that will give us confidence that this universe of bearings are adequate.

This matrix is designed to describe in summary form the application of the design review and quality revalidation program, the DRQR program, that Craig Seaman described. For all plants, the component selection process will be gone through in full. And the components that require design review and quality checks will be identified.

Let me emphasize again that the selection of a component for review, while it clearly is influenced by the available data base of problems, is far from exclusively influenced by that. In fact, if you took the total number of known problems, it would give you a very small number of things in terms of universe of parts to evaluate. So, the function of the part is what makes the primary decision on whether or not it requires a review. If it's an important part at all, it gets reviewed.

If it's a maintenance platform, it probably doesn't get reviewed unless it might fall on something.

ATTENDEE: Will you be providing some basis for exclusion of a component from the selection process?

MR. EISENHUT: Let me help that. Yes, we will. You will have to do that.

MR. COLLINS: I would like to see a documentation.

MR. MUSELER: Let me say this. I think you, the NRC, looks at the first part of this which is what components were selected, which components were not selected. I don't think that's going to be an issue, just from what I've looked at in terms of what has not been selected. It is not things that are relative to the operation of the engine.

But clearly we need to convince you that that choice was appropriate, and we intend to do that.

In terms of the reviews, the lead engines, Shoreham and Grand Gulf, will be performing, let's say, the largest number of reviews because they are the first ones up. And you follow on, River Bend will go through a selection process, and we will do the design and quality reviews, minus any common parts associated with Shoreham engines, and so on down.

In regard to Grand Gulf, they would do design and quality reviews on those items that were not common with R-48s, and there are quite a few parts that are common to all the engines. Now, that philosophy --

ATTENDEE: Minus the common parts? I'm trying to understand you. In the previous slide, you indicated that there was a wide variation in the pipes, a type of bearing material.

MR. MUSELER: Stay with me a moment. I know where you are going.

ATTENDEE: You have that same kind of concern with respect to deciding what was common and why it should be excluded, unless you understand it's very similar in each engine.

MR. MUSELER: Okay. The answer to your question is that in terms of items that need to be considered, that have quality attributes, why it the right material, was it manufactured the right way, we may have done a design review on a component on Shoreham and it's an identical component on Grand Gulf, so we won't redo the design review but we will in the universe of inspections include common parts that are common to Shoreham, Grand Gulf and anybody else in the universe of inspections of that common part.

So, I believe that -- is that responsive to your concern?

ATTENDEE: You said design/quality review?

MR. MUSELER: Yeah. We wouldn't do a quality review on it, because we know what the quality attributes are. But it would be included in the universe of inspections to validate that quality. So, it would be valid.

All parts -- let me say, if I'm talking about widget X and it happens to be a widget that's common to all the engines, when I establish that I say: Well, I only have to worry about the design of that thing once unless it operates differently in a different engine.

And I have a quality plan for what needs to be looked at, but I don't just look at that part on the lead engine. I decide, via the quality review group, how many of these widgets are there, how many need to be looked at, in each engine or in each grouping of engines, in order to be sure that we have confidence that it really does meet the manufacturer requirements.

So, that follows through the -- that philosophy follows through the design and quality review area, just as it does in the resolution of known problems. And, in two slides down, very briefly I'm going to go over what our current list of known significant problems are.

With regard to the testing program -- and this slide combines the overall preop testing program and some of the inspections that we talked about previously, but just to give you a feel for what will be done throughout the universe of engines, Shoreham's program has been submitted to the NRC and that will total 300 hours on each engine roughly with these 100 hour durations at full power.

River Bend will do that 100 hours at full power in one of the engines, and we will also perform an endurance run of the same general type of Shoreham's. Following that, the major inspections we talked about earlier are to do NDE on the crankshafts to make sure that they are, in fact, beyond the endurance limit so that they have the same life as the engine. Bearings will be included in this universe of bearing inspections that we discussed earlier. And pistons, in the case of the lead engines, will also be pulled and reinspected.

In the case of Shoreham, for example, we are going to pull three AE pistons on each engine, and that same type of philosophy will apply to following engines, with reduced frequency if the results indicate them.

ATTENDEE: Is there a specific reason why cylinder heads are excluded from inspections?

MR. MUSELER: Cylinder heads are not excluded from inspections. This slide was just meant to illustrate major inspections you have on these runs. We have not established the inspection plan for cylinder heads at the present time. That's one of the lead design and quality review efforts.

So, just because a component doesn't appear here doesn't mean that it is not going to be inspected after the preop testing.

In other words, I don't intend to say that only these components are going to be inspected. I'm just trying to give you a feel for what the nature of this is.

ATTENDEE: The total list won't be confirmed until you do all your component design reviews?

MR. MUSELER: Until we do our component selections and perhaps design review, which in the case of Shoreham and Grand Gulf -- well, Shoreham's is done. Grand Gulf's is going to be done the first week in February. So, that information will be available very quickly.

With respect to Grand Gulf, they've got actually more than 100 hours at full power on each engine, and they've run the engines for a considerable amount of time. I think of the nuclear units, Grand Gulf probably has more hours on the engines at the present time than anyone else.

Crankshaft inspections have already been done on Grand Gulf, and they are positive there are no indications in the fillet areas; therefore, while the analysis isn't complete, we conclude that based on available data that those crankshafts are in that category.

So, the same philosophy follows, goes on through -- follows on through the others. We believe that if we prove those components that have an endurance limit requirement on the early engines, and if we establish that the quality attributes of those components are reliable, that we won't have to repeat those kinds of major engine tests. Again, this -- obviously whenever you put something like this together, you assume favorable results.

The program will be modified as we see things that require additional testing or additional inspections.

ATTENDEE: Bill, before you go on, perhaps it would be appropriate to point out that those inspections you have on that slide, some of that has already been done.

MR. MUSELER: I think I indicated on Grand Gulf, the crankshafts have been inspected and the bearings. Some of the bearings have been inspected, and have both crankshafts been inspected?

ATTENDEE: Right.

MR. MUSELER: Based on the information we currently have, we have to finish the analysis. But on what we currently have, we have no reason to believe there is any problem with the V-16 crankshafts. But the rest of the things have yet to be done.

The overall schedule looks like this at the present time. The major problems, we believe that the crankshaft problem, while analysis will have to be done on some of the subsequent engines, that the lead units and their inspections will be done in mid-March to early April, so that the crankshaft situation, subject to confirmation of material attributes, and some analysis on the follow on engines, will be resolved at that point.

Bearings, we believe we are at the point where we understand what the initial problem was. We believe that the bearings are adequate, and that there is no problem with them. However, the inspection programs that cover that universe of eight years of manufacture still does have to be performed.

Pistons, it's difficult to determine exactly when that analysis will come together. The analysis by FaAA is reasonably far along, although not nearing completion. The subsequent analysis by Karl Schmidt in Germany is about six to eight weeks away at the present time.

In the meantime, we will be doing the inspections on the units. We are going to be able to look, I believe, at several more pistons from the Kodiak engine which has over 9,000 hours on it. I believe either 7 or 9,000 is the number. And by the time we get to early or late

March, we will have had significant running time at high power levels on the Shoreham and Grand Gulf pistons and, therefore, the results of those inspections are obviously keyed to the adequacy of at least one type of piston.

We are analyzing all three types of pistons. And we need to ensure we have all the available data on all types.

Let me say one thing that didn't come out earlier. We know they are having problems with AF pistons. We also know there have been some problems with AN pistons. However, the current data base indicates that those problems were related to the Part 21 heat treatment problem. So, based on that current available data, we do not have evidence of problems with AN pistons, excuse me, with AN pistons, if they had been properly heat treated. But we don't have the entire data base assembled.

The current data does not indicate any field problems with those pistons.

Finally, the list of other problems which I will discuss in a moment, we think is going to take us out to early April, and those problems -- a number of them have been looked at by various entities, MP&L, FaAA and various vendors. We have not pulled all of that data together to be able to say we have a comprehensive answer to each of them. But we currently expect to be able to do that by early April.

The DRQR program, Craig described this, these are the issuance of the various reports which carry us out into the early summer of this year, by 1984. And, finally the testing requirements for all engines, we have not put back together -- some units are still a year or more away from operation, so we are still in the process of assemblying that composite schedule. And it depends to a large extent on the results on the early analysis of the DRQR program, in terms of what testing might need to be done.

At any rate, we believe that the lead engines by the end of March will have significant operation on them in the areas of concern.

This is our current list of items which we believe need to be addressed for all the engines for us to ensure that if this problem was a serious problem that it either is not applicable to these engines or different classes of these engines, or that if it does have applicability to any of our engines that it has been appropriately handled, either by replacing parts or by analysis if the particular operational situation is different than what we have.

But this list is subject to some change, but I'm sure that the items on this list are not any surprise to the NRC. They were no surprise to us when we tried to develop the overall list. This is not to say that this is a total list of all problems that are in our data base. There are obviously more problems than that in the data base, but we've made judgments as to which problems we think are of such significance that they need to be handled early on and addressed in a very short turn-around time.

The final item that I would like to address is our licensing situation. And, then Jim will sum up for us. We believe that it will be necessary to resolve all of these significant known problems for each engine that comes up for licensing. As I said before, we are attempting to do that in one document wherever possible to address the situation for all the plants at the same time. In some cases, that won't be possible and we may do it in groups of one, two or three plants at a time in order to accommodate the schedule requirements.

But the problems with generic are engine-unique, or engine-unique if they are of significance will be resolved prior to any decision on licensing. I guess I don't need to say that. We believe that a commitment to the overall design review program is appropriate for licensing.

All eleven utilities have committed to this program, so I think it's in place. With respect to the early part of that program, of the design review program, we believe that the component selection process needs to be accomplished for the plants prior to licensing. By that, I mean that any common parts need to be addressed so that they have been adequately treated and any engine-unique parts. In addition to the known problem list that come out of the design review process, as needing attention -- in other words, as being potentially -- having a potentially negative effect on the engine's reliability, would need to be addressed early on.

But that the overall completion of the design review program for those items that are not significant to the engine's operation, would be a follow on effort.

Clearly, the completion of preop testing, both as specified in the regulations and any additional testing that's required, such as the 100 hours full power runs, would need to be accomplished prior to licensing.

And, finally any major inspections that are indicated by the program would need to be accomplished prior to licensing. For example, any of the crankshafts that require NDT after preop testing, that would have to be accomplished, as would any bearing inspections that are called for in the program.

That summarizes the entire program. And Jim

McGaughy will wrap it up for us.

MR. EISENHUT: Let me ask you a question on something you said. On Item 3 on the last slide, about the items that were significant to the operation of the machine would have to be resolved prior to operations. That list you had up, some one to fifteen significant items. Do you consider those items to be significant to the operation of the machine?

MR. MUSELER: Yes, sir.

MR. CARUSO: Some of my questions are sort of technical. In evaluating the engines, or various different parts of the engines against known standards, for example, the Demis standard, there are other standards available for evaluating engines such as the American Bureau of Shipping Standard; which standards do you plan to use, or do you plan on using a composite of Demis, ABS and ASME?

MR. MUSELER: Let me say with respect to that particular component, we are going to be looking, at least in one case, at what the ABS standard says in terms of, if we apply the ABS standard what would it tell us about the crankshaft. The standard of record, at least in all the specifications that exist, I believe, that were specified, for example, calls for evaluation against Demis standard.

As you know on Shoreham -- and they got mixed and matched along the way, and we are going to evaluate the situation vis-a-vis. In other words, if Shoreham's design were evaluated against the ABS standard, what would that tell us. We don't presently plan to go through that exercise for all the units, because as I said earlier the problem with the Shoreham crankshaft we believe has been clearly identified. And the analysis that has been by FaAA indicates that had the appropriate parameters been utilized in the conventional methodology against the Demis standard, that those crankshafts would have been okay.

In fact, when one does that for the 13x12 crankshafts, one gets agreement between the more refined analysis and the testing, and that validates the conventional methodology. So, we are going to have some information to see what that means but we don't have any reason to doubt the original design standard.

MR. CARUSO: I was just wondering if you were going to consider other standards besides the Demis standard, because there are other standards with different specifications or different allowable limits out there.

Considering the sensitive use of these engines in a nuclear power plant, then you consider an appropriate standard to judge them against.

6 P.M.

MR. MUSELER: There are parts of the engine that wind up being judged against the Demis standard. For example, we are using IEEE standards where they are appropriate, using ASME standards where they are appropriate. So, there are many more standards than Demis. That's a relatively small population.

MR. CARUSO: That's fine. That's basically what I wanted to know.

MR. MUSELER: Yes.

MR. McGAUGHY: That covers our program. The only thing we haven't discussed is what our interaction will be with you along the way. And I know you would like to see our program, and we would like to get some feedback as we go along.

I don't propose that we hammer out those details today, but I would hope that perhaps maybe in the next week meeting on a technical level we could reach some kind of resolution on how we should handle this. We feel we have outlined here an aggressive program. It's thorough; it's extensive; it's also expensive. And when we are finished with this program, we feel we will be able to defend the reliability of these engines to anyone.

So, any questions we will be happy to try to answer.

MR. EISENHUT: Jim, let me go back and jump up away from the details. Clearly, you've laid out a program which is, I think, impressive in its sense of, you know, it's quite thorough. It's going to cover all the machinery. And it really gets down to a question, I assume you do want us on board with you, so to speak, as you go along.

At some point in time, you are going to say for the lead machine that you have a little interest in, you will say -- or one of the leads anyway -- we have now completed our job, and we are happy with it. This program you laid out is a very ambitious program. I'm very pleased by that.

But I want to impress upon you that clearly the program, a description of the program is going to have to somehow be submitted to the agency, formally submitted for our review. It's going to have to be reviewed by the agency. And I presume you will want it approved by the agency.

There are lots of questions. You know the staff as well as I do. They have probably got hundreds of questions out here. There are some basic questions, though.

Remember going in that we want, on any given plant, prior to licensing, even a low-power license, you are going to clearly have to have a certain level of confidence, and I don't know whether the last slide here --

I don't want our silence on the last slide to -- I mean, I'm going to make it clear, it's not acceptance by us. But it's going to have to clearly be something -- like, accounting for the fact that there were QA problems accounting for where the known experience problems are, addressing that this machine is, now we are confident that the quality is in it, by whatever way you got there. The known defects have been solved. And, in fact, the ones that may not have experienced themselves yet are low enough in probability of occurring, that this machinery we believe is adequate to do its job.

That's going to be the standard obviously prior to getting a license. And that's a big standard. That's why I think you have got to appreciate there is very little detailed information before the staff right now. For example, you go back -- if I go back to Part 2 of your briefing, Part 3, one of the first things you are going to do before you address the problem in any class of machinery is, you are going to understand what all the problems are, developing an operating experience report, or something to that effect.

And one of them -- if I read the schedule right, one of them on Shoreham, it's done. Those reports, I would expect, would have to be submitted to the agency. I don't think you would want to wait until you are completely in the end. So, you are going to have to work out some detail of getting that before the staff so that as you go along the staff and you folks are agreeing on what the problems are and how then to solve the problems.

We are agreeing with you that your solution is right. You are using -- at several levels, you are going to be using design reviews, you are going to be using sample approaches. We will want to make sure that we concur with you on the approach, the way you decide on an example, what is the specific item. Lots of terms were used here that are going to have to be ironed out, iron-clad, before you get to the end of the line.

And, obviously the lead plants are in a much more critical situation than others, because I want to emphasize it is going to have to be submitted, it has got to be reviewed, and that's going to take time. So, whatever you do in defining this program, be sure you don't get yourself to the point where you are ready to say: Today I'm happy. Tomorrow I want your approval.

That will not happen unless it has been a very thorough program as we go along. So, even though we are passing by and say we are not working out the details today, it's a very significant item, particularly for the lead plants. I don't want to under-emphasize that.

Also, there are a lot of questions about --

I'm sure the staff has got literally dozens of technical questions that I would strongly suggest we get together and hopefully in smaller groups and work through the detailed technical questions. We are going to have to lay those schedules out very shortly.

It's going to be -- to say that's not going to be a big challenge for everyone would be contrary to reality, because on one hand you want to get on with solving the problem and on the other hand, you are not solving the problem unless the staff is along with you. The staff is going to be using its set of consultants.

And by the time they sit down and go through each piece, I would encourage you in this program to have in it, submitting whatever pieces you can submit formally for the NRC review as you go along. For example, if you have -- if the Shoreham report, as each phase is completed, or whatever -- and I'm not sure what detail some of this is done, but if I look at the lead Shoreham engine, it says about January 15th on this chart the operating experience or operating data report is done, I would expect that to be submitted for our review.

And presumably our approval. The component selection of Shoreham, it says is done. I don't know to what degree --

MR. CARUSO: To date, the staff has received one description of the core review program, which is the Shoreham program. And that does list the components, and it provides a bit of an outline on where this program is going. But a lot of the details that are discussed in your slides are not developed very much, and we were hoping to see a little bit more detail on the development of those ideas.

MR. MUSELER: We have, and we will start submitting the actual task descriptions. They are largely done, and we can submit those on a real time, near time basis, on all the engines as we go through it. So, there is no problem with providing things as they are done.

MR. EISENHUT: I appreciate that. As I say, on one hand we would like to do it all generically. But on the other hand, particularly to the people out front, it is clearly going to be an impact if it's done differently. There is a basic general question I have, and it -- even though I'm applying it to the crankshaft problem and look at it in the general context, you feel you understand what the problem is, you feel you understood the problem enough to have gotten it fixed on Shoreham.

But I think you've got to address another question and that is, was it basically a design goof or what was the problem in the first place? Why did it occur?

How did it occur? And you have to address that question, I believe. Sort of the root cause of that problem. Because then you have to ask, whatever that root cause was, could it lead you to the conclusion that there may have been other random -- if it's design, I don't know, I'm speculating, but let me say, it was a design goof, you would have to ask the question, does the root cause behind that design goof lead you to question another component at random?

And you are going to have to address that question, as I see it. Now, you don't get there statistically or any other way. You've got to go back to what the root cause of that problem was. And, then you have to say that addressing the significant experience problem or experience data by itself would not cover that problem, because addressing every problem that you know of to date doesn't tell you necessarily that you solved all the problems that are out there, because these machines do not typically have that much experience.

I'm just saying those are the kinds of questions you are going to have to address. You may very well have the answer to that. I want to give you that benefit.

But at the same time, those are the kinds of questions that you are going to have to be looking at. We are going to be looking at it in both the broad context and the detailed context of item by item.

I don't know, Jim, to what degree you want to go through staff's detailed questions today. I don't know whether you want to schedule right away another meeting next week with the appropriate detail staff to start looking at it in more depth. Really, I don't know. Whatever your thoughts are, whatever the staff's thoughts are.

MR. McGAUGHY: We are willing to stay as long as you want to stay.

MR. EISENHUT: I'm not sure -- there is a lot here to look at.

ATTENDEE: I would like an opportunity to digest some of this. Maybe the best thing would be to get back in touch with you early next week and set up another meeting. We can have a working type thing.

ATTENDEE: We really only have a formal submittal of the program and this kind of thing before us, which you have outlined today. And in that is a significant amount of detail.

MR. McGAUGHY: We will try to get a formal program submittal to you.

MR. MUSELER: Let me say, Jim, not all aspects of the program have been submitted. But, for example, the design review and quality revalidation program has been submitted formally to the NRC. It happens to be in the Shoreham document. That program is exactly what is being applied.

MR. EISENHUT: Good. Then, that means it's easy for you to submit a description of your program by simply xeroxing the pages out of the Shoreham --

MR. MUSELER: That's no problem.

MR. EISENHUT: You can look at that either way. I would think you want -- certainly as utilities, you would want, and I know the staff wants, to review your program plan early in the process. And short of approving that program plan, I know we are not going to Step Number 2.

So, I think that is clearly on the critical path as far as I see it. So, you will need to work on when you can do that.

ATTENDEE: Jim, may I ask a question along these lines. Excuse me. I am Harold Tucker, Duke Power Company.

Listening to what you are saying, and as a member of the Owner's Group, I'm interested in a parallel understanding, by your comments the implication is you are going to pursue independently to your satisfaction manufacturing process of their records. Now, we are very much appreciative of your questions and are willing to provide you progress as we go along and make sure you understand what we are doing. I would like to have an understanding with you that if, in your review, you find something, don't wait until you complete your progress to bring it to us. Let's have a dual understanding as we embark on these independent programs, that we keep each other advised.

MR. EISENHUT: I agree with you one hundred percent. And, clearly it's in everybody's best interest to get to the bottom of this problem as soon as possible, what was the cause, how did we get here, what's the solutions. And you have certainly got my assurance that that's what we are going to do.

We do have, of course, another parallel effort, and that's the vendor inspection program. We have, as Mr. Bixby referred to, the Office of Investigations looking at things. So, there are a number of efforts going on.

We will be looking at this thing, and whatever significant safety information we find, we certainly will share promptly with you. And that was really the thrust of us going through the summary of operating experience and summary of QA findings, inspection findings, which is sort of an unusual situation to start with. We hoped that everyone in the room was certainly apprised and aware of everything we said. They may not have been.

And I know a month or so ago, there were cases where we had information that certain elements of the industry did not. Sort of a clearing of the overall data, as we see it, and the way you see it. I think it was very valuable to put it together.

Let me ask if there are any questions from staff? Any questions at this time, or would you prefer to wait? (No reply.) No questions?

Let me suggest, Jim, what we do is set up a meeting, I think a technical meeting. I would strongly encourage it to be some time next week. Otherwise, you lose another week. I know this is a program. I can envision that the -- you folks will be after us for approval, being together on this program, in a very short order.

So I would strongly encourage us to get together, and I want to reiterate also that I'm very pleased to see the industry's commitment to the program, a very impressive program laid out. I hope it continues. And I'm sure we are going to have some tweaks to the program, some you folks may not like. But at the same time, I'm very encouraged the program is succeeding along these lines.

Basically, if you go back to it from a very simplistic view where the staff is, there have been so many questions raised about the overall quality of the machine; that is, was the quality built in or not, that it's very hard to know from the front end that you've got a quality machine. So, then you have to lay out a program and rigorously go through it, machine by machine.

Any other questions? Any other comments? Not staff, not utility. You are staff.

ATTENDEE: I'm sorry.

MR. EISENHUT: Go ahead.

ATTENDEE: There was mention made in one of the presentations that a set of questions had been raised and written answers generated at the Owner's Group meeting at the end of November. Would it be possible that we could get a copy of those questions and answers that were raised by the Owner's?

MR. MUSELER: You have a copy. We would prefer, however, that -- and we don't think there is anything necessarily wrong with that information, but that was generated prior to, let's say, the overall Owner's Group -- I think the NRC has that information. We would really prefer for you to look at that and look at your other questions, and then if you have additional information you want, to get it to us in the form of additional questions.

ATTENDEE: Were you referring to the TDI responses?

MR. EISENHUT: No. Whoever has got the

questions in staff. Let me clear up one thing. Any information we get on this matter is going to go in the PDR; I will tell you right up front. Standard golden rule.

And it's going to also -- my full intention is to serve every piece of information we get on this subject to those Hearing Boards where diesel reliability is an issue. You know, you all are going to go through the process, the formal process, by whatever means it is.

I just believe the only way to do it is everything goes into the PDR. So, whatever we -- whatever information we get will be in that context and promptly sent out. Similarly, that means any information we get will -- to answer Harold Tucker's question -- be provided utilities also, regardless of the source they come from.

Are there any other representatives of any other group? I know there is a representative from Suffolk County here. Any other representative of any other groups that would like to make any comment? (No reply.)

Okay. I want to thank all of you for coming today. I appreciate the meeting. And I think the staff finds it very helpful, and we look forward to seeing where we go.

(Whereupon, the meeting is adjourned at 6:18 p.m., this same day.)

CERTIFICATE OF PROCEEDING

This is to certify that the attached proceeding before the NRC Staff

In the matter of: Meeting on TDI Diesel Generators

Date of Proceeding: January 26, 1984

Place of Proceeding: Phillips Building, Bethesda , Maryland

was held as herein appears, and that this is the original transcript for the file of the Commission.

MYRTLE H. TRAYLOR
Official Reporter - Typed

Myrtle H. Traylor
Official Reporter - Signed

Enclosure 1

TRANSAMERICA DELAVAL, INC.

EMERGENCY DIESEL GENERATOR DISTRIBUTION

Plant	Docket	Utility
Shoreham	50-322	Long Island Lighting
Grand Gulf 1, 2	50-416, 417	Middle South Energy
San Onofre 1	50-206	Southern California Edison
Rancho Seco	50-312	SMUD
River Bend	50-458, 459	Gulf States Utilities
Shearon Harris 1, 2	50-400, 401	Carolina Power and Light
Catawba 1, 2	50-413, 414	Duke Power
Perry 1, 2	50-440, 441	Cleveland Electric Illuminating
Bellefonte 1, 2	50-438, 439	TVA
Comanche Peak 1, 2	50-445, 446	Texas Utilities Services
Vogtle 1, 2	50-424, 425	Georgia Power
Midland 1, 2	50-329, 330	Consumers Power
WNP-1	50-460	Washington Public Power

Enclosure 2

ATTENDANCE LIST 1/26/84
TDI EDG MEETING

NAME	ORGANIZATION
R. Caruso	NRC/DL
J. Collins	NRC/RA/R-IV
D. Eisenhut	NRC/DL
F. Miraglia	NRC/DL
C. Berlinger	NRC/DSI
H. Denton	NRC/NRR
D. Garner	NRC/OCM
S. Brooks	NIRS/Palmetto Alliance
J. Kammeyer	SWEC/Shoreham
J. Deddens	GSU
J. Price	GSU
J. Hamilton	GSU
T. Ippolito	NRC/AEOD
J. Olshinski	NRC/R-II
B. Angle	MP&L
F C. Duvall	Operations Analysis Corp.
A. Dynner	Kirkpatrick, Lockhart, Hill, Christopher & Phillips
N. Bell	CFSP
R. Condello	NUTECH Engineers
D. Scheidt	Kirkpatrick, Lockhart, Hill, Christopher & Phillips
P. Eselgroth	NRC/R-I
J. Schroeder	TDI
C. Brinkman	Combustion Engineering
R. Huston	Engineering Planning & Mgmt.
J. Taylor	NRC/IE
R. DeYoung	NRC/IE
J. George	Texas Utilities
R. Sharpe	Duke Power
H. Tucker	Duke Power
W. Owen	Duke Power
E. Hall	BECHTEL
T. Houghton	KMC
H. Schmidt	Texas Utilities
D. Wade	Texas Utilities
J. Austin	NRC/OCM
L. Mills	TVA
D. Wilson	TVA
A. Thadani	NRC/DL
B. Barnes	EG&G Idaho
R. Burg	BECHTEL
M. Capicchioni	Consumers Power
L. Connor	The NRC Calendar
H. Cheatheam	Texas Utilities
J. Knight	NRC/DE
G. Gisonda	LILCo
M. Williams	NRC/DL

NAME	ORGANIZATION
T. Novak	NRC/DL
V. Noonan	NRC/DE
S. Israel	NRC/DST
B. D. Liaw	NRC/DE
R. Wright	NRC/DE
B. Saffell, Jr.	Battelle Columbus Lab.
G. Zech	NRC/IE
R. Bosnak	NRC/DE
J. Taylor	B&W
M. Srinivasan	'RC/DSI
A. Ungaro	NRC/DSI
R. Rodriquez	SMUD
J. Bobbitt	SMUD
C. Woodhead	NRC/OELD
R. Goddard	NRC/OELD
E. Jordan	NRC/IE
J. Graham	GA Technologies, Inc.
L. Rubenstein	NRC/DSI
W. Museler	LILCo
C. Seaman	LILCo
J. Richard	MP&L
J. McGaughy, Jr.	MP&L
B. Herrick	Franklin Research Ctr.
C. Wells	Failure Analysis Assoc.
M. Milligan	LILCo
A. Earley	Hunton & Williams
D. Foster	Georgia Power
G. Bockhold, Jr.	Georgia Power
M. Miller	NRC/DL
W. Ramsey	Southern Co. Services, Inc.
C. Wylie	Duke Power
D. Owen	Duke Power
R. Muschick	Duke Power
M. Pollock	LILCo
W. Uhl	LILCo
G. Leidich	Cleveland Electric
L. Beck	Cleveland Electric
M. Lyster	Cleveland Electric
D. Bauser	Shaw, Pittman, Potts & Trowbridge
K. Basklim	Southern California Edison
R. Phelps	Southern California Edison
J. Mangum	Southern California Edison
C. Matthews	TDI
D. Bixby	TDI
M. Towrey	TDI
C. Kano	Teledyne Engineering
M. McDuffie	Carolina P&L
A. Cutter	Carolina P&L
C. Hinnant	Carolina P&L
P. Skinner	NRC/R-II

NAME	ORGANIZATION
R. Walker	NRC/R-III
W. Shenton	Carolina P&L
B. Harshe	Consumers Power
J. Grinaldi	Braun & Co.
F. McClure	TDI
J. Pinto	MP&L
R. Jackson	BECHTEL
F. Schroeder	NRC/DST
J. Lieberman	NRC/OELD
C. Sellers	NRC/MTEB
R. Kiessel	NRC/EGCB
G. Klinglen	NRC/IE
E. Gilbert	NRC/OI
E. Reis	NRC/OELD
J. Jankovich	NRC/DHFS
W. Keller	NUTECH Engineers
L. Wheeler	NRC/DL
R. Vollmer	NRC/DE
E. Case	NRC/NRR

TRANSAMERICA DELAVAL HAS SUPPLIED THE DSR AND DSRV ENGINES TO THE FOLLOWING SITES:

UTILITY	SITE	SERIAL NO.	MODEL
LONG ISLAND LIGHTING	SHOREHAM	74010/12	DSR 48
MIDDLE SOUTH ENERGY	GRAND GULF	74033/36	DSRV 16
GULF STATES UTILITIES	RIVER BEND	74039/40	DSR 48
CAROLINA POWER & LIGHT	SHEARON HARRIS	74046/49	DSRV 16
DUKE POWER COMPANY	CATAWBA	75017/20	DSRV 16
SOUTHERN CALIFORNIA EDISON	SAN ONOFRE	75041/42	DSRV 20
CLEVELAND ELECTRIC ILLUM.	PERRY	75051/54	DSRV 16
TVA	BELLEFONTE	75080/83	DSRV 16
WASHINGTON PUBLIC POWER	WPPSS 1	75084/85	DSRV 16
WASHINGTON PUBLIC POWER*	WPPSS 4	76031/32	DSRV 16
TEXAS UTILITIES SERVICES	COMANCHE PEAK	76001/04	DSRV 16
GEORGIA POWER	VOGTLE	76021/24	DSRV 16
CONSUMERS POWER	MIDLAND	77001/04	DSRV 12
TVA*	HARTSVILLE/ PHIPPS BEND	77024/35	DSRV 16
SMUD	RANCHO SECO	81015/16	DSR 48

*PROJECT DELAYED OR CANCELLED

U. S. NUCLEAR EXPERIENCE

WITH

TDI DIESEL GENERATORS

SAN ONOFRE 1

GRAND GULF

SHOREHEAM

SAN ONOFRE 1

- TWO TDI DIESEL ENGINES INSTALLED IN 1976 - MODEL DSRV-20
- DECLARED OPERATIONAL IN APRIL 1977
- ENGINE OPERATING TIME TO DATE - 450 HOURS/ENGINE
- SERIAL NO. 75041/42, RATED AT 6000 KW (NOMINAL)
  8800 KW (PEAK)
- FIRST TDI ENGINES TO ACTUALLY ENTER NUCLEAR SERVICE
- ONLY V-20 IN NUCLEAR SERVICE

SIGNIFICANT PROBLEMS TO DATE

- EXCESSIVE TURBOCHARGER THRUST BEARING WEAR
- LUBE OIL LEAK AND FIRE
- PISTON MODIFICATION TO PREVENT CROWN SEPARATION
- UNQUALIFIED INSTRUMENT CABLE
- POTENTIALLY DEFECTIVE GOVERNOR COUPLING MATERIAL

GRAND GULF

- TWO TDI ENGINES INSTALLED - MODEL DSRV-16
- SERIAL NO. 74033/34, RATED AT 7000 KW
- OPERATING HOURS TO DATE - DIVISION I = 1100 HOURS;
DIVISION II = 700 HOURS
- FIRST V-16 UNITS IN NUCLEAR SERVICE

SIGNIFICANT PROBLEMS TO DATE

- PISTON CROWN SEPARATION
- PISTON SKIRT CRACKS
- FUEL LINE FAILURES - FIRE
- CYLINDER HEAD CRACKS
- TURBOCHARGER PROBLEMS
- PUSH ROD CRACKS
- GENERATOR SHORT DUE TO ENGINE FASTENER FAILURE
- AIR STARTING VALVE PROBLEMS

SHOREHAM

- THREE TDI DIESEL ENGINES INSTALLED, MODEL DSR-48
- SERIAL NO. 74010-12, RATED AT 3500 KW
- OPERATING HOURS AT TIME OF CRANKSHAFT FAILURE (8/83)
  - #101 = 646 (CRACKED CRANKSHAFT)
  - #102 = 718 (FAILED CRANKSHAFT)
  - #103 = 818 (CRACKED CRANKSHAFT)
- FIRST STRAIGHT-8 ENGINES IN U. S. NUCLEAR SERVICE

SIGNIFICANT PROBLEMS TO DATE

- JACKET WATER PUMP PROBLEMS
- FUEL OIL LINES RUPTURED
- CYLINDER HEAD CRACKS
- CRANKSHAFT FAILURES
- CONNECTING ROD BEARING FAILURES
- PISTON SKIRT CRACKS
- FAILURES OF SEVERAL DIFFERENT TYPE FASTENERS

MARINE EXPERIENCE

- INFORMATION FROM THREE DIFFERENT OPERATORS OF MARINE ENGINES - V-16 AND V-12 ENGINES
- ENGINES OPERATING HOURS TO DATE RANGE FROM 3000 TO 30,000

SIGNIFICANT PROBLEMS TO DATE

- CYLINDER HEAD CRACKS (ALL OPERATORS)
- PISTON CRACKS AND COMPLETE FAILURES
- EXCESSIVE BEARING WEAR
- TURBOCHARGER PROBLEMS
- CRACKS IN PUSH ROD WELDS
- CRACKS IN CONNECTING RODS
- CYLINDER BLOCKS

STAFF ACTION

- TDI PROJECT GROUP FORMED
- WILL INTERNALLY COORDINATE NRC EVALUATION OF TDI ENGINES
- CENTRAL POINT-OF-CONTACT FOR INTERACTION WITH APPLICANTS AND OWNERS GROUP
- COORDINATION OF STAFF TECHNICAL REVIEWS AND OVERALL STAFF POSITION ON TDI ENGINES

Delaval Diesel Generator Operation Experience

U. S. Nuclear Experience

In 1974, the Long Island Lighting Company (LILCo) contracted with TDI to purchase three emergency diesel generators for the Shoreham Nuclear Power Station. This was the first order received by TDI to provide an EDG for a commercial nuclear power station. In the next seven years, engines for 14 other plants were ordered from TDI.

San Onofre 1

- ° Two TDI Diesel Engines Installed in 1976 - DSRV-20
- ° Serial No. 75041/42, Rated at 6000KW (nominal)
  8800KW (peak)
- ° Engine Run Time to Date - 450 hours per engine

The first plant to actually place a TDI engine into nuclear service was San Onofre Unit 1 (SONGS 1), which purchased two V-20 units to provide emergency power for its feed pumps, which also serve as Emergency Core Cooling System pumps.

The engines at SONGS 1 were installed in 1976, and declared operational in April 1977. Since then, SONGS has experienced some problems with the operation of the engine turbochargers, a lube oil pressure sensing line failure which resulted in a fire, and several other minor problems. Because SONGS did not commit to meet the guidelines of Regulatory Guide 1.108, but rather Regulatory Guide 1.9, the program it used to test the engines before they were placed in service was more abbreviated than for a new plant. A detailed list of problems to date follows.

Date	Problem	Cause/Solution
12/80	Excessive Turbocharger thrust bearing wear.	No lube oil during standby. Lube oil system modified. 10 CFR Part 21 report issued because problem generic.
7/81	Lube oil leak and fire.	Excessive vibration of a lube oil test line which had inadvertently been left installed by the licensee. Line removed.
12/81	Piston modification to prevent crown separation.	Pistons reworked by TDI to respond to Part 21 report. Problem identified at Grand Gulf.
9/83	Unqualified instrument cable.	Replaced in accordance with Part 21 report.

Grand Gulf

- Two TDI engines installed - Model DSRV-16
- Serial No. 74033/34, Rated at 7000KW
- Operating Hours to Date - Division I = 1100 hours; Division II = 700 hours

In 1981, Mississippi Power & Light (MP&L) commenced pre-operational testing of two V-16 engines installed at Grand Gulf Unit 1. They represent the first V-16 units ordered from TDI, and in fact, one of the Grand Gulf engines was used to qualify the entire TDI V-16 line of machines for nuclear applications.

The Grand Gulf engines have experienced significant problems in completing the pre-operational test program, have had several major failures, including a fuel line break which caused a fire, and many minor failures. A detailed list of problems at Grand Gulf follows.

Date	Problem	Cause/Solution
11/81	Piston crown separation during operation.	Holddown studs failed. Pistons returned to TDI for rework. Generic problem.
3/81	Excessive turbocharger thrust bearing wear.	No lube oil during standby. Lube oil system modified.
6/11/82	Air starting valve capscrews replaced. Too long for holes.	Response to Part 21 report.
8/23/82	Flexible drive coupling material incompatible with operating environment.	Replaced with different material.
8/82	Latching relay failed during testing.	Relay replaced.
3/8/82	Air start sensing line not seismically supported.	Sensing line relocated and properly supported.
1/29/82	Governor lube oil cooler located too high. Possibility of trapping air in system.	Lube oil cooler relocated to lower elevation.
3/23/82	Engine pneumatic logic improperly design. Could result in premature engine shutdown.	Pneumatic logic design corrected.

Date	Problem	Cause/Solution
4/29/81	Non-Class 1E motors supplied with EDG auxiliary system pumps.	Motors replaced with Class 1E qualified motors.
3/15/82	Crankcase cover capscrew failed. Head lodged in generator and shorted it out.	Capscrews replaced with higher strength screws. Lock tab washers installed. Generator screens installed.
8/2/83	High pressure fuel injection line failed.	Manufacturing defect in tubing. Tubing replaced.
9/4/83	Fuel oil line failed. Caused major fire.	High cycle fatigue of Swagelock fitting. Additional tubing supports to be installed.
8/11/83	Cracks in connecting push rod welds.	All push rods replaced.
1983	Turbocharger vibration.	Turbocharger replaced.
1983	Cracked jacket water welds.	Excessive turbocharger vibration. Cracks re-welded.
1983	Turbocharger mounting bolt failures.	Excessive turbocharger vibration. Bolts replaced.
7/83	Air start valve failures.	Cause unknown. System cleaned and several valves replaced. More frequent maintenance scheduled.
10/28/83	Fuel oil leak. Cracked push rod weld.	Tubing replaced. Push rod replaced.
During EDG Installation	Cylinder head cracks.	Head replaced.
12/83	Cylinder head cracks.	Two heads replaced.
12/83	Cracks in piston skirts on Division II EDG.	All Division II pistons replaced. Division I pistons to be inspected.
9/83	Unqualified instrument cable.	Replaced in response to Part 21 report.

Shoreham

- Three TDI Diesel Engines installed, Model DSR-48
- Serial No. 74010-12, Rated at 3500KW
- Operating hours at time of crankshaft failure (8/83)
  - #101 = 646 (cracked crankshaft)
  - #102 = 718 (failed crankshaft)
  - #103 = 818 (cracked crankshaft)

The engines at Shoreham are the first straight-8 units to be placed in nuclear service in the U. S. One of the Shoreham engines (#101) was used to qualify the straight-8 series (R48) diesel engine for nuclear service.

Pre-operational testing of the engines at Shoreham started in late 1981 and continued until the major failure of the #102 crankshaft on August 12, 1983. After the performance of extensive tests in late September and early October, which were observed by staff members from NRR and Region I, as well as an NRC consultant, LILCo presented the results of its crankshaft failure investigation in a meeting on November 3, 1983. It reported that the crankshaft had been improperly designed, and had failed because the loading function used in the original design calculations was too small. LILCo also reported that it was investigating four failed connecting rod bearings which were discovered when the EDGs were disassembled. Their preliminary finding was that the failures occurred because the bearing material did not meet specifications, and the bearing loads had not been properly accounted for. A detailed list of the EDG problems at Shoreham follows.

Date	Problem	Cause/Solution
3/81	Excessive turbocharger thrust bearing wear.	No lube oil during standby. Lube oil system modified.
12/81	Piston modifications to prevent crown separation.	Pistons reworked by TDI to respond to Part 21 report. Problem identified at Grand Gulf.
9/82	Engine jacket water pump modifications.	Water pumps reworked by TDI.
6/82	Air starting valve capscrews replaced. Too long for holes.	Response to Part 21 report.
9/82	Engine jacket water pump shaft failed by fatigue.	Pump shafts redesigned and replaced.
Spring/1983	Cracks in engine cylinder heads.	Fabrication flaws. All heads replaced.

Date	Problem	Cause/Solution
3/83	Two fuel oil injection lines ruptured.	Manufacturing defect in tubing. Tubing replaced with shielded design.
3/83	Engine rocker arm shaft bolt failure.	High stress cycle fatigue. Bolts replaced with new design.
8/12/83	Broken crankshaft. Cracks in remaining crankshafts.	Inadequate design. Replaced with larger diameter crankshafts.
9/83	Cracked connecting rod bearings.	Inadequate design and substandard material. Replaced with new design.
10/83	Cracked piston skirts.	Replaced all piston skirts with new design. Generic problem.
11/83	Broken cylinder head stud nuts.	Replaced all head stud nuts.
9/83	Cracked bedplates in area of main journal bearings.	Cracks evaluated by LILCo and determined to not be significant.
9/83	Unqualified instrument cable.	Replaced in response to Part 21 report.

Operating Experience - Non-Nuclear

Marine Applications

Besides being used for stationary electric power generation, TDI diesel engines have been placed in service as propulsion units on commercial cargo vessels. As part of the Shoreham operating license hearing, an intervenor, Suffolk County, requested and was granted by the Licensing Board, subpoenas for the State of Alaska, U. S. Steel, and Titan Navigation, Inc. These three organizations operate vessels which use TDI V-16 diesel engines which are very similar to most of the TDI units installed in nuclear power plants. The responses which were received indicate that the TDI engines in marine service for these organizations have experienced severe reliability problems. Most have related to faulty cylinder heads, but they have also included problems with pistons, cylinder liners, turbochargers, cylinder blocks, connecting rods, connecting rod bearings, main journal bearings, and camshafts. A detailed experience list follows. The staff is reviewing this material to see how much of it is applicable to engines in nuclear service.

Marine Experience with TDI Diesel Generators

State of Alaska, M. V. Columbia

- Vessel fitted with two DMRV-16-4 Engines - Serial No. 72033/34
- Rated at 9200 HP (6900 KW) at 450 RPM
- Vessel and engines placed in service in June 1974.
- Each engine has approximately 30,000 hours of operating time to date.

Document Date	Problem Description
12/76	All cylinder liner seals replaced. All cylinder heads have been removed, reinstalled, or renewed at least three times.
	All pistons have been removed and reinstalled at least once.
	Turbochargers have been removed, repaired and reinstalled, or renewed 16 times due to leaking oil seals, vibration, rotor damage, or defective bearing seal housing.
	Exhaust manifolds have been removed and reinstalled because of frozen expansion joints and resulting cylinder head flange face damage.
	Lube oil consumption is excessive.
6/15/78	Rapid deteriorations of fire seal rings causing blowby across gasket surface of cylinder heads.
	Very low lube oil filter life (40 hours). Caused by blowby of pistons and valve guides.
	Stainless steel exhaust bellows burn out rapidly. Installed backwards by TDI.
11/28/78	(Letter to Alaska from TDI).
	Recommends timing changes to improve turbocharger performance.

Document Date	Problem Description
1/31/79	Valve seats and valve guides not concentric. Results in bad valve contact.
	Defective piston rings shipped as replacement parts.
	Reworked cylinder head received from TDI without all required modifications and with damaged gasket face.
	Newly furnished cylinder liners received with incorrect surface finish (twice).
	Connecting rod bearings furnished as spare parts were wrong size - 13" vice 12".
	Turbocharger exhaust flex section incorrectly furnished by TDI.
2/2/79	Chrome plating failure of piston rings. Caused heavy scoring of cylinder liner. Associated cylinder head found cracked.
	Seven cylinder heads replaced during 15 weeks of operation.
	Excessive lube oil filter change out rate. Due to piston blowby.
	Fuel injector spray tips changed at TDI recommendation to reduce carbon buildup and eliminate washing of liner walls with fuel oil.
	Three major overhauls of engines in 5 years of operation.
	Carbon accumulations in rocker box areas.
	Excessive oil vapor discharge from engine crankcases.
	Heavy carbon deposits on valve springs. Suspect valve blowby.
	When exhaust valve guides were modified by TDI, they did not follow the procedure outlined in their SIM (Service Information Memo).

Document Date	Problem Description
	Loose piston pin end caps.
	Incorrect piston crown to skirt bolt torque.
	Bad connecting rod bearings. Excessive wear, cracks.
	Damaged connecting rod bolts.
	Valve push rods cracked at weld of ball to pipe. QC problem.
	Crankshaft size changed after engines for ship installed. No notice to owners of reason for change.
	Excessive main bearing wear.
	Camshaft lobe hard facing worn.
	TDI recommended the installation of a new flexible exhaust duct which was too short (new design). Installation attempted at insistence of TDI. Unit damaged by attempt and returned to TDI for repair.
3/19/79	QC or material problems with respect to non-concentricity/out-of-round valve seats, push rods, rod bolts, bearing shells, valve stem plating.
6/14/79	Thermal growth and cracking of exhaust manifold.
12/26/79	Failure of new connecting bearings.
	Cracks of 25% of connecting rods.

Document Date	Problem Description
1/16/80	Ten (10) new cylinder heads have cracks. This includes 8 that were previously repaired.
	Fifteen (15) valves are defective with chrome flaking off the valve stems.
	Valve stems are being deformed.
	Five additional push rods have cracks.
	Turbocharger air cooler inlet housing is cracked for fourth time.
	Internal bracing in engine intercoolers is cracked.
2/5/80	Piston rings installed improperly because mistake by TDI in the drawing used by TDI shop.
2/29/80	Piston crown-to-skirt nut torque inconsistent among nuts on various pistons.
	Excessive link rod bushing bail wear caused by improperly relieved, drilled oil passages on the matching link rod pins.
3/24/80	Abnormal carbon deposits and formations noted on pistons and cylinder head assemblies.
	Fretting of jaw areas of connecting rods.
	Insufficient turbo (manifold) air except at near full speed operation.
	Cracked exhaust manifold end plates.
	Cracking of connecting rod boxes.
	Cracking of newly installed connecting rod bearing shells at 4500/hours.

Document Date	Problem Description
	Fretting of link rod and link rod pins at their attachment together.
	Fretting between link rod bushings and link rod bushing bore.
	Galling of link rod bushings in way of link rod pin outer drilled oil passages.
	Improper wear/contact pattern on newly installed connecting rod bearings at 4500/hours. Four-point loading.
	Insufficient connecting rod bearing wear/contact area to journal wherein it is less than 15% of the total bearing area.
	Upsetting of stems in valve keeper area.
	Damage to number four piston ring and ring groove on all pistons modified during the 1978-79 engine teardown and rebuilt after 4500/hours operation.
	Fretting between piston crown and skirts at 4500/hours since piston modifications.
	Variations in piston bolt torque, beyond specified limits, at 4500/hours since piston modifications.
	Damage to rod bolts, including cracking, and damage to threads on both the bolt and in the rod boxes.
4/18/80	Exhaust manifold conversion kits received with cuts and grooves in finished surface. Required rework by owner before installation.
5/12/80	New connecting rods received without required code (American Bureau of Shipping) approval. TDI did not have record of which rods were shipped with approval or without approval.
	Some new connecting rods shipped with oversize bearings but no note to customer informing of difference.

Document Date	Problem Description
5/14/80	Cylinder head returned to TDI has been lost by TDI. Cannot be located.
5/15/80	Customer received new connecting rod bolt in rusty condition with damaged threads.
5/27/80	Customer received reworked cylinder heads with lip left on exhaust seats which prevents valves from seating.
	Customer noted that it now was in possession of two cylinder heads with the same serial number.
	Could not install lockwire in new connecting rod cap screw. Hole drilled partway through with drill broken off in center of hole. Also noted that edges of lockwire holes on other screws had not been rounded to prevent damage to lockwire.
5/29/80	Discovered leaks in newly installed exhaust manifold head plates.
9/4/80	(Meeting Summary)
	TDI says that all cylinder head problems should be corrected by new design.
	TDI reports that connecting rod bearing cracks could have resulted from bad bearing alloy makeup by vendors. TDI looking at different bearing materials.
	TDI stated that they had erred on piston modifications. Effected others besides COLUMBIA.
9/30/80	Eleven remaining master connecting rods to be sent to TDI to have oversize bearings and other modifications installed.
	Many of the original cylinder heads that were returned to TDI for rework were exchanged for other used heads.

Document Date	Problem Description
11/6/80	Cylinder head changed due to heavy external water leakage.
	Severe smoke causing excessive lube oil contamination and engine room atmosphere problems. Engine secured to prevent possible crankcase explosion.
12/10/80	All connecting rods removed. New rod cap screws and washers to be installed because increased torque specified by TDI caused galling.
	New connecting rod bearing shell found cracked.
	Heavy wear noted on piston side thrust areas. Heavy hard carbon buildup noted in area of compression rings. Fourth ring groove area to be reworked by TDI due to design/machine error by TDI during previous modifications.
	Nineteen (19) of 32 cylinder liners exceed spec for out-of-round. TDI to modify limits to permit continued usage.
	Twenty-one (21) of 32 liners lost crush. New phenomena. Repairs require machining of engine block.
	Fuel injectors removed and to be changed from 140° spray pattern to 135° pattern. Original nozzles had 150° pattern.
1/16/81	Cylinder block bores found to be distorted.
	Four new engine camshafts installed.

Document Date	Problem Description
3/13/81	Reworked cylinder heads were returned to the customer without removing the grinding compound from the valves and valve seats.
	Two reworked pistons returned to customer without roll pins, which lock the securing nuts in place.
	Cylinder liner delivered with wrong surface finish.
	Cracks found in cylinder blocks. All replaced.
	Main engine blocks found to be cracked and warped. The main block-to-base through bolts appear to have been improperly torqued during initial assembly.
	One "new" camshaft found to be a rebuilt unit containing several damaged bearing journal areas.
	The threaded head stud holes in the new cylinder blocks were not counterbored deeper, as TDI had indicated they currently do. This was to eliminate cracking of the block near the stud holes. The customer re-machined each of the 256 head studs to accomplish the same intent.
4/9/81	Several reworked pistons were returned without groove pins.
	In response to a request for 20 [illegible]" capscrews and washers, TDI supplied 1 7/8" capscrews.
	Drawings furnished by TDI for head stud modifications were not applicable to the studs in question.
	50% of the fuel pump bases would not fit onto the new cylinder blocks because of slight changes in the design of the blocks.

Document Date	Problem Description
	Two new cylinder liners provided with incorrect surface finish.
	One new cylinder liner provided with flange thickness larger than manufacturer's maximum tolerance.
	New connecting rod capscrews were found to be galled and unfit for use.
4/29/81	Service manual showed incorrect installation of engine camshafts.
	2/3 of fuel cam tappet assemblies on one engine could not be installed on one engine because the new cylinder blocks had not been properly counterbored.
	Cylinder liner counterbore depths were off to such an extent that difficulty experienced in establishing proper liner crush.
	Weld spatter noted on many seating surfaces.
	Dirt, sand, and metal showings found in passages and holes which should have been clean.
	Cylinder head water port outlet locations varied considerably, causing a water flow restriction.
	Air start distributor not properly assembled at factory.
6/1/81	Exhaust manifold head plate developed a leak. Cracks found around 2 of 3 tie rods due to poor initial welding.
11/19/81	Defective valve springs found on one engine.
7/29/82	Valve rotator failed.
	Cracks discovered in the intercooler.

Document Date	Problem Description
7/29/82	"In nine years of operation every basic engine component has been modified or replaced with an improved item, at least once, with the exception of the crankshaft (which is obsolete and has not been used for years), the engine base, the fuel pumps and the governor. The last two items are not manufactured by TDI."
10/15/82	Turbochargers replaced.
	Exhaust valve lubricating system to be installed.
3/9/83	Cracks discovered in three cylinder heads.
	Reworked cylinder returned to customer with tap broken off in threaded hole. Others returned with internal cracks and damaged flange faces.

Titan Navigation, M. V. Pride of Texas

- Vessel fitted with two DMRV-12-4 engines, Serial No. unknown
  Rated at 7800 HP at 450 RPM
- Engines installed 1981 - no information on total engine hours to date.

Document Date	Problem Description
7/16/82	Catastrophic piston failure. Due to crack in piston skirt. Engine had 5791 hours of operation.
4/1/82	Cylinder block broken and cracked.
	Cylinder head cracked.
	Cylinder liner cracked.
	Piston skirt fractured.
	Suspect that all of above problems caused by water leaking into cylinder from air intake manifold. Leaking tubes found in air intercooler.
8/19/82	Cracks discovered in six piston skirts.
7/22/82	Cracked exhaust valve seats in cylinder heads. Engine had 3000 hours service.
	Camshaft lobe design appears to be deficient. Causes excessive stress on fuel cam lobe and roller.
	Tappet assembly rollers severely galled. Believed to be due to camshaft and lobe placement and inadequate heat treatment.
	Fuel cam lobes have failed twice due to improper heat treatment.
	Chrome plating lost from one piston wrist pin.
	All four intercoolers have failed because of erosion due to high fluid velocity.
	Air start valves have suddenly ceased to function, for no apparent reason.

Document Date	Problem Description
	Plugs in crankshaft oil ways may be cracking because improper material used. Under investigation.
	Fuel oil return lines have failed. To be replaced with heavier wall tubing.
4/1/83	Exhaust valves fail after about 2000 hours of use. Serious problems with cylinder head cracks.
	Turbochargers experiencing difficulty supplying sufficient air.

U. S. Steel, MV E. H. Gott

- Vessel fitted with two DMRV engines (model unknown)
  Engine Serial No. 75039-40
- No information on engine hours to date.

Document Date	Problem Description
11/13/80	Cracked cylinder head. Replaced.
11/1/79	Cracked cylinder head. Replaced.
6/1/80	Cracked cylinder head. Replaced.
10/8/81	Cracked cylinder head. Replaced.

Note: This information was summarized from documents provided by U. S. Steel in response to a subpoena which asked specifically for information about cyliner head failures. Many other portions of the documents were deleted by U. S. Steel, and it appears that the deleted portions referred to problems with other engine parts.

Other Applications

The staff understands that other TDI engines are in service as stationary electric power generators. The operating history of these engines will be taken into consideration during the staff assessment of TDI engines.

Reference List

Shoreham

Letter dated 1/6/84 from B. McCaffrey (LILCo) to H. Denton (NRC)

Board Notification 83-160 dated 10/21/83

Board Notification 83-160 dated 11/17/83

Letter dated 12/9/83 from J. Smith (LILCo) to T. Muley (NRC)

Letter dated 12/9/83 from A. Schwencer (NRC) to M. Pollock (LILCo)

Letter dated 12/29/83 from A. Schewncer (NRC) to M. Pollock (LILCo)

Letter dated 12/16/83 from C. Matthews (TDI) to T. Novak (NRC)

Letter dated 12/16/83 from J. Smith (LILCo) to T. Murley (NRC)

Letter dated 12/16/83 from A. Dynner (Suffolk County) to A. Earley (LILCo)

Letter dated 10/20/83 from A. Earley (LILCo) to L. Brenner (NRC)

Letter dated 10/16/83 from R. Boyer (TDI) to NRC

Letter dated 11/17/83 from A. Earley (LILCo) to L. Brenner (NRC)

IE Information Notice 83-51, dated 8/5/83

IE Inspection Report 99900334/83-01, dated 10/3/83

IE Information Notice 83-58, dated 8/30/83

Grand Gulf

Letter dated 11/15/83 from L. Dale (MP&L) to H. Denton (NRC)

Letter dated 10/19/83 from L. Dale (MP&L) to H. Denton (NRC)

LER 50-416/83-171/03L-0 dated 11/28/83

Letter dated 10/26/83 from L. Dale (MP&L) to H. Denton (NRC)

LER 50-416/83-082/01T-0

LER 50-416/83-126/01T-0

San Onofre Unit 1

LER 50-206/81-017 dated 8/12/81

Letter dated 9/15/81 from H. Ray (SCE) to R. Engelken (NRC)

LER 50-206/80-039 dated 12/23/80

Letter dated 6/8/81 from J. Haynes (SCE) to R. Engelken (NRC)

Marine Applications

Letter dated 12/21/83 from A. Dynner (Suffolk County) to A. Earley (LILCo)

Includes many other individual documents.

Vendor Inspection History

To date, the Region IV Vendor Inspection program has inspected the TDI facility in Oakland, California, nine times. The following inspection reports have been published in the PDR regarding these inspections:

1. Docket No. 99900334/79-1, dated 3/20/79
2. Docket No. 99900334/80-01, dated 1/22/81
3. Docket No. 99900334/81-01, dated 5/27/81
4. Docket No. 99900334/81-02, dated 9/18/81
5. Docket No. 99900334/82-01, dated 4/15/82
6. Docket No. 99900334/82-02, dated 12/8/82
7. Docket No. 99900334/83-01, dated 10/3/83

Attached is a summary by the Vendor Inspection Branch of the TDI inspection history. The history includes some results from the last two inspections, which are being reviewed for proprietary information, and which will be published when that review is complete.

ATTACHMENT

TRANSAMERICA DELAVAL INSPECTION HISTORY
VENDOR PROGRAM BRANCH FINDINGS 1979-1983

MANUFACTURING PROCESS CONTROL:

1. Performance of required inspections for completed operations on Shop Engine No. 2931 Tank Lube Oil Sump Inlet Compartment could not be verified, in that neither inspection acceptance stamps were present on the route sheets for the completed operations nor were inspection reports available to indicate rejectable conditions had been found upon inspection.

2. Route sheets were not available to confirm required inspection acceptance of assembly operations for the emergency diesel generator (EDG) jacket water pump reflected on Drawing No. 101973, Revision C.

3. Absence of evidence of inspection acceptance for components manufactured during jacket water pump modifications performed in September and October 1982.

4. a. Acceptance signoff by QC inspectors was made on route sheets in regard to installation of rocker arm hold down bolts. These bolts were subsequently found to be missing on inspection at the Shoreham Nuclear Power Station (SNPS).

   b. Shipment of reworked pistons to San Onofre, Unit 1, prior to dates indicated on route sheets by QC inspectors that various manufacturing operations were accepted.

5. a. Route sheets not issued for rework of 92 pistons from SNPS and Grand Gulf EDGs and there is, thus, no evidence of inspection acceptance of the various manufacturing operations.

   b. No records of quality activities for rework activities on Grand Gulf EDG pistons which was a specific requirement of the procurement specification.

6. Absence of required NDE reports for SNPS replacement cylinder head castings.

7. Apparent use of unqualified personnel for performance of NDE operations on SNPS replacement cylinder head assemblies.

8. Improper signoffs and dates for acceptance of SNPS replacement cylinder heads with respect to personnel identity and use of a surrendered inspection stamp prior to expiration of the minimum 6-month period.

9. Use of a different hard facing welding procedure specification to that specified on the route sheets for valve seats in SNPS replacement cylinder head assemblies.

10. Requirements not provided for welding of and acceptance of Shearon Harris EDG fuel oil line clamps

11. Prior to October 1981, manufacture of piston skirt castings did not comply with engineering component drawing instructions with respect to performance of specified stress relief heat treatment.

12. Route sheets for Job No. 02933 did not provide instructions in regard to swaging operations performed on crankshaft oil plugs.

13. No assembly route sheets available for SNPS replacement cylinder head assemblies.

CONTROL OF SPECIAL PROCESSES:

1. Absence of procedures for examination of Level III NDE personnel and failure to qualify personnel performing visual examinations in accordance with ASME Code requirements.

2. a. [illegible]formance of vertical up position welding on ASME Section III [illegible]ing (Shop Engine No. 2931, Shop Order No. 94302) by welder qualified only for flat position welding.

   b. Welding of a 2-inch ASME Section III piping assembly by unqualified welder.

3. Observations during three different inspections of failure to return unused welding electrodes in required 4-hour issuance period.

4. Identification of welders used for certain operations on Shop Engine Nos. 2931 and 2959 could not be verified.

5. Unacceptable fillet weld size in Shop Engine No. 2931 Tank Lube Oil Sump Inlet Compartment due to bad fitup of tank roof and sidewall resulting in almost flush condition.

6. Use of welding electrode sizes that were not permitted by applicable welding procedure specifications on Job Nos. 94922 and 96632.

7. Use of Job No. 95395 of welding amperage and voltage in excess of welding procedure specification requirements.

8. Performance of welding on Job Order No. 97-485-3085 without specified revision of welding procedure specification being in welder's possession.

9. Certification records for nondestructive examination personnel did not indicate the use of ten checkpoints by the examiner during the practical examination as required by SNT-TC-1A and internal procedures.

PROCUREMENT CONTROL:

1. Failure of Quality Engineering to both update Qualified Suppliers List every 3 months and to provide a monthly summary of vendor quality ratings to QC and Purchasing.

2. Evidence not available to assure that the seller of auxiliary lube oil and jacket water pump motors complied with the requirements of the purchase order.

3. Betts Spring Company, a supplier of critical valve springs, had not been surveyed every 3 years. The available evidence showed it was approximately 5 years since a survey had been made.

4. Associated Spring Company (Barnes Group) was placed on the Approved Suppliers List and used for procurement without completion of a survey or audit.

5. Kobe Steel Ltd., a supplier of crankshaft, was not surveyed every 3 years as required by the quality assurance program. The only available record was a self evaluation survey form completed by Kobe Steel's American representative.

6. Fuel oil tubing for Purchase Order No. 45333 was accepted by receiving inspection without issue of a nonconformance report, although required mill test reports had not been received.

7. Purchased Material Specification No. RL 019000 dated October 6, 1982, was not approved as required by Engineering Operating Procedure 7.

8. A QA program was not imposed on the manufacturer of exhaust silencers for EDGs furnished to Perry, Units 1 and 2, as required by Perry Specification Nos. SP-750-4549-00 and SP-706-4549-00.

9. Purchased material specifications for engine mounted electrical control cables required only commercial grades of cable and did not invoke applicable customer specification requirements.

10. a. No available evidence to indicate that materials which were used to fabricate EDG ASME Section III Code Class 3 component supports (Midland) and fuel oil systems (Midland and Grand Gulf) were procured from vendors who were either identified on the Approved Suppliers List or had been subject to audits.

    b. Prior to 1982, ASME Section III Code fasteners were procured from vendors who had neither been audited nor were identified on the Approved Suppliers List as being approved for supply of this product.

11. Acceptance by receiving inspection of ASME Section III Code fastener certifications which did not comply with purchase order requirements with respect to: (a) conformance of chemical composition to material specification requirements, (b) completeness of mechanical test data, and (c) compliance with ASME Section III Code requirements for reporting of material heat treatment.

12. Failure to comply with testing requirements of paragraph NCA-3867.4(e) in the ASME Section III Code when purchasing stock materials from unsurveyed vendors.

MATERIAL IDENTITY AND CONTROL:

Eleven discrepancies in material identity observed in a sample of 45 between the identity of material issued and that recorded as being used for Midland EDG S/N 77002 piping system component supports.

DESIGN AND DOCUMENT CONTROL:

1. Failure to comply with Division Standard Practice Nos. 4.101 and 4.201 requirements with respect to:

   a. Release of a drawing revision to the shop without receiving approval of the applicable Engineering Change Notice from Industrial Engineering.

   b. Maintenance of the Engineering Change Log, classification of changes as major or minor, and initiation of required forms.

2. Parts list and component drawings released by Engineering did not define acceptance criteria for installation of crankshaft oil plugs.

3. Absence of any instructions in regard to installation location of governor lube oil cooler to engine.

4. Failure to comply with Drafting Room Practice during 1982 redesign of the EDG jacket water pump in regard to certain layout drawings not being either drawn on tracing paper or signed and dated.

5. Dynamic analysis or testing not performed in accordance with Stone & Webster Specification No. SHI-89 after redesign of the SNPS EDG jacket water pumps.

6. Failure to comply with Engineering Operating Procedure 4 and Drafting Room Practice requirements with respect to signing and dating of calculations by the designer for the SNPS jacket water pump redesign.

7. No evidence of required approval of "D Sheets" by the applicable Engineering manager. Examples noted were D-4986 and D-4956 which were entitled, "Assembly Instructions," and pertained to the EDG jacket water pump.

8. Jacket water pump analyses dated September 24 and October 4, 1982, and July 15, 1983, for SNPS had not received required certification from the staff Registered Professional Engineer.

NONCONFORMANCES AND CORRECTIVE ACTION:

1. No evidence to indicate that required quarterly submittal of completed corrective action activity to the Division General Manager had ever been accomplished.

2. Failure of Quality Engineering to process a required Corrective Action Request Form after customer identification of TDI failure to meet weld quality requirements in ASME Section III Code Class 3 diesel generator piping.

3. a. Removal and replacement of a defective weld in Shop Engine No. 2931, Part No. 02-717-02YR, without required rejection and documentation on an Inspection Report.

   b. Disposition of a dimensional nonconformance on Shop Engine No. 2931, Part No. 02-540-07-B7, made by QC supervision without required submission of the Inspection Report to the Material Review Board for review.

4. Failure to comply with ASME QA Manual requirements with respect to immediate identification of nonconforming items on Inspection Reports and segregation of the items.

5. Weld shop audit not performed in the fall of 1981 in accordance with corrective action commitments made to the NRC.

EQUIPMENT CALIBRATION:

1. Actual calibration measurements for micrometers and a pressure gage were not recorded as required by Quality Control Procedure No. IP-100.

2. Gage used to measure, accept/reject the diameter and depth of the link rod dowel counterbore had not been identified in accordance with QA program requirements for calibration equipment.

3. Measures were not established to assure that tools used in crankshaft oil plug installation were properly controlled and adjusted at specified periods to maintain accuracy within necessary limits.

4. a. A welding machine in Weld Area No. 3 (Foundry) was observed in September 1983 to have calibration stickers showing a calibration due date of August 30, 1980. The QA program calibration frequency requirement for this equipment is 12 months.

   b. A heat treat furnace was observed in September 1983 to have calibration stickers on the meters and temperature recorder showing a calibration due date of March 13, 1983.

INTERNAL AUDITS:

Failure to perform required semiannual audits of the Foundry, Manufacturing and support activities.

10 CFR PART 21 PRACTICES:

1. Records were not available with respect to fractured thermostatic control valves in Grand Gulf, Unit 1, EDGs to indicate either that an evaluation had been conducted in accordance with 10 CFR Part 21 requirements or that actions had been taken to determine whether the product deviation contributing to the valve fractures (i.e., improper use of raised face flanges in connecting piping) was present in equipment supplied to other customers.

2. Notification to affected parties in regard to a potential problem with isoprene flexible elements of drive couplings was made after the committed date in the 10 CFR Part 21 report.

3. Failure to notify the NRC in regard to:

   a. Jacket water pump shaft failures at SNPS.

   b. Potential defect in fuel injection line tubing that was used on EDGs furnished to Grand Guld and San Onofre, Unit 1.

QA RECORDS:

1. Records not available to demonstrate environmental qualification of auxiliary lube oil and jacket water pump motors with respect to Bechtel Specification Nos. 9645-M-018.0 and 9645-G-QA-1.

2. Failure to protect records against fire in accordance with QA Manual requirements noted during two separate inspections.

MISCELLANEOUS:

Failure to have Certificate of Compliance for SNPS replacement cylinder head assemblies notarized in accordance with customer specification requirements.

<u>TRANSAMERICA DELAVAL, INCORPORATED</u>
<u>VENDOR PROGRAM BRANCH INSPECTION HISTORY SUMMARY</u>
<u>OF NINE INSPECTIONS DURING 1979-1983</u>

Subject	Number of Nonconformances/Violations
Manufacturing Process Control	13
Control of Special Processes	11
Procurement Control	10
Material Identity and Control	1
Design and Document Control	8
Nonconformances and Corrective Action	5
Equipment Calibration	4
Internal Audits	1
10 CFR Part 21 Practices	3 (Violations)
QA Records	3
Miscellaneous	1

TRANSAMERICA DELAVAL, INCORPORATED
VENDOR PROGRAM BRANCH INSPECTION HISTORY SUMMARY
OF NINE INSPECTIONS DURING 1979-1983

SUBJECT	NUMBER OF NONCONFORMANCES/VIOLATIONS
MANUFACTURING PROCESS CONTROL	13
CONTROL OF SPECIAL PROCESSES	11
PROCUREMENT CONTROL	12
MATERIAL IDENTITY AND CONTROL	1
DESIGN AND DOCUMENT CONTROL	8
NONCONFORMANCES AND CORRECTIVE ACTION	5
EQUIPMENT CALIBRATION	4
INTERNAL AUDITS	1
10 CFR PART 21 PRACTICES	3 (VIOLATIONS)
QA RECORDS	3
MISCELLANEOUS	1

MANUFACTURING PROCESS CONTROL

ROUTE SHEETS WERE NOT AVAILABLE TO CONFIRM REQUIRED INSPECTION ACCEPTANCE OF ASSEMBLY OPERATIONS FOR THE EMERGENCY DIESEL GENERATOR (EDG) JACKET WATER PUMP REFLECTED ON DRAWING NO. 101973, REVISION C.

ABSENCE OF EVIDENCE OF INSPECTION ACCEPTANCE FOR COMPONENTS MANUFACTURED DURING JACKET WATER PUMP MODIFICATIONS PERFORMED IN SEPTEMBER AND OCTOBER 1982.

ACCEPTANCE SIGNOFF BY QC INSPECTORS WAS MADE ON ROUTE SHEETS IN REGARD TO INSTALLATION OF ROCKER ARM HOLD DOWN BOLTS. THESE BOLTS WERE SUBSEQUENTLY FOUND TO BE MISSING ON INSPECTION AT THE SHOREHAM NUCLEAR POWER STATION (SNPS).

SHIPMENT OF REWORKED PISTONS TO SAN ONOFRE, UNIT 1, PRIOR TO DATES INDICATED ON ROUTE SHEETS BY QC INSPECTORS THAT VARIOUS MANUFACTURING OPERATIONS WERE ACCEPTED.

ROUTE SHEETS NOT ISSUED FOR REWORK OF 92 PISTONS FROM SNPS AND GRAND GULF EDGs AND THERE IS, THUS, NO EVIDENCE OF INSPECTION ACCEPTANCE OF THE VARIOUS MANUFACTURING OPERATIONS.

NO RECORDS OF QUALITY ACTIVITIES FOR REWORK ACTIVITIES ON GRAND GULF EDG PISTONS WHICH WAS A SPECIFIC REQUIREMENT OF THE PROCUREMENT SPECIFICATION.

APPARENT USE OF UNQUALIFIED PERSONNEL FOR PERFORMANCE OF NDE OPERATIONS ON SNPS REPLACEMENT CYLINDER HEAD ASSEMBLIES.

REQUIREMENTS NOT PROVIDED FOR WELDING OF AND ACCEPTANCE OF SHEARON HARRIS EDG FUEL OIL LINE CLAMPS.

PRIOR TO OCTOBER 1981, MANUFACTURE OF PISTON SKIRT CASTINGS DID NOT COMPLY WITH ENGINEERING COMPONENT DRAWING INSTRUCTIONS WITH RESPECT TO PERFORMANCE OF SPECIFIED STRESS RELIEF HEAT TREATMENT.

NO ASSEMBLY ROUTE SHEETS AVAILABLE FOR SNPS REPLACEMENT CYLINDER HEAD ASSEMBLIES.

PROCUREMENT CONTROL

PURCHASED MATERIAL SPECIFICATIONS FOR ENGINE MOUNTED ELECTRICAL CONTROL CABLES REQUIRED ONLY COMMERCIAL GRADES OF CABLE AND DID NOT INVOKE APPLICABLE CUSTOMER SPECIFICATION REQUIREMENTS.

NO AVAILABLE EVIDENCE TO INDICATE THAT MATERIALS WHICH WERE USED TO FABRICATE EDG ASME SECTION III CODE CLASS 3 COMPONENT SUPPORTS (MIDLAND) AND FUEL OIL SYSTEMS (MIDLAND AND GRAND GULF) WERE PROCURED FROM VENDORS WHO WERE EITHER IDENTIFIED ON THE APPROVED SUPPLIERS LIST OR HAD BEEN SUBJECT TO AUDITS.

PRIOR TO 1982, ASME SECTION III CODE FASTENERS WERE PROCURED FROM VENDORS WHO HAD NEITHER BEEN AUDITED NOR WERE IDENTIFIED ON THE APPROVED SUPPLIERS LIST AS BEING APPROVED FOR SUPPLY OF THIS PRODUCT.

ACCEPTANCE BY RECEIVING INSPECTION OF ASME SECTION III CODE FASTENER CERTIFICATIONS WHICH DID NOT COMPLY WITH PURCHASE ORDER REQUIREMENTS WITH RESPECT TO: (A) CONFORMANCE OF CHEMICAL COMPOSITION TO MATERIAL SPECIFICATION REQUIREMENTS, (B) COMPLETENESS OF MECHANICAL TEST DATA, AND (C) COMPLIANCE WITH ASME SECTION III CODE REQUIREMENTS FOR REPORTING OF MATERIAL HEAT TREATMENT.

MATERIAL IDENTITY AND CONTROL

ELEVEN DISCREPANCIES IN MATERIAL IDENTITY OBSERVED IN A SAMPLE OF 45 BETWEEN THE IDENTITY OF MATERIAL ISSUED AND THAT RECORDED AS BEING USED FOR MIDLAND EDG S/N 77002 PIPING SYSTEM COMPONENT SUPPORTS.

NONCONFORMANCES AND CORRECTIVE ACTION

NO EVIDENCE TO INDICATE THAT REQUIRED QUARTERLY SUBMITTAL OF COMPLETED CORRECTIVE ACTION ACTIVITY TO THE DIVISION GENERAL MANAGER HAD EVER BEEN ACCOMPLISHED.

FAILURE OF QUALITY ENGINEERING TO PROCESS A REQUIRED CORRECTIVE ACTION REQUEST FORM AFTER CUSTOMER IDENTIFICATION OF TDI FAILURE TO MEET WELD QUALITY REQUIREMENTS IN ASME SECTION III CODE CLASS 3 DIESEL GENERATOR PIPING.

WELD SHOP AUDIT NOT PERFORMED IN THE FALL OF 1981 IN ACCORDANCE WITH CORRECTIVE ACTION COMMITMENTS MADE TO THE NRC.

INTERNAL AUDITS

FAILURE TO PERFORM REQUIRED SEMIANNUAL AUDITS OF THE FOUNDRY, MANUFACTURING AND SUPPORT ACTIVITIES.

10 CFR PART 21 PRACTICES

RECORDS WERE NOT AVAILABLE WITH RESPECT TO FRACTURED THERMOSTATIC CONTROL VALVES IN GRAND GULF, UNIT 1, EDGs TO INDICATE EITHER THAT AN EVALUATION HAD BEEN CONDUCTED IN ACCORDANCE WITH 10 CFR PART 21 REQUIREMENTS OR THAT ACTIONS HAD BEEN TAKEN TO DETERMINE WHETHER THE PRODUCT DEVIATION CONTRIBUTING TO THE VALVE FRACTURES (I.E., IMPROPER USE OF RAISED FACE FLANGES IN CONNECTING PIPING) WAS PRESENT IN EQUIPMENT SUPPLIED TO OTHER CUSTOMERS.

FAILURE TO NOTIFY THE NRC IN REGARD TO:

JACKET WATER PUMP SHAFT FAILURES AT SNPS.

POTENTIAL DEFECT IN FUEL INJECTION LINE TUBING THAT WAS USED IN EDGs FURNISHED TO GRAND GULF AND SAN ONOFRE, UNIT 1.

OWNER'S AGENDA

TDI OWNER'S GROUP MEETING WITH NRC

DATE: 01/26/84

TIME: 3:00 P.M.

LOCATION: PHILLIPS BUILDING - BETHESDA

I.	OWNER'S GROUP FORMATION AND CHARTER	J.P. McGAUGHY
II.	OWNER'S GROUP PROGRAM DESCRIPTION	W.J. MUSELER
III.	CURRENT STATUS OF MAJOR GENERIC FAILURE ANALYSIS ACTIVITIES - FaAA	C. WELLS
IV.	DESIGN REVIEW/QUALITY REVALIDATION PROGRAM (DRQR)	C.K. SEAMAN
V.	TRANSAMERICA/DELAVAL ACTIVITIES - TDI	C. MATTHEWS
VI.	INTEGRATED PROGRAM APPROACH SCHEDULE	W.J. MUSELER
VII.	SUMMARY	J.P. McGAUGHY

SUMMARY OF OWNER'S GROUP ACTIVITIES

1. TIE MEETING

NEED FOR A UTILITY TECHNICAL INFORMATION EXCHANGE ON D/G RELIABILITY EXPERIENCES PROMPTED MP&L TO SPONSOR 1ST D/G TIE MEETING IN ATLANTA ON 10/25/83.

- 26 UTILITIES REPRESENTED
- 59 INDUSTRY REPRESENTATIVES INCLUDING INPO, NRC, AND NSAC/EPRI
- PRESENTATIONS GIVEN BY SEVERAL D/G OWNERS
- REVIEWED MUTUAL PROBLEMS AT BREAKOUT SESSIONS
- ATTENDEES MADE 2 RECOMMENDATIONS
  - (1) HOLD WORKSHOP OF D/G OWNERS
  - (2) ORGANIZE D/G OWNERS'S GROUP
- STEERING COMMITTEE FORMED

2. STEERING COMMITTEE MEETING

STEERING COMMITTEE MEETING HELD NOVEMBER 30, 1983 AT OAKLAND, CALIFORNIA.

- 12 STEERING COMMITTEE MEMBERS AND 23 OTHER REPRESENTATIVES FROM UTILITIES, TDI, EPRI/NSAC, FAA REPRESENTED
- PRESENTATIONS ON SHOREHAM TECHNICAL PROBLEMS GIVEN BY FAA
- LIST OF D/G PROBLEMS WERE DEVELOPED FOR DISCUSSION WITH TDI
- DRAFT CHARTER PREPARED BY AN OG SUBCOMMITTEE
- TDI CONDUCTED TOUR AND PRESENTED INFORMATION ON CRANKSHAFTS, PISTONS, CONNECTOR ROD BEARINGS, PUSH RODS, QA PROGRAM
- STEERING COMMITTEE RECOMMENDED IMPROVEMENTS IN TDI'S QA AND PRODUCT IMPROVEMENT PROGRAM AND COMMUNICATIONS
- STEERING COMMITTEE RECOMMENDED TDI RESPOND WITH WRITTEN REPORT
- COMPREHENSIVE REPORT WAS PREPARED BY TDI AND DISTRIBUTED TO OWNER'S GROUP MEMBERS

SUMMARY OF OWNER'S GROUP ACTIVITIES

(CONTINUED)

3. EXECUTIVE MEETING

DELAVAL D/G OWNER'S EXECUTIVE MEETING HELD DECEMBER 21, 1983, ATLANTA, GEORGIA.

- MP&L AND LILCO VP'S SPONSOR EXECUTIVE'S MEETING:

  PURPOSE OF MEETING:

  - UTILITIES TO MANAGE EFFORT
  - DEVELOP COORDINATED EFFORT - BACK TO BASICS
  - ADDRESS NRC AND UTILITY TDI ENGINE RELIABILITY ISSUES
  - DESIGN, MANUFACTURE, TESTING
  - MUST HAVE TDI INVOLVEMENT
  - ALL UTILITIES TO SUPPLY ACTIVE TECHNICAL PARTICIPATION
  - BUILD ON LILCO EFFORT - HIT THE GROUND RUNNING
  - LILCO APPOINTED AS TECHNICAL PROGRAM MANAGER
  - MP&L V.P. WAS APPOINTED TO CHAIR COMMITTEE

SUMMARY OF OWNER'S GROUP ACTIVITIES
(CONTINUED)

4. TDI OG Technical Meeting

TDI - Owner's Group Technical Program Meeting held January 6, 1984, at LILCO/Shoreham Site, N.Y.

- LILCO, TUGCO, Duke, MP&L represented
- Proposed TDI-OG program outlined
- Major elements defined
- Costs estimated
- Agenda for OG and NRC presentation approved
- Recommendations made for utilities to immediately implement components selection phase of program
- Scheduled presentation to OG Executives for approval
- Utility personnel assigned to Technical Reviews

SUMMARY OF OWNER'S GROUP ACTIVITIES

(CONTINUED)

5. PROGRAM APPROVAL - ALL TDI OWNERS

- EXECUTIVE COMMITTEE MET JANUARY 16
- FINAL PROGRAM PRESENTED TO OWNERS
- PROGRAM WAS APPROVED BY ALL PARTICIPATING UTILITIES
- TDI COMMITTED TO EFFORT

SUMMARY OF OWNER'S GROUP ACTIVITIES

(CONTINUED)

6. OG UTILITY PARTICIPANTS

GULF STATES UTILITIES (GSU)

SOUTHERN CALIFORNIA EDISON (SCE)

CAROLINA POWER AND LIGHT (CP&L)

DUKE POWER

SACRAMENTO MUNICIPAL UTILITY DISTRICT (SMUD)

TEXAS UTILITIES GENERATING CO. (TUGCO)

CONSUMERS POWER

MISSISSIPPI POWER AND LIGHT (MPL)

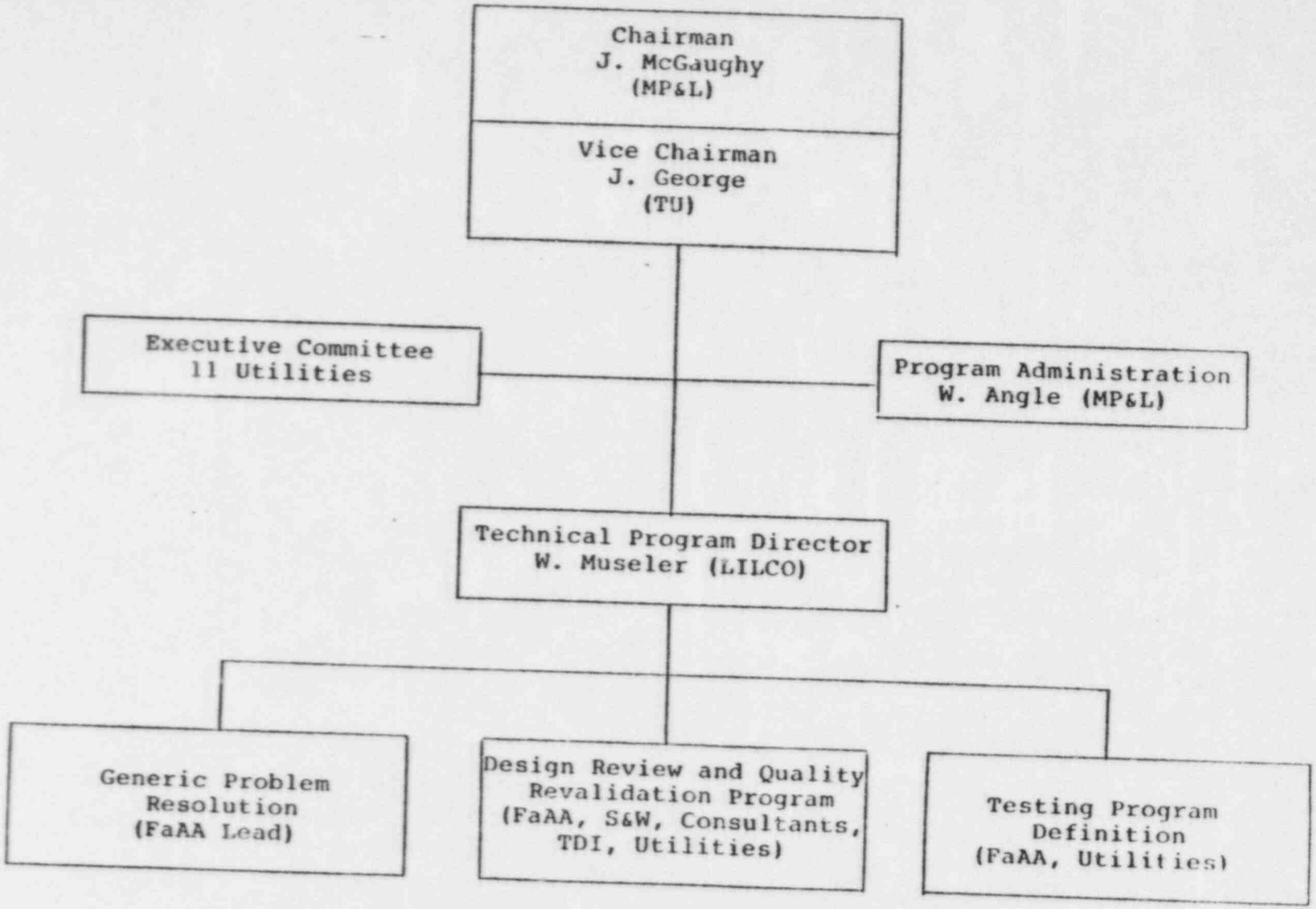
CLEVELAND ELECTRIC ILLUMINATING CO. (CEICO)

LONG ISLAND POWER AND LIGHT CO. (LILCO)

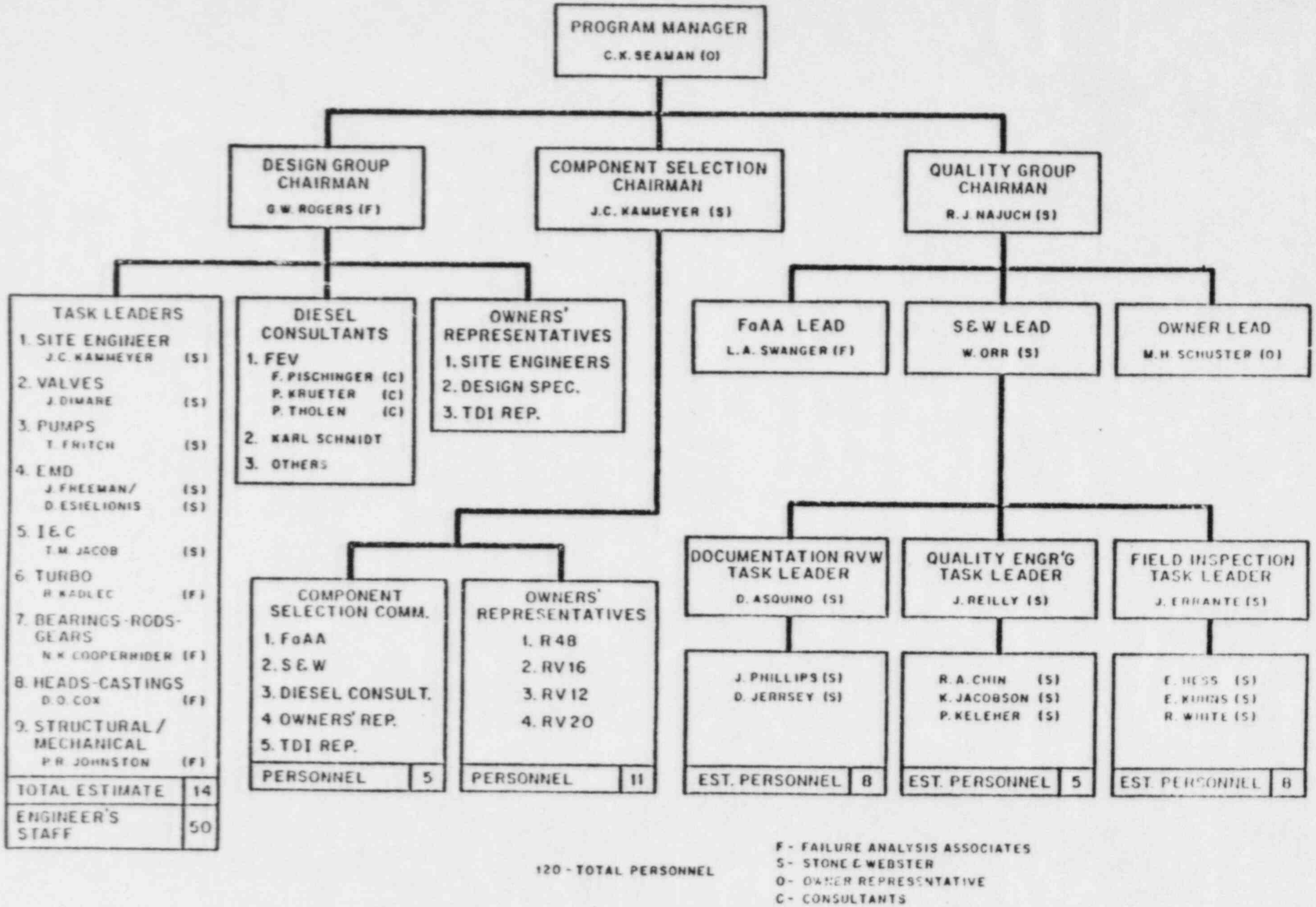
GEORGIA POWER

Attachment 2

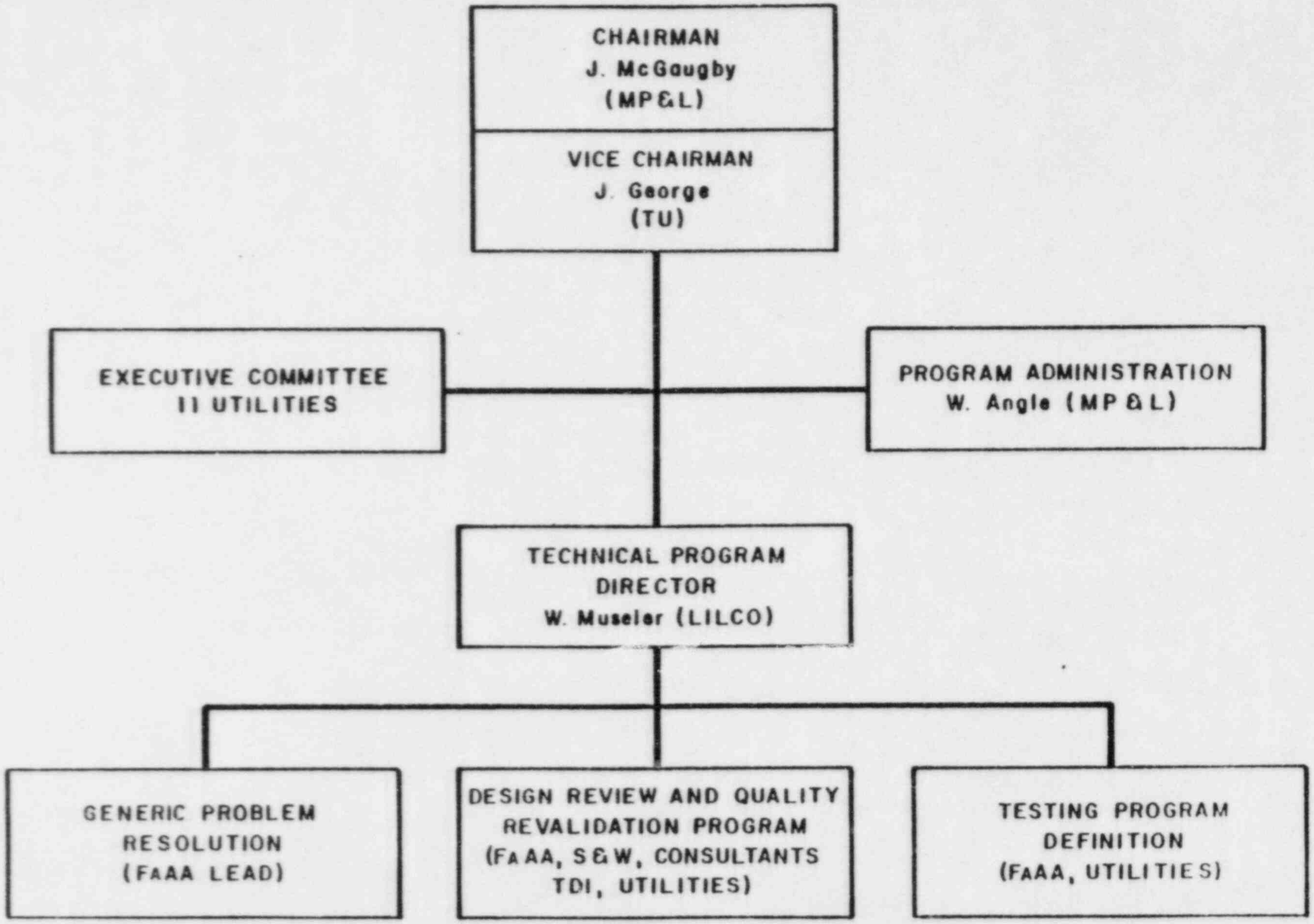
TDI DIESEL GENERATOR OWNERS' GROUP



D.G. DESIGN REVIEW QUALITY REVALIDATION PROGRAM VI-2



TDI DIESEL GENERATOR OWNERS GROUP



PROGRAM PARTICIPANTS

1. OWNERS' GROUP UTILITIES (11)
2. FaAA
3. TDI
4. SWEC
5. D.G. CONSULTANTS

DR. FRANZ F. PISCHINGER

- CURRENT POSITION
  - DIRECTOR, INSTITUTE FOR APPLIED THERMODYNAMICS, AACHEN TECHNICAL UNIVERSITY, AND
  - VICE PRESIDENT, FORSCHUNGSGESELL - SCHAFT FÜR ENERGIETECHNIK UND VERBRENNUNGSMOTOREN (FEV)
  - 30 YEARS EXPERIENCE IN ALL ENGINEERING ANALYSIS AND DESIGN ASPECTS OF DIESEL ENGINES
- FORMER POSITION
  - DIRECTOR, RESEARCH AND DEVELOPMENT, K.H.D. AG, DIESEL ENGINE MANUFACTURER, WEST GERMANY
  - RESEARCH DEPARTMENT HEAD, INSTITUTE FOR INTERNAL COMBUSTION ENGINES GRAZ
- PUBLICATIONS
  - AUTHORED TEXTBOOKS AND TECHNICAL PAPERS ON DIESEL ENGINE DESIGN AND ENGINEERING ANALYSIS

PAUL THOLEN

- **CURRENT POSITION**
  - CONSULTANT TO DR. F. F. PISCHINGER, FEV
- **FORMER POSITION**
  - DIRECTOR OF RESEARCH AND DEVELOPMENT, K.H.D. AG, DIESEL ENGINE MANUFACTURER, WEST GERMANY
  - RESPONSIBLE FOR:
    - DIESEL ENGINE DEVELOPMENT
    - TESTING AND MEASUREMENT
    - THERMODYNAMICS
    - DESIGN ANALYSIS
  - DEVELOPED HIGHLY-TURBOCHARGED DIESEL ENGINES
- **PUBLICATIONS**
  - "WEAR AND FUEL CONSUMPTION IN DIESEL ENGINES", S.A.E. MILWAUKEE CONFERENCE, SEPTEMBER 1983
  - "TURBOCHARGING OF DIESEL ENGINES", PRESENTED IN TOKYO, JAPAN 1977
  - "NEW PROCEDURES IN TURBO CHARGING OF ENGINES", SIEMAG CONFERENCE, WASHINGTON, D.C. 1973

DR. CLIFFORD H. WELLS (FaAA)

- CURRENT POSITION
  - VICE PRESIDENT, RESEARCH AND DEVELOPMENT
  - RESPONSIBLE FOR:
    - FATIGUE AND RELIABILITY ANALYSIS
    - NONDESTRUCTIVE EVALUATION

- FORMER POSITIONS
  - DIRECTOR OF ENGINEERING MECHANICS, SOUTHWEST RESEARCH INSTITUTE
  - ASSISTANT MANAGER, MATERIALS ENGINEERING AND RESEARCH, PRATT & WHITNEY AIRCRAFT CORP.
  - CHAIRMAN, EXECUTIVE COMMITTEE, MATERIALS DIVISION, ASME

- PUBLICATIONS
  - EDITOR, "FATIGUE OF ENGINEERING MATERIALS AND STRUCTURES"

GARY W. ROGERS, P.E. (FaAA)

- **CURRENT POSITION**
  - DIRECTOR, FaAA, PHOENIX OFFICE
  - RESPONSIBLE FOR:
    - RECIPROCATING AND TURBO MACHINERY DESIGN
    - VIBRATIONS ANALYSIS AND FIELD TESTING
  - CONDUCTED:
    - DIESEL MAIN BEARING AND GENERATOR SHAFT FAILURE ANALYSIS, ARKANSAS NUCLEAR - 1
    - MOTOR BEARING FAILURE ANALYSIS, SAN ONOFRE - 2
    - RCP SEAL FAILURE ANALYSIS, INDIAN POINT - 2

- **FORMER POSITION**
  - GARRETT CORPORATION
  - RESPONSIBLE FOR:
    - G-T ENGINE DESIGN AND DEVELOPMENT
    - DESIGN ANALYSIS OF DRIVESHAFT TORSIONAL INSTABILITY
    - MEMBER MATERIAL REVIEW BOARD (DESIGN/QUALITY REVIEW)

DR. LEE A. SWANGER, P.E. (FaAA)

- CURRENT POSITION
  - MANAGING ENGINEER
  - RESPONSIBLE FOR:
    - PALO ALTO EXPERIMENTAL LABORATORIES
    - METALLURGICAL ANALYSIS
- FORMER POSITION
  - DIRECTOR, RESEARCH AND DEVELOPMENT, IMPERIAL CLEVITE INC.
  - RESPONSIBLE FOR:
    - COMPONENT DEVELOPMENT
    - BEARING FAILURE ANALYSIS
    - COMPONENT MANUFACTURE PROCESS DEVELOPMENT
- PUBLICATIONS
  - "SELECTION OF CRANKSHAFT MATERIALS FOR OPTIMUM BEARING PERFORMANCE", SOCIETY OF MANUFACTURING ENGINEERS CM80-392
  - "DEVELOPMENT IN BEARINGS AND PISTONS", PRESENTED AT O MOTOR NO FUTURO, SAO PAULO, BRAZIL, SEPTEMBER 1980
- U.S. PATENT NO. 4333215 "BEARING MATERIAL AND METHOD OF MAKING"

PROGRAM CONCEPTS

1. FOCUS ON SPECIFIC COMPONENTS
2. CONSIDER ALL ENGINE COMPONENTS FOR POTENTIAL REVIEW
3. NUCLEAR AND INDUSTRY EXPERIENCE FACTORED IN
4. HIGH QUALITY RESOURCES
5. UNIFIED TEAM APPROACH
6. ADDRESS SUBSTANTIVE ATTRIBUTES (SMALL "q" VS. CAPITAL "Q" FOR QUALITY)
7. ADDITIONAL TESTING WHERE REQUIRED
8. ADDITIONAL INSPECTIONS WHERE REQUIRED

OWNERS' GROUP PROGRAM ELEMENTS

- KNOWN PROBLEM RESOLUTION (GENERIC AND ENGINE UNIQUE)
- DESIGN REVIEW AND QUALITY REVALIDATION (DRQR)
- ADDITIONAL TESTING AND INSPECTION (WHERE REQUIRED)
- RESPONSES TO NRC QUESTIONS

SIGNIFICANT KNOWN PROBLEMS

1. CRANKSHAFT
2. CONNECTING ROD BEARINGS
3. PISTONS
4. CYLINDER HEADS
5. CYLINDER LINERS
6. CYLINDER BLOCK
7. ENGINE BASE
8. HEAD STUDS
9. PUSH RODS
10. ROCKER ARM CAPSCREWS
11. CONNECTING RODS
12. ELECTRICAL CABLE
13. FUEL INJECTION LINES
14. TURBOCHARGER
15. JACKET WATER PUMPS
16. AIR START VALVE CAPSCREWS

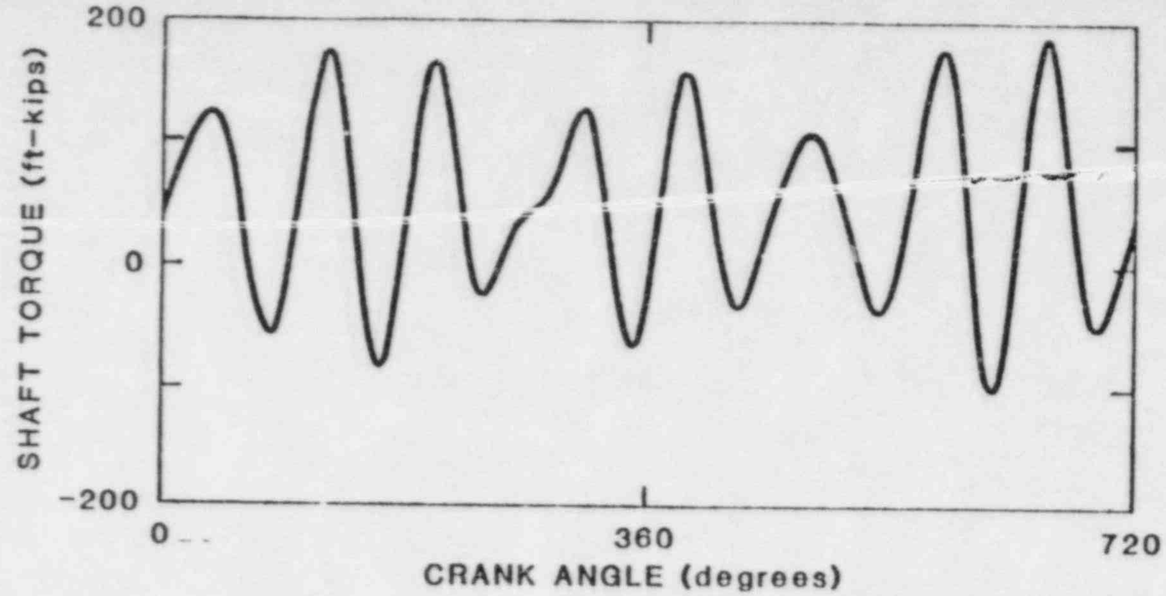
DOCUMENT PACKAGES FOR NRC REVIEW

(FOR EACH OWNER)

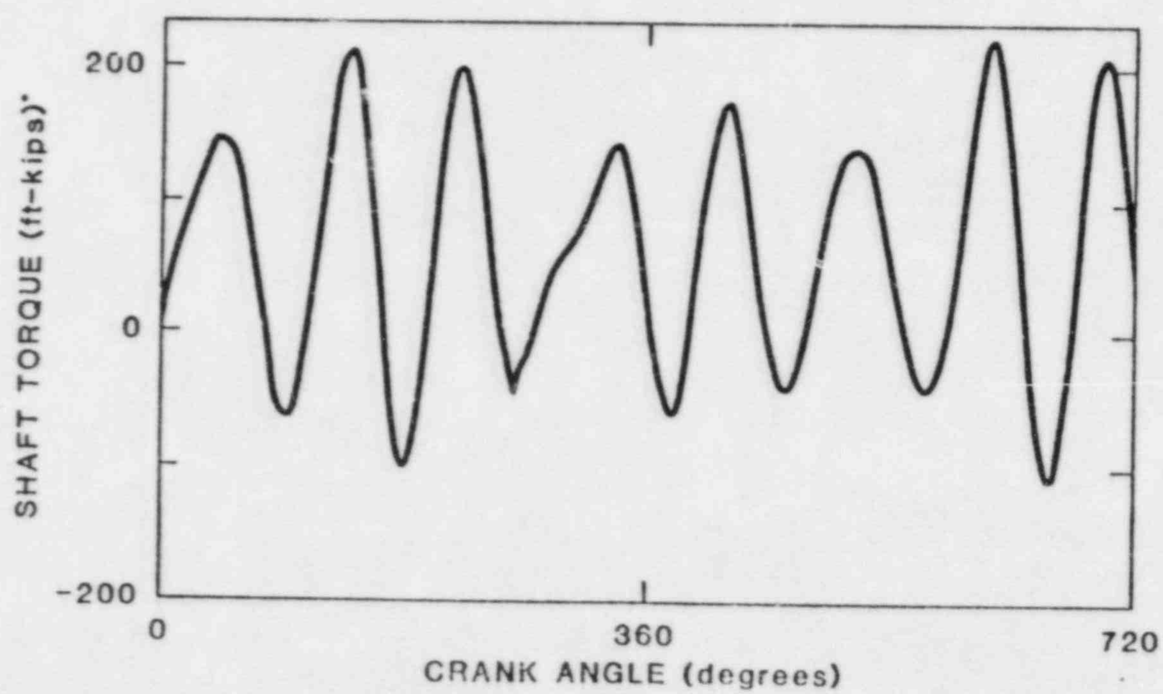
1. SPECIFIC REPORTS ON EACH KNOWN PROBLEM
   - GENERIC
   - ENGINE SPECIFIC
2. ENGINE SPECIFIC DRQR REPORT
3. PREOPERATIONAL TEST REPORTS (VIA I&E)
4. SPECIAL TEST REPORTS (IF APPLICABLE)
5. RESPONSES TO NRC QUESTIONS
   - GENERIC
   - ENGINE SPECIFIC

CRANKSHAFT FAILURE RESOLUTION

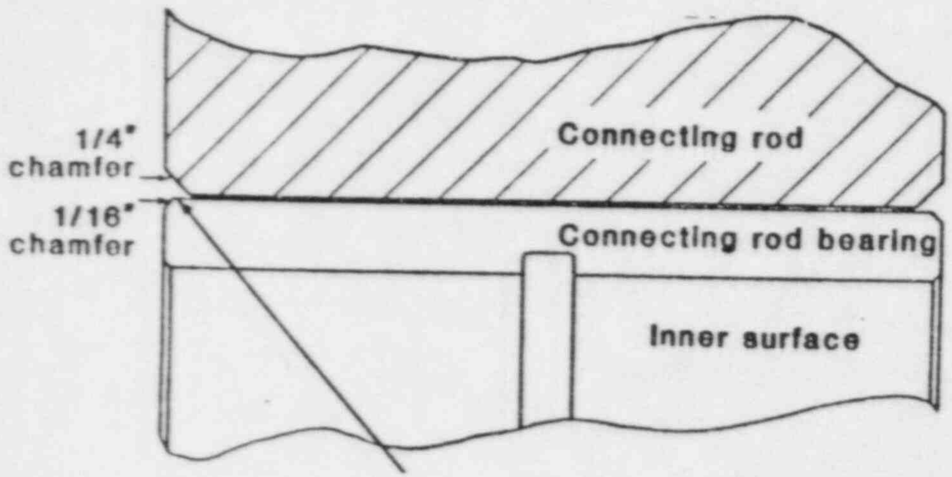
1. CAUSE IDENTIFIED VIA MULTIPLE METHODOLOGIES
   - HOLZER ANALYSIS
   - MODAL SUPERPOSITION
   - FINITE ELEMENT ANALYSIS
2. TEST OF 13 X 11" SNPS CRANKSHAFT CONFIRMED ANALYSIS
3. ADEQUACY OF NEW 13 X 12" CRANKSHAFT CONFIRMED
   - ANALYTICALLY
   - TESTING
4. PROBLEM WAS SHOREHAM UNIQUE
5. OTHER CRANKSHAFT TYPES BEING CONFIRMED



CALCULATED

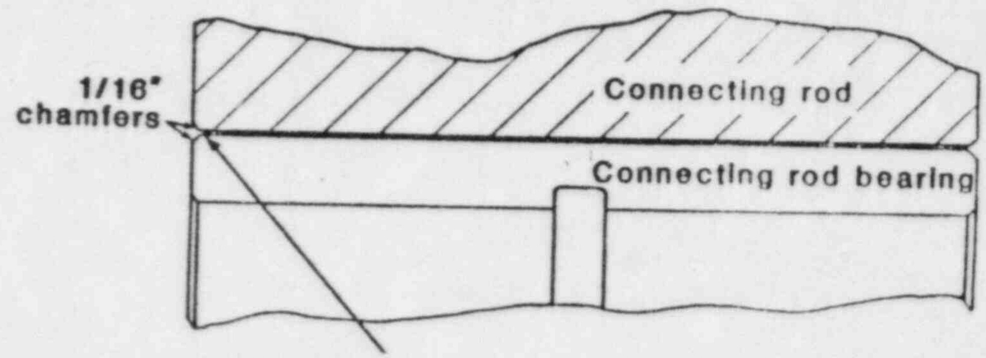


MEASURED



UNSUPPORTED END

Bearing: Connecting rod configuration with original 11-inch journals.



COMPLETELY SUPPORTED END

Bearing: Connecting rod configuration with replacement 12-inch journals.

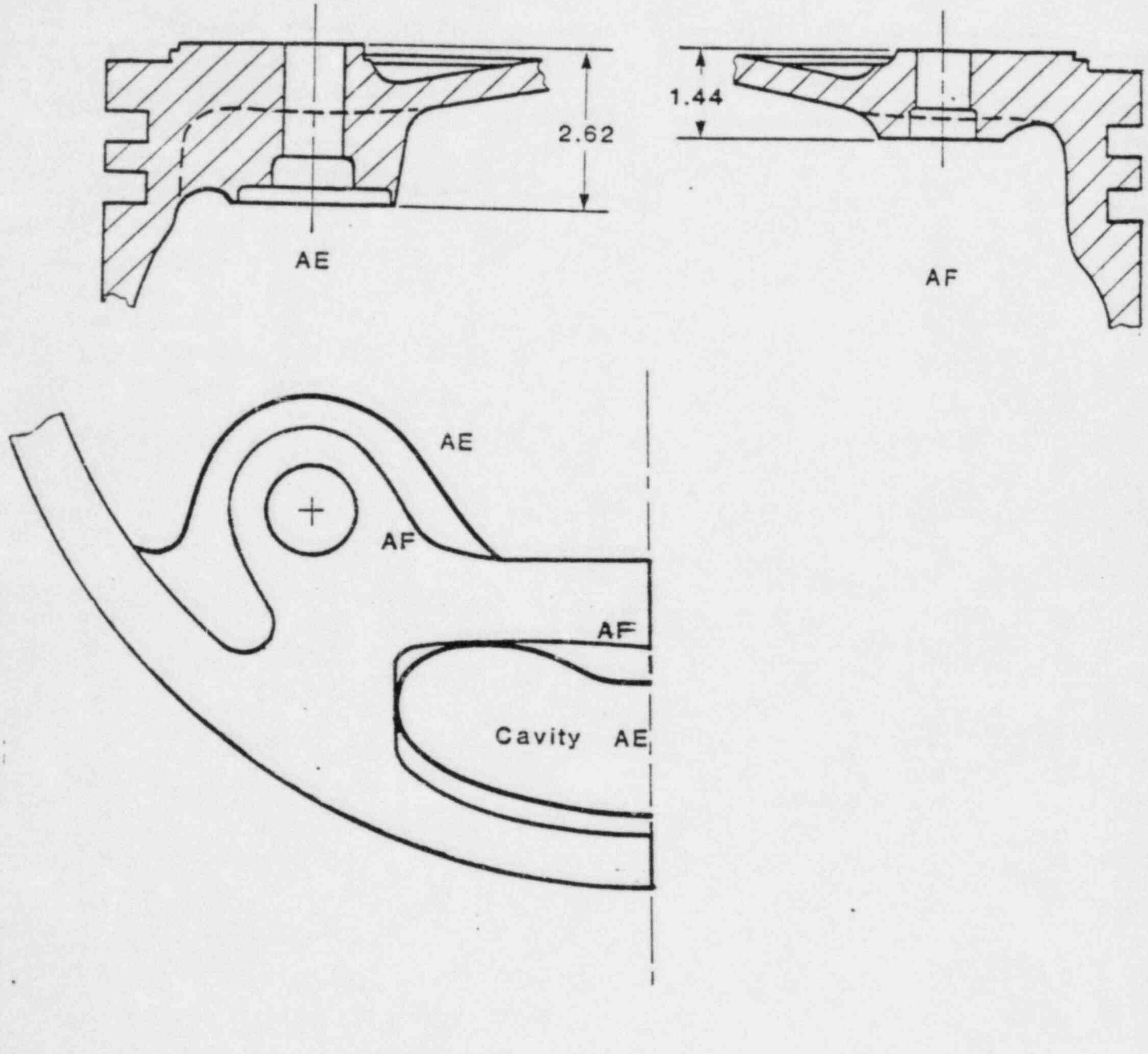
CRANK PIN JOURNAL BEARING

	11 INCH PIN DIAMETER	12 INCH PIN DIAMETER
Peak Oil Film Pressure	29,745 psi	26,780 psi
Max. Predicted Yaw	0.0079 inch	0.0052 inch
Max. Calculated Stress	10,931 psi	5,412 psi
Crack Growth Life from From 0.7mm Diameter Defect	250 hour	38,000 hour

FaAA-M-84-1-6

BEARING FAILURE RESOLUTION

1. CAUSE IDENTIFIED
2. PROBLEM WAS SHOREHAM UNIQUE
3. NEW SHOREHAM DESIGN FOUND ADEQUATE VIA
   - ANALYSIS
   - INSPECTION
   - MATERIAL TESTING
4. BEARINGS ON OTHER ENGINES TO BE CONFIRMED VIA
   - ANALYSIS
   - INSPECTION
   - MATERIAL TESTING


2.62
1.44
AE
AF
AE
AF
AF
Cavity
AE

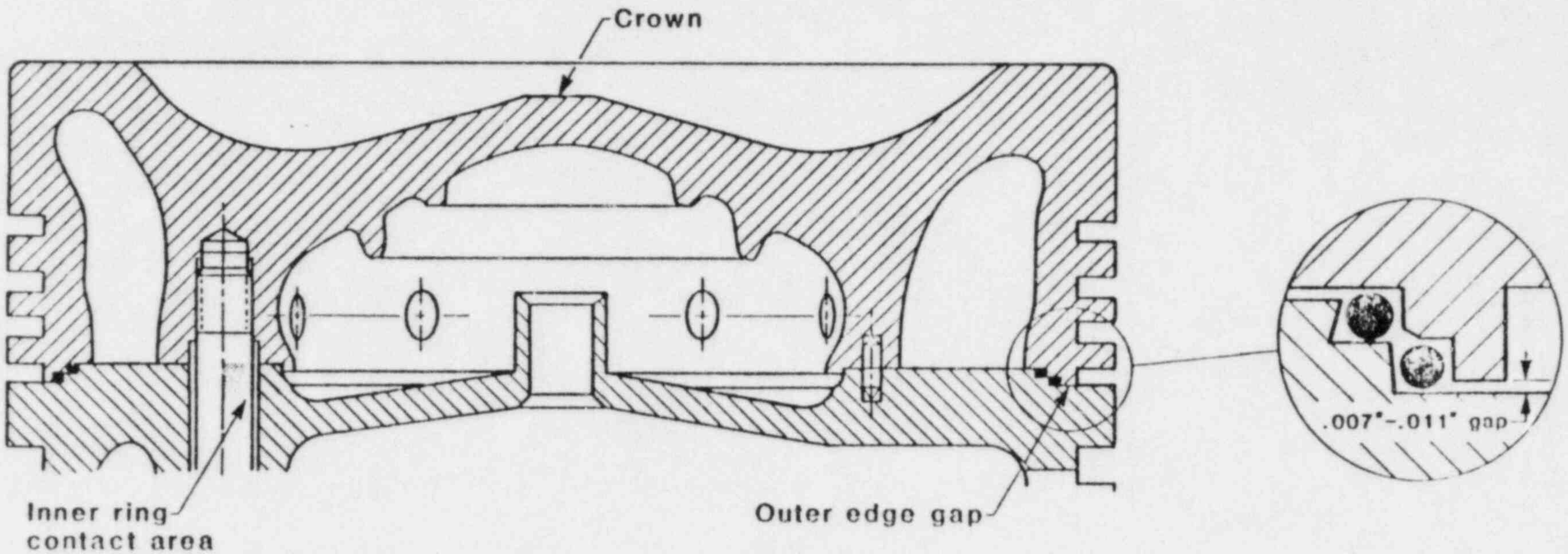


Figure 3-2. Cross section of crown and skirt indicating the two areas of load transfer from the crown to the skirt.

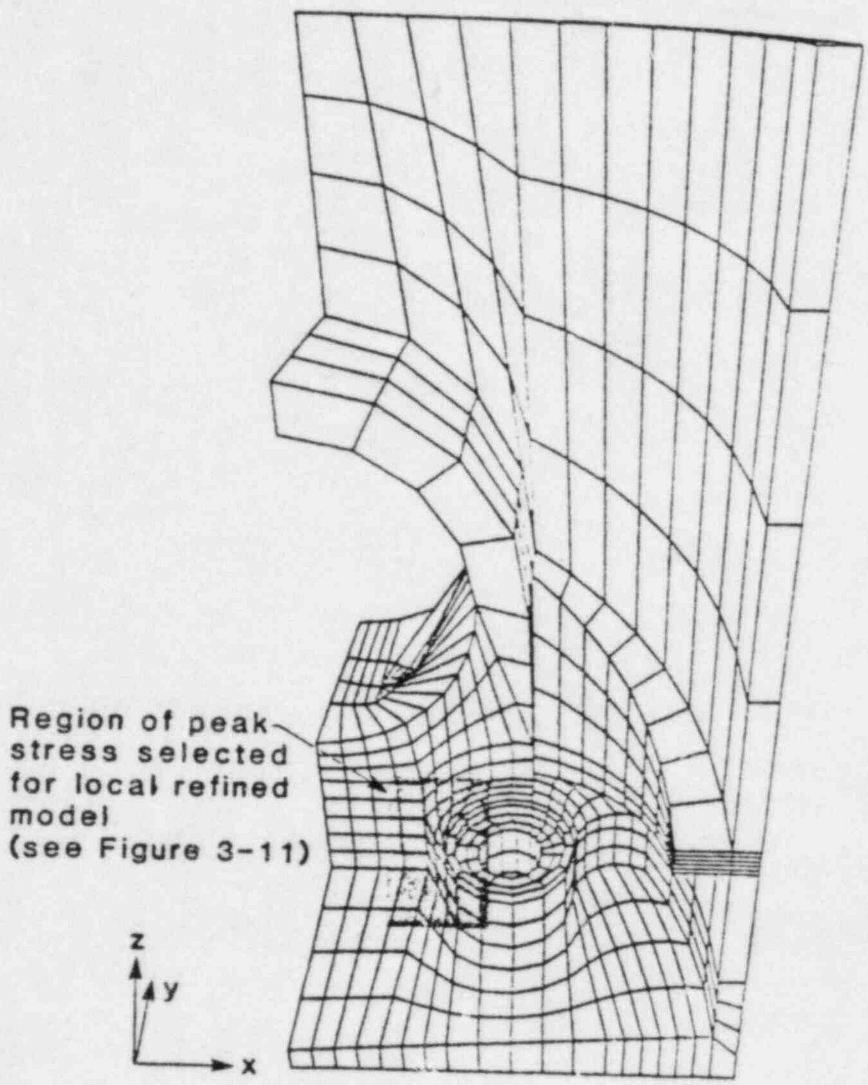


Figure 3-10. Global model of AE piston skirt.

STATUS OF PISTON ANALYSIS

1. Three piston skirt types involved (AF, AN, AE)

2. Analytical model still under development by FaAA

3. Strain gage rig test planned

4. German piston consultant engaged for additional analysis

5. AE piston operating experience good

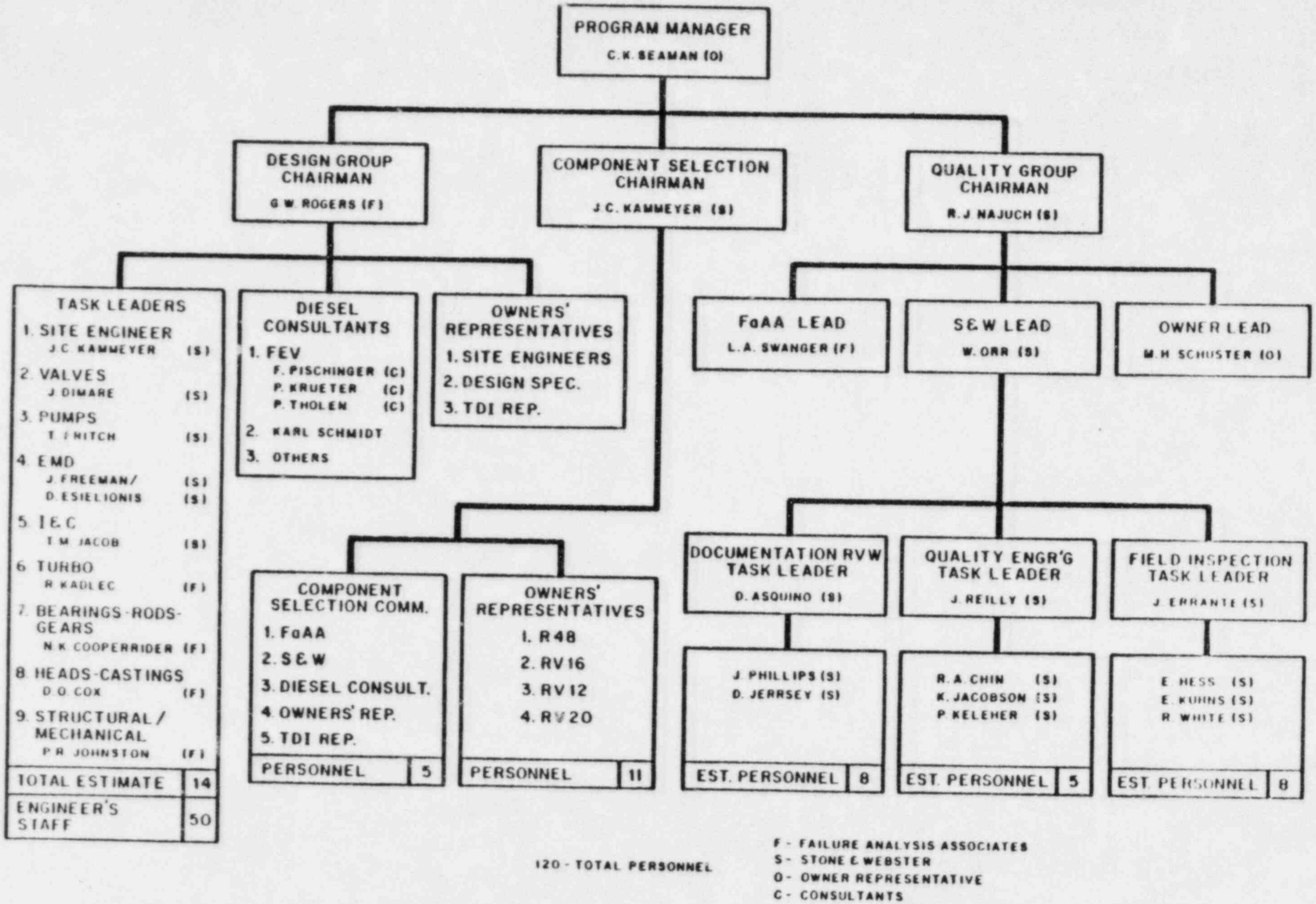
   - TDI test engine (2)

   - Kodiak utility engine (16)

DESIGN REVIEW / QUALITY REVALIDATION PROGRAM

- ORGANIZATION
- PROGRAM DESCRIPTION
- SCHEDULE AND STATUS
- SAMPLE TASK DESCRIPTIONS

D.G. DESIGN REVIEW QUALITY REVALIDATION PROGRAM



PROGRAM DESCRIPTION

PROGRAM IS CONDUCTED IN FIVE PHASES:

I. ASSEMBLE EXPERIENCE DATA

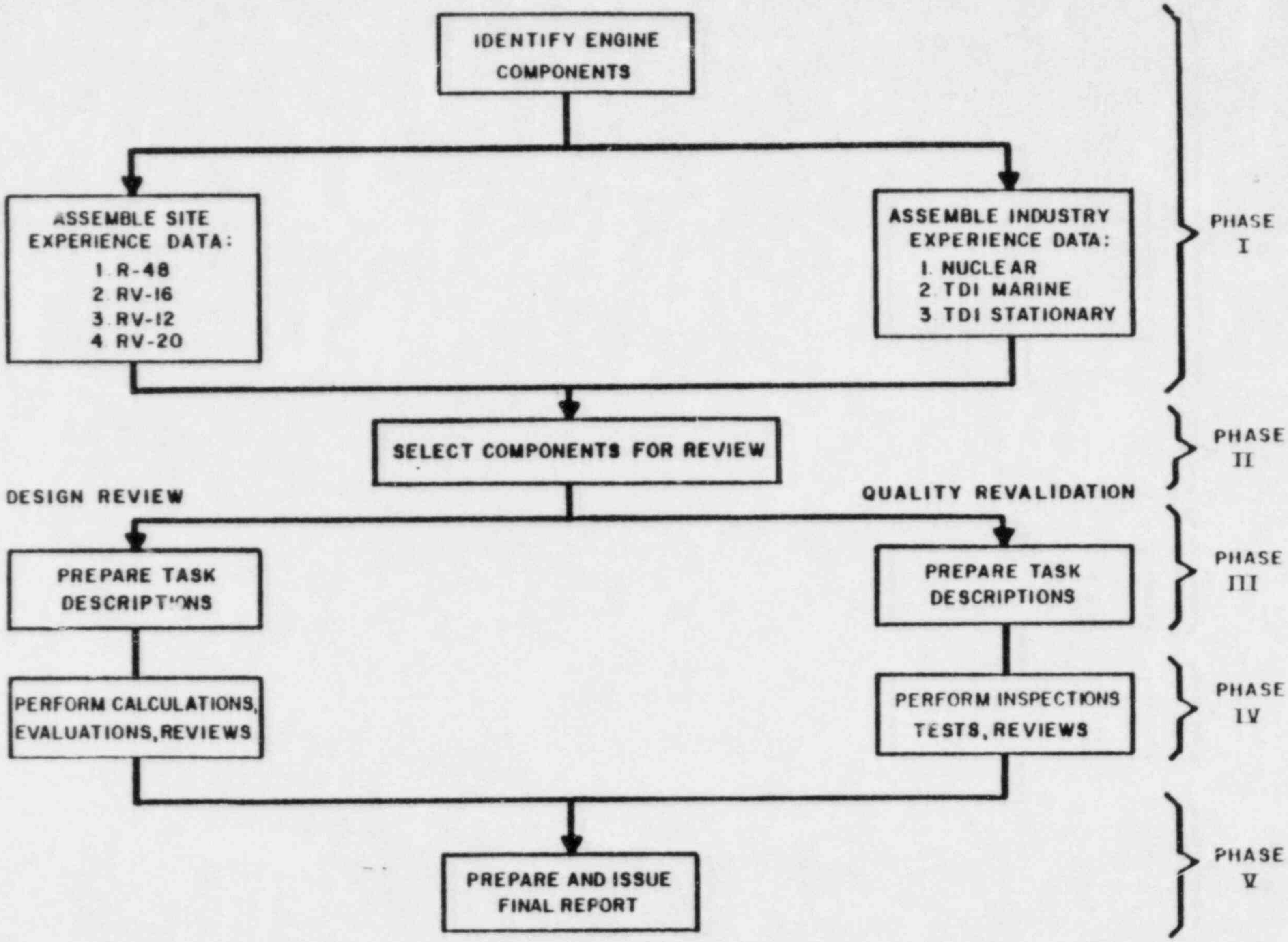
II. COMPONENT SELECTION

III. PREPARATION OF TASK DESCRIPTIONS

IV. IMPLEMENT TASK DESCRIPTIONS

V. PREPARE FINAL REPORT

DR/QR PROGRAM FLOW CHART



I. ASSEMBLE EXPERIENCE DATA

A. SITE EXPERIENCE

MAINTENANCE RECORDS

OPERATING LOSS

DESIGN CHANGES & IMPROVEMENTS

FAILURES

B. INDUSTRY EXPERIENCE

NUCLEAR – ALL MANUFACTURERS

NON-NUCLEAR – TRANSAMERICA DELAVAL ONLY

C. COMPUTER SUMMARY REPORT

II. COMPONENT SELECTION

A. TRANSAMERICA DELAVAL PARTS LIST

- BASE DOCUMENT
- IDENTIFY COMMON PARTS

B. SELECTION COMMITTEE

- OWNERS REPRESENTATIVE
- SWEC
- FaAA
- TDI
- DIESEL GENERATOR SPECIALIST

C. SELECTION BY CONSENSUS

- COMPONENT FUNCTION (CLASSIFICATION)
- REVIEW EXPERIENCE DATA

D. OUTLINE MINIMUM REVIEW REQUIREMENTS

- IDENTIFY IMPORTANT QUALITY ATTRIBUTES
- OUTLINE DESIGN REVIEW REQUIREMENTS

E. SHOREHAM R-48 COMPONENT SELECTION

- TOTAL COMPONENTS – 217
- DESIGN REVIEW – 152
- QUALITY REVALIDATION – 133
- TOTAL COMPONENTS REVIEW OR REVALIDATED – 166

III. PREPARATION OF TASK DESCRIPTIONS

A. TASK LEADER ASSIGNED

- ENGINEERING OR QUALITY SPECIALISTS
- RESPONSIBILITIES

B. QUALITY REVALIDATION

- NDE
- DESTRUCTIVE EXAMINATIONS
- IDENTIFY SAMPLE SIZE
- PROCEDURES SPECIFIED

C. DESIGN REVIEW

- INDUSTRY STANDARDS
- DETAIL METHODOLOGY & REQUIRED INFORMATION
- UNIQUE ANALYSIS (FEM)
- EVALUATIONS

D. TASK DESCRIPTION REVIEWS

- OWNER'S REPRESENTATIVES
- TDI
- GROUP CHAIRPERSON & PROGRAM MANAGER

IV. IMPLEMENT TASK DESCRIPTION

A. REVIEW / REVALIDATION IMPLEMENTED BY TASK LEADER

B. QUALITY REVALIDATIONS
- USE OF SPARE OR REPLACEMENT PARTS
- ENGINE INSPECTIONS & TESTS
- DOCUMENT RESULTS
- ANALYZE RESULTS (USE DESIGN GROUP IF NECESSARY)

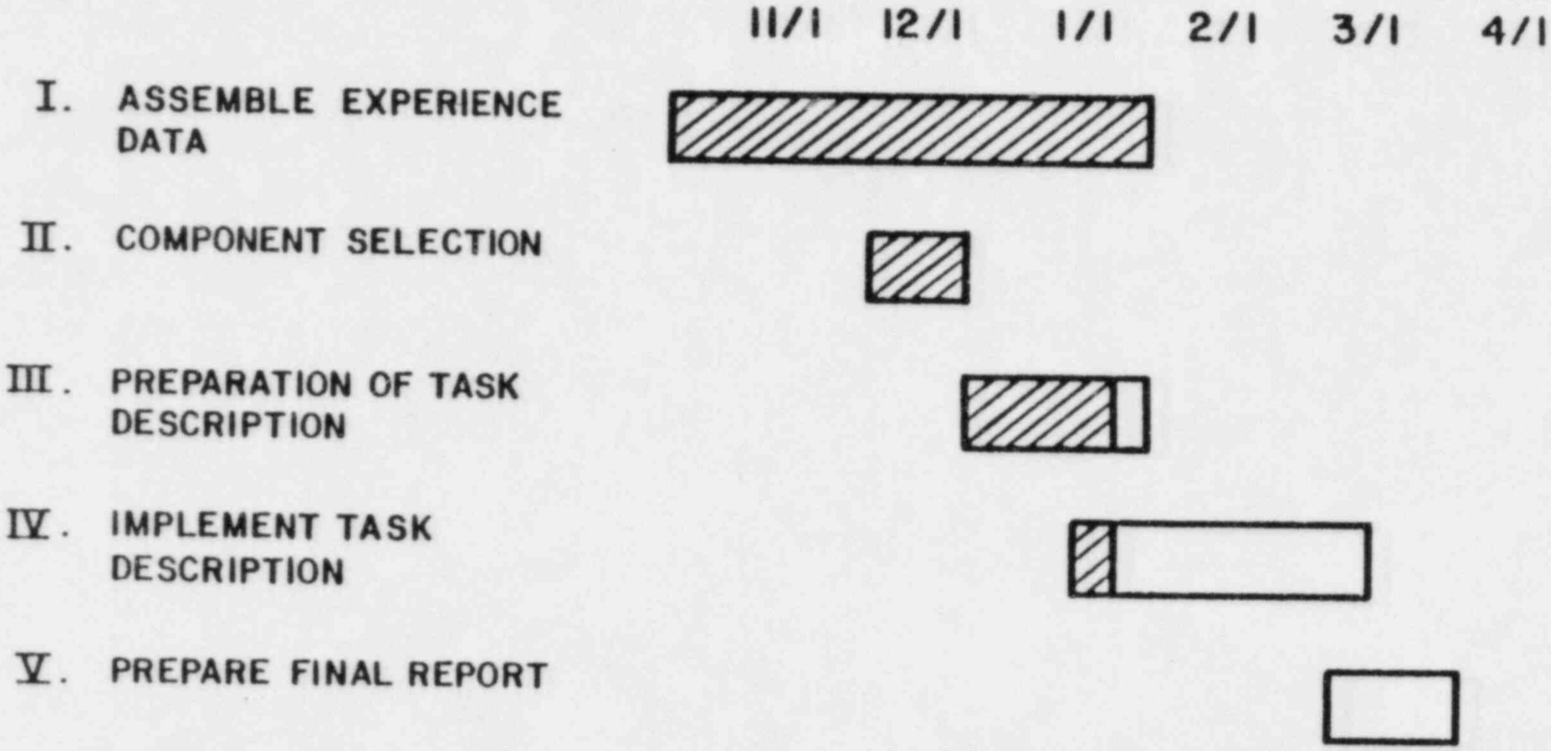
C. DESIGN REVIEWS
- REVIEW EXPERIENCE DATA
- CALCULATIONS PERFORMED
- EVALUATIONS BY CONSULTANTS
- FEEDBACK TO QUALITY GROUP

D. IDENTIFY RESULTS AND RECOMMENDATIONS
- REVIEWED BY OWNER'S REPRESENTATIVES, TDI, GROUP CHAIRPERSON AND PROGRAM MANAGER
- COMPONENT ACCEPTABLE
- INCREASE INSPECTION / MAINTENANCE FREQUENCY
- UPGRADE / REPLACEMENT

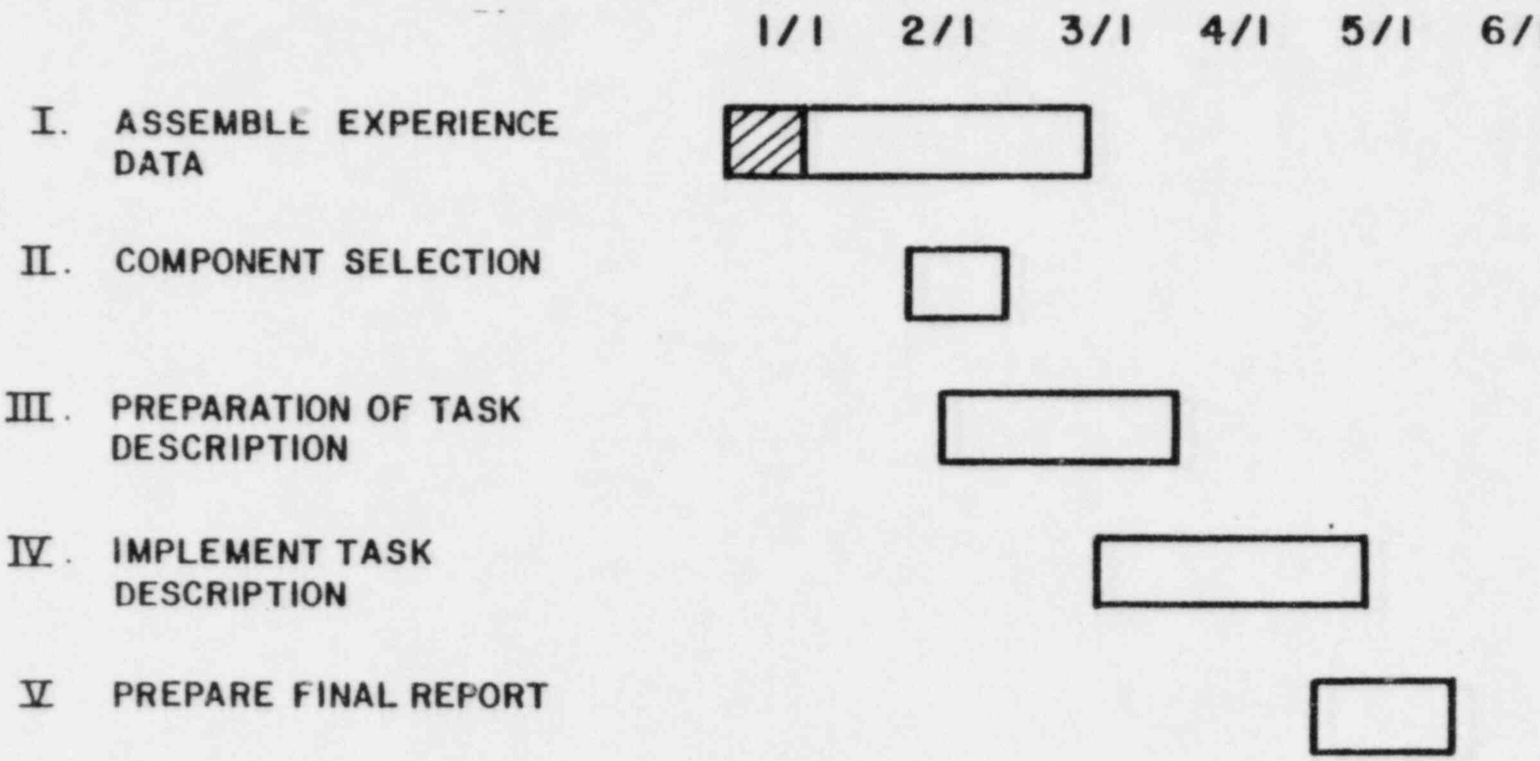
V. PREPARE FINAL REPORT

- EXECUTIVE SUMMARY
- PROGRAM DESCRIPTION
- METHODOLOGY FOR SELECTING COMPONENTS
- SUMMARY LIST OF COMPONENTS AND CLASSIFICATION
- METHODOLOGY AND RESULTS OF COMPONENT DESIGN REVIEW
- METHODOLOGY AND RESULTS OF COMPONENT QUALITY REVALIDATION
- TABULATION AND DISCUSSION ON ANY DEVIATIONS THAT WERE FOUND
- CORRECTIVE ACTIONS AND RECOMMENDATIONS

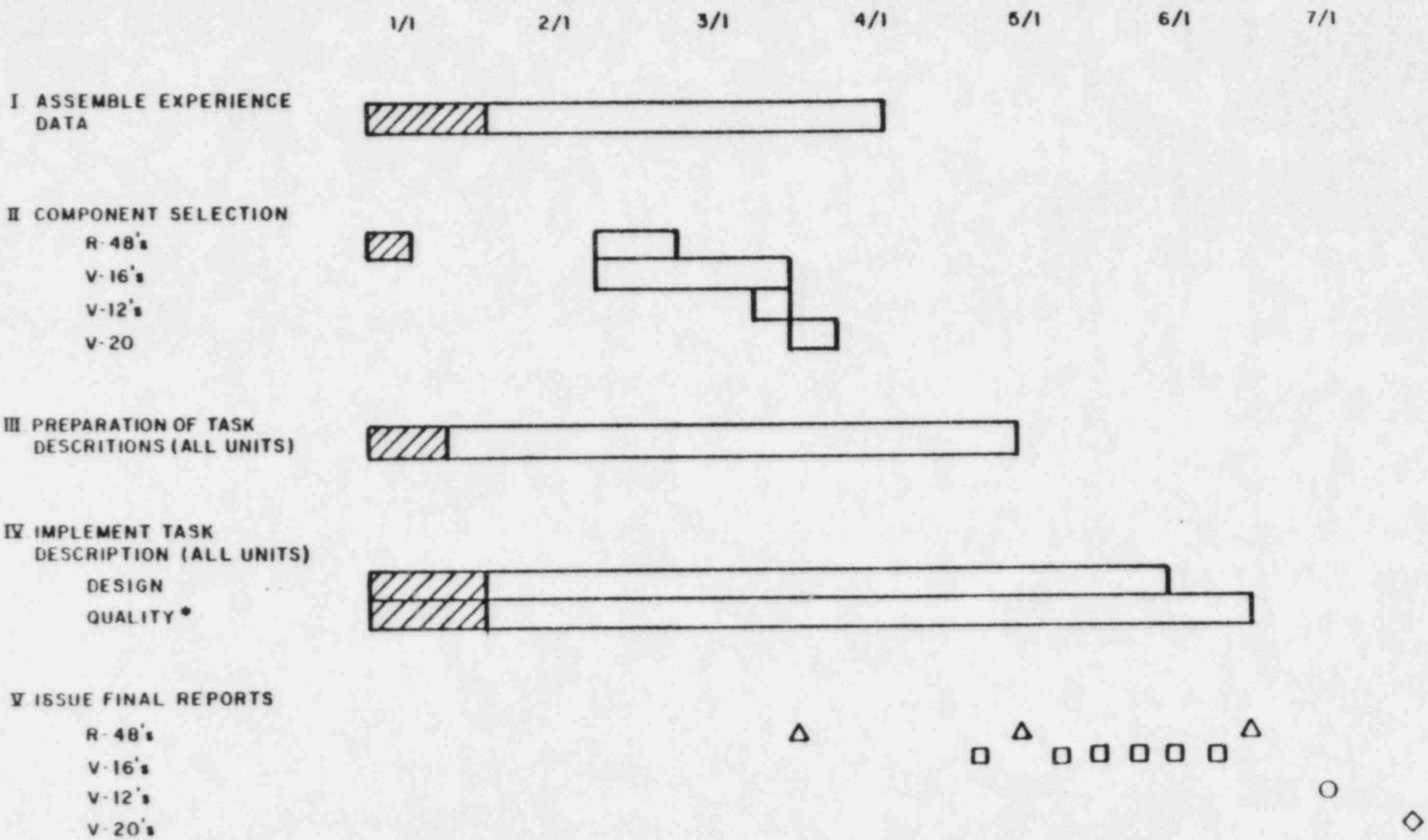
SCHEDULE/STATUS
R48 LEAD ENGINE (SHOREHAM)



SCHEDULE / STATUS
LEAD V-ENGINE (GRAND GULF, V-16)



PRELIMINARY DRQR SCHEDULE (ALL PLANTS)



*INSPECTIONS, NDE, ETC. WILL BE PERFORMED IN ACCORDANCE WITH EXISTING SITE CONSTRUCTION AND S/U TESTING SCHEDULES

INTEGRATED PROGRAM APPROACH

- GENERIC CONCERNS RESOLVED ON LEAD ENGINES
- DESIGN REVIEWS OF LATER ENGINES BUILT ON EARLY UNITS
- SAMPLE INSPECTIONS ON ALL UNITS INCREASE SAMPLE UNIVERSE
- CONFIDENCE BUILDS AS PROGRAM PROGRESSES

GENERIC PROBLEM RESOLUTION

I. PROBLEM: SHOREHAM CRANKSHAFT FAILURES
II. RESOLUTION:

UNIT	ANALYTICAL WORK	CRANKSHAFT TESTING & INSPECTION REQUIREMENTS	HARDWARE CHANGES
R-48 ENGINES:			
SHOREHAM	• HOLZER ANALYSIS • MODAL SUPERPOSITION • FINITE ELEMENT ANALYSIS	• 100 HRS AT 100% POWER-3 ENGINES • NDT INSPECTION OF 3 CRANKSHAFTS • TORSIOGRAPH TEST-1 ENGINE • STRAIN GAUGE TEST-1 ENGINE	• REPLACE 13"x11" CRANKSHAFT WITH 13"x12"
RIVER BEND	• HOLZER ANALYSIS (IF DIFFERENT FROM ABOVE)	• 100 HRS. AT 100% POWER-1 ENGINE • NDT INSPECTION OF 1 CRANKSHAFT • TORSIOGRAPH TEST-1 ENGINE	• NONE
RANCHO SACHO	• HOLZER ANALYSIS (IF DIFFERENT FROM ABOVE)	• TORSIOGRAPH TEST-1 ENGINE	• NONE
V-16 ENGINES:			
GRAND GULF	• HOLZER ANALYSIS	• 100 HRS. AT 100% POWER-1 ENGINE • NDT INSPECTION OF 1 CRANKSHAFT • TORSIOGRAPH TEST-1 ENGINE	• NONE
CATAWBA	• HOLZER ANALYSIS (IF DIFFERENT FROM ABOVE)	• TORSIOGRAPH TEST-1 ENGINE • NDT INSPECTION AFTER PREOP TESTING-1 ENGINE	• NONE
PERRY	• HOLZER ANALYSIS (IF DIFFERENT FROM ABOVE)	• TORSIOGRAPH TEST-1 ENGINE • NDT INSPECTION AFTER PREOP TESTING-1 ENGINE	• NONE
COMMANCHE PEAK	• HOLZER ANALYSIS (IF DIFFERENT FROM ABOVE)	• TORSIOGRAPH TEST-1 ENGINE	• NONE
HARRIS	• HOLZER ANALYSIS (IF DIFFERENT FROM ABOVE)	• TORSIOGRAPH TEST-1 ENGINE	• NONE
VOGTLE	• HOLZER ANALYSIS (IF DIFFERENT FROM ABOVE)	• TORSIOGRAPH TEST-1 ENGINE	• NONE
V-12 ENGINES:			
MIDLAND	• HOLZER ANALYSIS	• TORSIOGRAPH TEST-1 ENGINE	• NONE
V-20 ENGINES:			
SAN ONOFRE	• HOLZER ANALYSIS	• TORSIOGRAPH TEST-1 ENGINE	• NONE

GENERIC PROBLEM RESOLUTION

I. PROBLEM: CONNECTING ROD BEARINGS
II. RESOLUTION

UNIT	ANALYTICAL WORK	CONNECTING ROD BEARING TESTING & INSPECT. REQMTS	HARDWARE CHANGES
R-48 ENGINES			
SHOREHAM	• JOURNAL ORBIT ANALYSIS • FINITE ELEMENT ANALYSIS • FATIGUE/FRACTURE MECHANICS	• 100 HRS AT 100% POWER-3 ENGINES • NDT INSPECTION OF BEARINGS-SAMPLE BASIS- ALL ENGINES	• REPLACE WIDE CHAMBER CONNECTING RODS WITH NARROW CHAMBER CONNECTING RODS REPLACE 11" BEARINGS WITH 12" BEARINGS
RIVER BEND	• JOURNAL ORBIT ANALYSIS (IF DIFFERENT FROM ABOVE)	• 100 HRS AT 100% POWER-1 ENGINES • NDT INSPECTION OF BEARINGS-SAMPLE BASIS- ALL ENGINES	• NONE
RANCHO SACHO	• JOURNAL ORBIT ANALYSIS (IF DIFFERENT FROM ABOVE)	• NDT INSPECTION OF BEARINGS-AFTER PREOP TESTING-SAMPLE BASIS-ALL ENGINES (IF REQUIRED)	• NONE
V-16 ENGINES			
GRAND GULF	• JOURNAL ORBIT ANALYSIS • FINITE ELEMENT ANALYSIS • FATIGUE/FRACTURE MECHANICS	• 100 HRS. AT 100% POWER-1 ENGINE • NDT INSPECTION OF BEARINGS AFTER PREOP TESTING-SAMPLE BASIS-ALL ENGINES	• NONE
CATAWBA	• JOURNAL ORBIT ANALYSIS (IF DIFFERENT FROM ABOVE)	• NDT INSPECTION OF BEARINGS-AFTER PREOP TESTING-SAMPLE BASIS-ALL ENGINES	• NONE
PERRY	• JOURNAL ORBIT ANALYSIS (IF DIFFERENT FROM ABOVE)	• NDT INSPECTION OF BEARINGS-AFTER PREOP TESTING-SAMPLE BASIS-ALL ENGINES (IF REQUIRED)	• NONE
COMMANCHE PEAK	• JOURNAL ORBIT ANALYSIS (IF DIFFERENT FROM ABOVE)	• NDT INSPECTION OF BEARINGS-AFTER PREOP TESTING-SAMPLE BASIS-ALL ENGINES (IF REQUIRED)	• NONE
HARRIS	• JOURNAL ORBIT ANALYSIS (IF DIFFERENT FROM ABOVE)	• NDT INSPECTION OF BEARINGS-AFTER PREOP TESTING-SAMPLE BASIS-ALL ENGINES (IF REQUIRED)	• NONE
VOGTLE	• JOURNAL ORBIT ANALYSIS (IF DIFFERENT FROM ABOVE)	• NDT INSPECTION OF BEARINGS-AFTER PREOP TESTING-SAMPLE BASIS-ALL ENGINES (IF REQUIRED)	• NONE

NOTE:
THE SELECTION OF BEARINGS FOR NDT & DESTRUCTIVE TESTING WILL ENSURE COVERAGE OF THE ENTIRE PERIOD DURING WHICH THE INSTALLED & SPARE BEARINGS IN THE OWNERS' GROUP ENGINES WERE MANUFACTURED. THE OVERALL SAMPLE WILL THEREFORE BE PROPERLY REPRESENTATIVE & THE SAMPLE SIZE WILL BE SUFFUCUENTLY LARGE TO PROVIDE ADEQUATE CONFIDENCE IN ALL THE BEARINGS.

GAGENPROB2

GENERIC PROBLEM RESOLUTION (CON'T.)

I. PROBLEM: CONNECTING ROD BEARINGS
II. RESOLUTION:

UNIT	ANALYTICAL WORK	CONNECTING ROD BEARING TESTING & INSPECT. REQMTS.	HARDWARE CHANGES
V-12 ENGINES:			
MIDLAND	• JOURNAL ORBIT ANALYSIS (IF DIFFERENT FROM ABOVE)	• NDT INSPECTION OF BEARINGS - AFTER PREOP TESTING - SAMPLE BASIS - ALL ENGINES (IF REQUIRED)	• NONE
V-20 ENGINES:			
SAN ONOFRE	• JOURNAL ORBIT ANALYSIS (IF DIFFERENT FROM ABOVE)	• NDT INSPECTION OF BEARINGS - AFTER PREOP TESTING - SAMPLE BASIS - ALL ENGINES (IF REQUIRED)	• NONE

NOTE:
THE SELECTION OF BEARINGS FOR NDT & DESTRUCTIVE TESTING WILL ENSURE COVERAGE OF THE ENTIRE PERIOD DURING WHICH THE INSTALLED & SPARE BEARINGS IN THE OWNERS' GROUP ENGINES WERE MANUFACTURED. THE OVERALL SAMPLE WILL THEREFORE BE PROPERLY REPRESENTATIVE & THE SAMPLE SIZE WILL BE SUFFUCIENTLY LARGE TO PROVIDE ADEQUATE CONFIDENCE IN ALL THE BEARINGS.

GENERIC DESIGN REVIEW AND QUALITY REVALIDATION (DRQR) PROGRAM MATRIX

UNIT	COMPONENT SELECTION	DESIGN/QUALITY REVIEW	HARDWARE INSPECTIONS (SAMPLE OR 100% BASIS)
R-48 ENGINES:			
SHOREHAM	FULL	FULL	• COMMON PARTS • ENGINE UNIQUE PARTS
RIVER BEND	FULL	FULL (MINUS COMMON PARTS)	• COMMON PARTS (IF REQUIRED) • ENGINE UNIQUE PARTS
RANCHO SECO	FULL	FULL (MINUS COMMON PARTS)	• COMMON PARTS (IF REQUIRED) • ENGINE UNIQUE PARTS
V-16 ENGINES:			
GRAND GULF	FULL	FULL (MINUS R-48 COMMON PARTS)	• COMMON PARTS (V-16/R-48 - IF REQUIRED) • COMMON PARTS (V-16) • ENGINE UNIQUE PARTS
CATAWBA	FULL	FULL (MINUS COMMON PARTS)	• COMMON PARTS (IF REQUIRED) • ENGINE UNIQUE PARTS
PERRY	FULL	FULL (MINUS COMMON PARTS)	• COMMON PARTS (IF REQUIRED) • ENGINE UNIQUE PARTS
COMMANCHE PEAK	FULL	FULL (MINUS COMMON PARTS)	• COMMON PARTS (IF REQUIRED) • ENGINE UNIQUE PARTS
HARRIS	FULL	FULL (MINUS COMMON PARTS)	• COMMON PARTS (IF REQUIRED) • ENGINE UNIQUE PARTS
VOGTLE	FULL	FULL (MINUS COMMON PARTS)	• COMMON PARTS (IF REQUIRED) • ENGINE UNIQUE PARTS
V-12 ENGINES:			
MIDLAND	FULL	FULL (MINUS R-48/V-16 COMMON PARTS)	• COMMON PARTS (V-12/V-16/R-48 - IF REQUIRED) • ENGINE AND V-12 UNIQUE PARTS
V-20 ENGINES:			
SAN ONOFRE	FULL	FULL (MINUS R-48, V-16, V-12 COMMON PARTS)	• COMMON PARTS (V-20/V-12/V-16/R-48 - IF REQUIRED) • ENGINE AND V-20 UNIQUE PARTS

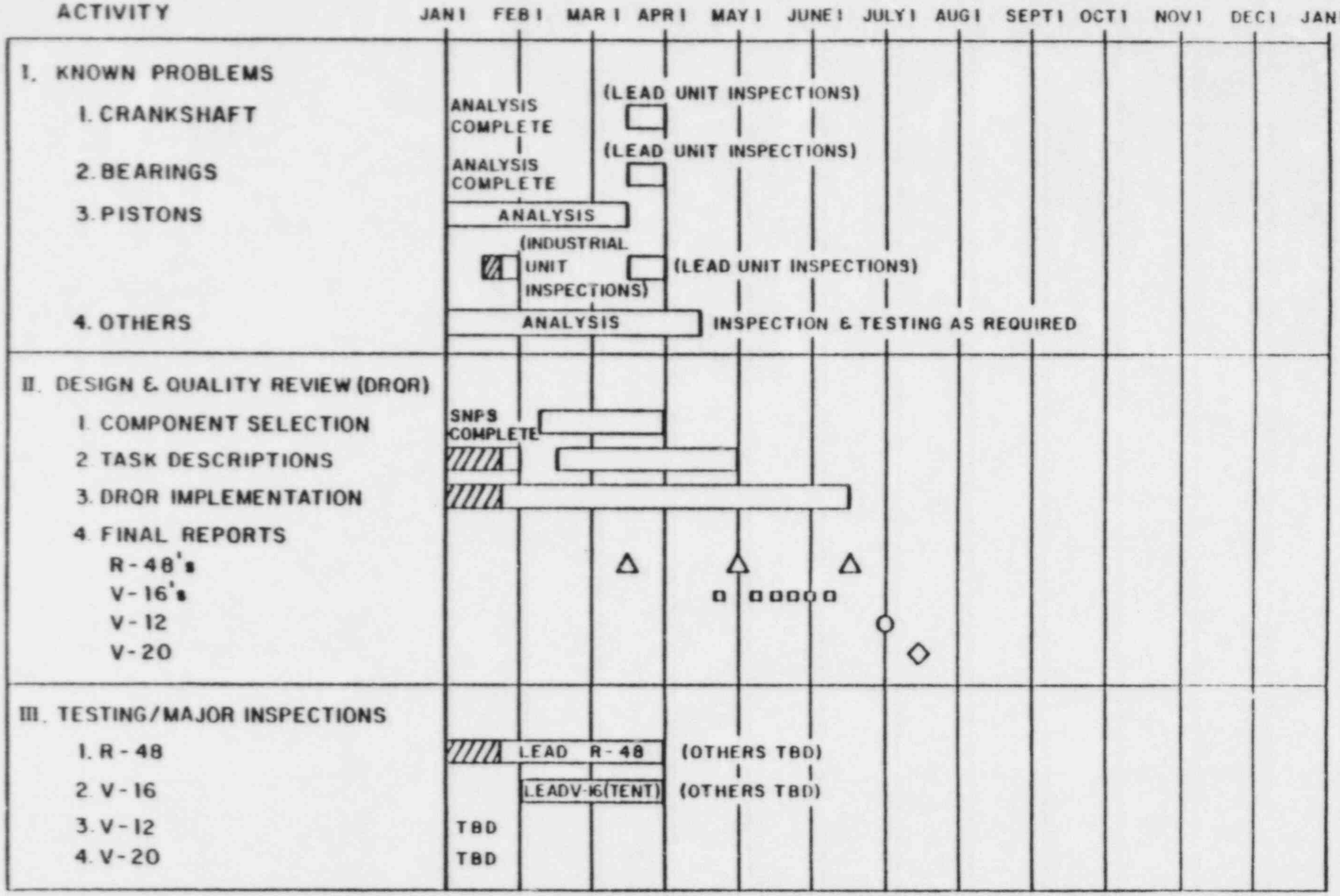
TDI OWNERS' GROUP TESTING PROGRAM SUMMARY

UNIT	PRE-OP TESTS	INSPECTIONS
R 48 ENGINES:		
SHOREHAM	• NRC PREOPS • 100 HRS. AT FULL POWER • SIMULATED LOCA RUN • TOTAL TESTING 300 HRS.	• NDE CRANKSHAFT (ALL ENGINES) • NDE CONNECTING ROD BEARINGS (SAMPLE) • NDE PISTONS (SAMPLE)
RIVER BEND	• NRC PREOPS • 100 HRS. AT FULL POWER (1 ENGINE) • SIMULATED LOCA RUN (1 ENGINE)	• NDE CONNECTING ROD BEARINGS (SAMPLE) • NDE CRANKSHAFT (1 ENGINE - SAMPLE) • NDE PISTONS (SAMPLE)
RANCHO SACHO	• NRC PREOPS	• NDE CONNECTING ROD BEARINGS (SAMPLE)
V-16 ENGINES:		
GRAND GULF	• NRC PREOPS • 100 HRS. AT FULL POWER (1 ENGINE) • ENDURANCE RUN (1 ENGINE)	• NDE CRANKSHAFT (1 ENGINE) • NDE CONNECTING ROD BEARINGS (SAMPLE) • NDE PISTONS (1 ENGINE - SAMPLE)
CATAWBA	• NRC PREOPS	• NDE CRANKSHAFT (1 ENGINE - SAMPLE) • NDE CONNECTING ROD BEARINGS (SAMPLE) • NDE PISTONS (1 ENGINE - SAMPLE)
PERRY	• NRC PREOPS	• NDE CRANKSHAFT (1 ENGINE - SAMPLE, IF REQUIRED) • NDE CONNECTING ROD BEARINGS (SAMPLE, AS REQUIRED) • NDE PISTONS (SAMPLE - IF REQUIRED)
COMMANCHE PEAK	• NRC PREOPS	• NDE CRANKSHAFT (1 ENGINE - SAMPLE, IF REQUIRED) • NDE CONNECTING ROD BEARINGS (SAMPLE, AS REQUIRED) • NDE PISTONS (SAMPLE - IF REQUIRED)
HARRIS	• NRC PREOPS	• NDE CRANKSHAFT (1 ENGINE - SAMPLE, IF REQUIRED) • NDE CONNECTING ROD BEARINGS (SAMPLE, AS REQUIRED) • NDE PISTONS (SAMPLE - IF REQUIRED)
VOGTLE	• NRC PREOPS	• NDE CRANKSHAFT (1 ENGINE - SAMPLE, IF REQUIRED) • NDE CONNECTING ROD BEARINGS (SAMPLE, AS REQUIRED) • NDE PISTONS (SAMPLE - IF REQUIRED)
V-12 ENGINES:		
MIDLAND	• NRC PREOPS	• NDE CRANKSHAFT (1 ENGINE - SAMPLE) • NDE CONNECTING ROD BEARINGS (SAMPLE)
V-20 ENGINES:		
SAN ONOFRE	• NRC PREOPS	• NDE CRANKSHAFT (1 ENGINE - SAMPLE) • NDE CONNECTING ROD BEARINGS (SAMPLE)

TDI OWNERS GROUP SUMMARY SCHEDULE

IX-1

(PRELIMINARY)



REQUIREMENTS FOR LICENSING

1. RESOLUTION OF SIGNIFICANT KNOWN PROBLEMS
   - GENERIC (IF APPLICABLE)
   - ENGINE UNIQUE
2. COMMITMENT TO DRQR PROGRAM
3. COMPONENT SELECTION (DRQR) AND PRELIMINARY REVIEW OF SELECTED COMPONENTS FOR SIGNIFICANT ITEMS
4. COMPLETION OF PREOP TESTING AND ANY ADDITIONAL TESTING (100 HRS. @ FULL POWER FOR SOME UNITS)
5. COMPLETION OF ANY MAJOR INSPECTIONS (CRANKSHAFTS, BEARINGS, AND PISTONS)