UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TEXAS 76011-4005

March 23, 2004

James J. Sheppard, President and
Chief Executive Officer
STP Nuclear Operating Company
P.O. Box 289
Wadsworth, TX 77483

SUBJECT: SOUTH TEXAS PROJECT ELECTRIC GENERATING STATION, UNITS 1 AND 2 - NRC SPECIAL INSPECTION REPORT 05000498/2004-006; 05000499/2004-006

Dear Mr. Sheppard:

On March 4, 2004, the US Nuclear Regulatory Commission (NRC) completed a special inspection at your South Texas Project Electric Generating Station, Units 1 and 2. The enclosed report documents the inspection findings, which were discussed on March 4, 2003, with Mr. G. Parkey and Mr. T. Jordan and other members of your staff.

This special inspection examined your staff's response to the failure of Standby Diesel Generator 22 on December 9, 2003. The inspectors reviewed selected procedures and records, observed activities, and interviewed personnel.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

/RA/

Dwight D. Chamberlain, Director
Division of Reactor Safety

Dockets: 50-498; 50-499
Licenses: NPF-76; NPF-80

Enclosure:
Inspection Report 05000498/2004-06;
05000499/2004-06

cc w/enclosure:
Tom Jordan, Vice President
Engineering & Technical Services
STP Nuclear Operating Company
P.O. Box 289
Wadsworth, TX 77483

S. M. Head, Manager, Licensing
Nuclear Quality & Licensing Department
STP Nuclear Operating Company
P.O. Box 289, Mail Code: N5014
Wadsworth, TX 77483

A. Ramirez/C. M. Canady
City of Austin
Electric Utility Department
721 Barton Springs Road
Austin, TX 78704

L. D. Blaylock/W. C. Gunst
City Public Service Board
P.O. Box 1771
San Antonio, TX 78296

D. G. Tees/R. L. Balcom
Houston Lighting & Power Company
P.O. Box 1700
Houston, TX 77251

Jon C. Wood
Matthews & Branscomb
112 E. Pecan, Suite 1100
San Antonio, TX 78205

A. H. Gutterman, Esq.
Morgan, Lewis & Bockius
1111 Pennsylvania Avenue NW
Washington, DC 20004

C. A. Johnson/A. C. Bakken
AEP Texas Central Company
P.O. Box 289, Mail Code: N5022
Wadsworth, TX 77483

INPO
Records Center
700 Galleria Parkway
Atlanta, GA 30339-5957

Director, Division of Compliance
& Inspection
Bureau of Radiation Control
Texas Department of Health
1100 West 49th Street
Austin, TX 78756

Brian Almon
Public Utility Commission
William B. Travis Building
P.O. Box 13326
1701 North Congress Avenue
Austin, TX 78711-3326

Environmental and Natural
Resources Policy Director
P.O. Box 12428
Austin, TX 78711-3189

Judge, Matagorda County
Matagorda County Courthouse
1700 Seventh Street
Bay City, TX 77414

Terry Parks, Chief Inspector
Texas Department of Licensing
and Regulation
Boiler Program
P.O. Box 12157
Austin, TX 78711

Susan M. Jablonski
Office of Permitting, Remediation and Registration
Texas Commission on Environmental Quality
MC-122, P.O. Box 13087
Austin, TX 78711-3087

Ted Enos
4200 South Hulen
Suite 630
Fort Worth, TX 76109

Electronic distribution by RIV:
Regional Administrator **(BSM1)**
DRP Director **(ATH)**
DRS Director **(DDC)**
Senior Resident Inspector **(JXC2)**
Branch Chief, DRP/A **(WDJ)**
Senior Project Engineer, DRP/A **(TRF)**
Staff Chief, DRP/TSS **(PHH)**
RITS Coordinator **(NBH)**
Rebecca Tadessee, OEDO RIV Coordinator **(RXT)**
STP Site Secretary **(LAR)**

ADAMS: ☐ Yes ☐ No Initials: ______
☐ Publicly Available ☐ Non-Publicly Available ☐ Sensitive ☐ Non-Sensitive

SRI:PEB	RI:EB	RI:PBA	SRA	C:EB	C:PBA	C:EB
NO'Keefe/lmb	WSifre	GGuerra	MRunyan	CSMarschall	WDJohnson	CSMarschall
/RA/ E	/RA/	/RA/	/RA/	/RA/	/RA/	/RA/
03/23/04	03/11/04	3/16/04	3/19/04	3/19/04	3/19/04	3/22/04

OFFICIAL RECORD COPY T=Telephone E=E-mail F=Fax

ENCLOSURE

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

Dockets:	50-498; 50-499
Licenses:	NPF-76; NPF-80
Report No.:	05000498/2004-006; 05000499/2004-006
Licensee:	STP Nuclear Operating Company
Facility:	South Texas Project Electric Generating Station, Units 1 and 2
Location:	FM 521 - 8 miles west of Wadsworth Wadsworth, Texas
Dates:	December 15, 2003, through March 4, 2004
Inspectors:	N. O'Keefe, Senior Reactor Inspector (Team Leader) G. Guerra, Resident Inspector W. Sifre, Reactor Inspector
Approved By:	Charles S. Marschall, Chief Engineering Branch

SUMMARY OF FINDINGS

IR 05000498/2004-006; 05000-499/2004-006; January 31, 2004; South Texas Project Electric Generating Station, Units 1 and 2: Special Team Inspection Report. Problem identification and resolution, event response, operability evaluations, and post-maintenance testing.

This report covers a special inspection that reviewed the failure of Standby Diesel Generator 22 and assessed the licensee personnel's response to the failure. This inspection team was composed of a resident inspector and two region-based engineering inspectors. No findings were identified. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 3, dated July 2000.

Summary of Event and Inspection Results

On December 9, 2003, shortly after reaching full load during a monthly surveillance run, Standby Diesel Generator 22 experienced a sudden, catastrophic failure on the No. 9 master connecting rod. The resulting damage ejected parts, damaged the engine casing, and ruptured both the lube oil header and shutdown air lines. The engine continued to run for 6 minutes without lubrication before being manually shut down, since most means of shutdown were inoperative due to the damage sustained.

The inspection team determined that the licensee personnel's root-cause assessment was prompt and reached an appropriate conclusion based on factual data. However, it was not completely rigorous in evaluating human performance, comparing actual damage to the theorized chain of events, or in looking at multiple or contributing causes. Corrective actions to prevent recurrence, particularly periodic monitoring, were appropriate.

Overall, operator response was appropriate, and neither caused nor contributed to the failure. Poor communications conditions and limited control room instrumentation for the diesel limited the control room operators' understanding of what had happened. As a result, their efforts to plan, coordinate, and control the response to the diesel problem resulted in unnecessarily having people in a hazardous location.

Operator performance contributed to a delay in shutting down the engine, but did not affect the outcome. Condition Report 04-3260 was written to address the operator knowledge issues. Condition Report 03-18103 was the primary corrective action program document used to address this event.

The licensee's programs for maintenance, testing, and performance monitoring of the standby diesel generators were appropriate, met applicable requirements, and did not contribute to this failure. The cause of the failure was pre-existing microcracks in the connecting rod that slowly combined into a macroscopic crack and propagated to the point of structural failure through fatigue. This condition was not detectable by the normal manufacturing or in-service inspections. Based upon these conclusions, no performance deficiency was identified as a result of this inspection.

Licensee personnel aggressively developed a nondestructive examination technique to verify that no macroscopic cracks existed in other connecting rods. These inspections were promptly completed in each of the connecting rods for all diesels, eliminating concerns about the potential for a common failure mode in the other five engines.

Additional inspection outside the scope of this special inspection is planned for Standby Diesel Generator 22. A region-based inspection of permanent modifications made to the engine during the course of repair will be performed as part of the baseline inspection prior to the engine returning to service. Also, the post-maintenance testing program to demonstrate operability of the system will be inspected on a sample basis by the resident inspectors as part of the baseline inspection program.

No performance deficiencies or violations of NRC requirements were identified.

NRC-Identified and Self Revealing Findings

No findings of significance were identified.

REPORT DETAILS

REACTOR SAFETY

1.0 SPECIAL INSPECTION SCOPE

The NRC conducted this special inspection to better understand the circumstances surrounding the failure of Standby Diesel Generator 22, and whether it was related to an earlier failure of the same engine in 1989. This inspection reviewed the cause of the diesel failure, the extent of the condition, the potential generic implications, and the corrective actions proposed by the licensee personnel. The team used NRC Inspection Procedure 93812, “Special Inspection Procedure,” to conduct the inspection. The special inspection team reviewed procedures, corrective action documents, and design and maintenance records for the equipment of concern. The team interviewed key station personnel regarding the event, the root-cause analysis, and corrective actions. A list of specific documents reviewed is provided in Attachment 1. The charter for the special inspection effort is provided as Attachment 2.

2.0 SYSTEM AND EVENT DESCRIPTION

2.1 System Description

Standby Diesel Generator 22 is a 20-cylinder, V-type turbo-charged engine, Model KSV-20, supplied by Cooper Energy Services. The engine operates at 600 rpm and has a rated output of 5500 kW. The engine was manufactured in 1979. The failed connecting rod was a KSV-4-2A assembly with two connecting rods, a master and an articulated rod. This arrangement allows two cylinders to be connected to the crankshaft on a single bearing. The twin cylinders operate on opposite portions of the 4-stroke cycle. The configuration is shown in the diagram in Attachment 3.

The failure occurred in the ligament between the articulated rod bushing and the main crankshaft throw journal. The primary failure caused the articulated bearing straps to subsequently fail due to overload. The failed component was forged from AISI 1050 steel, which was quenched and tempered.

Each of the two units at the South Texas Project Electric Generating Station had three standby diesel generators to provide emergency power to its respective train of safety-related equipment in the event that normal power was not available from offsite. The diesel generators are normally in a standby condition, although they are run monthly for approximately 4 hours for routine testing, as well as infrequently for other purposes.

The South Texas Project design for the standby diesel generator and support systems is typical of KSV engines, but some design features differed from other nuclear-application emergency diesel generators in some ways that were important to this event. In order to shut down the engine automatically, remotely, or by some of the local manual methods, nonsafety-related shutdown air pressure must be available. This was designed to maximize engine availability to perform its safety function, since the engine would not trip if air pressure was inadvertently lost while the engine was running. If this air source is not available, the engine can only be shut down locally by either securing the fuel source or by securing the combustion air source. Also, the engine had very few parameters that could be monitored by the plant computer or displayed in the main control room, so many potential problems must be diagnosed locally.

2.2 Event Description

On December 9, 2003, Standby Diesel Generator 22 experienced a significant mechanical failure during testing that resulted in ejection of a connecting rod. Unit 2 operators were conducting a monthly surveillance on Standby Diesel Generator 22. At 10:20 a.m., the diesel reached a fully loaded condition. A trouble alarm at 10:38 a.m. indicated that the diesel had low lube oil pressure and the output breaker had tripped open. Control room operators attempted unsuccessfully to shut down the engine from the control room. Equipment operators in the diesel room also made several unsuccessful attempts to shut down the engine before successfully shutting off the fuel supply to the diesel. Because of reports of smoke in the diesel room, the fire brigade responded, but reported that they found no flames. The diesel had ejected part of a piston, the articulating rod, and other parts from the No. 9R and 9L cylinders.

Unit 2 was operating at full power during this event. The engine failure had no effect on plant operations or other equipment.

2.3 Preliminary Significance of Events

The NRC staff considered both deterministic and safety significance criteria, established in NRC Management Directive 8.3, “NRC Incident Investigation Program,” to determine whether a special inspection would be performed. The NRC staff determined that the following two deterministic criteria were met: (1) the diesel generator failure involved possible adverse generic implications, and (2) the failure appeared to involve repetitive failures of safety-related equipment.

An NRC senior reactor analyst performed a preliminary risk assessment using the NRC's Standard Plant Analysis Risk (SPAR) Model, Revision 3i, and the SAPHIRE (GEM) software. The risk assessment conservatively assumed that the diesel generator failure was the result of a common cause failure mechanism. The exposure time of the condition was unknown, but was estimated as one-half of the time since the previous surveillance test, or 15 days. This resulted in an incremental conditional core damage probability (ICCDP) of 4.7E-6. This result would increase if the exposure time included the chronological time that had passed since the accrued run time exceeded the diesel mission time. The result would diminish if the failure was determined to have resulted from an independent failure mechanism.

This ICCDP was within the band for a special inspection. Based on deterministic criteria that were met and the ICCDP value, NRC management determined that a special inspection was warranted, as provided for in the reactor oversight program to further examine the circumstances surrounding the failure.

3.0 Special Inspection Areas

3.1 Sequence of Events and Operator Response (Charter Items 1 and 2)

a. Inspection Scope

The team developed a sequence of events and evaluated operator response to the failure. The team reviewed the plant procedures for engine operation and surveillance testing, as well as alarm response procedures associated with the standby diesel generators. Plant computer printouts and operator logs were reviewed. Specific documents reviewed are listed in Attachment 1. The team walked through the sequence of events with the plant operator who was running the engine locally in the engine room on December 17, 2003. The team also conducted interviews with operators involved in the event and subsequent response, as well as with the fire brigade leader.

b. Findings and Observations

Sequence of Events

On December 9, 2003, Unit 2 operators were conducting a monthly surveillance on Standby Diesel Generator 22. At 10:20 a.m., the diesel reached a fully loaded condition. A trouble alarm at 10:38 a.m. indicated that the diesel had low lube oil pressure and the output breaker had tripped open. As the local operator was taking logs on the right side of the engine, the No. 9 master connecting rod had failed suddenly. This resulted in the articulated connecting rod and its piston being ejected through the engine casing on the left side of the engine, carrying away an inspection cover and some casing structure around it. The parts were ejected at the same location where shutdown air tubing ran up the outside of the engine casing; these lines were damaged, causing loss of pressure in the shutdown air system. The master connecting rod was forced downward crushing the main lube oil header in the sump, which caused the header to rupture and depressurize the lube oil system. The low lube oil pressure initiated automatic trips of the generator output breaker (which were successful) and the engine (which did not occur because of loss-of-shutdown air pressure).

The plant operator immediately left the engine room, going into the adjacent stairwell. The operator was not in a position to see what happened, but was responding to the loud noise caused by the failure.

The licensed operator operating Standby Diesel Generator 22 from the control room observed conflicting indications that the engine and generator breaker had tripped and that the engine was still running. A diesel trouble alarm was received, but this was an alarm that could be caused by a number of conditions, which were not individually indicated in the control room. Control room operators attempted radio communications with the plant operator, but transmissions were difficult to understand due to the noise of the engine and the excited state of the plant operator. Because of the loss of lube oil pressure, the control room operator attempted unsuccessfully to shut the diesel down from the control room. Two senior licensed operators were dispatched to the engine room, and several plant operators listening to the radio conversations also went to the engine room without instructions to do so. The operators in the engine room also attempted unsuccessfully to shut down the engine using the local emergency stop pushbuttons multiple times.

Multiple attempts to shut the engine down by operating the plunger to shut the air intake butterfly valve were unsuccessful (this also required shutdown air pressure to function). Simultaneous efforts to shut the fuel racks and shutoff the fuel supply were successful in shutting down the engine. Because of reports of smoke and oil fumes in the diesel room, the fire brigade responded, but reported that they found no fire. The licensee fire brigade leader reported to the control room that the engine had ejected part of a piston, the articulating rod, and other parts. They also reported an oil mist and oil on the floor. The engine was quarantined to avoid disturbing evidence until an investigation team could be assembled.

Operator Response

The team concluded that operators responded appropriately to the event. Procedures were followed to the extent that they applied to the situation. However, the team noted that most of the operators that were not required in the control room quickly went to the engine room and assisted in shutting down the engine when it was clear that there was difficulty shutting the engine down. This included one fire brigade member. The control room operators did not have a clear understanding of what had happened, and were not planning, coordinating, and controlling the response the diesel problem. This resulted in unnecessarily having people in a hazardous location.

Communications were difficult during the event because the high noise made communications by radio difficult to understand. Radios were used almost exclusively during the event, whereas, communications from the engine rooms are normally made via sound powered phones designed for high noise areas. Also, the indications available on the plant computer and installed instrumentation in the control room were very limited, and almost exclusively associated with the generator rather than the engine. The majority of the indications are only available locally. The combination of lack of control room indications and poor communications hampered diagnosis and response efforts in the control room.

The team noted that procedures and training provided to the operators indicated that shutting the fuel racks required significant physical force to overcome the governor operating force, as well as holding it shut for about a minute. This was not the case, as the operator who eventually shut the fuel racks reported that it was not difficult, and the engine began coasting down immediately. This misconception played a part in the decision of the local plant operator to go upstairs to shut the fuel isolation valve, rather than attempt to shut the fuel off closer to the engine at the fuel racks.

An automatic trip should have occurred due to the low lube oil pressure. It did not occur because the initial damage severed the air lines required to accomplish a shutdown. The operators did not recognize that the automatic and remote trips were not working because of the design and damage, and repeatedly attempted to trip the engine even when earlier attempts were unsuccessful. This delayed getting the engine shut down and may have increased the ultimate damage somewhat, but did not change the overall outcome of the event.

The fire brigade was called out due to the smoke/oil mist and fire hazard present. It appears that the fire brigade response was appropriate. The fire brigade leader appropriately took charge of the affected area, stationed personnel to guard against a fire starting, and inspected adjacent areas for fire and injured personnel. Appropriate protective gear was used. At least one member of the fire brigade that actually dressed out was not part of the team designated to be a member that day. As an extra operator that day, the individual decided to help out. This added somewhat to the confusion at the scene of the event, but was fortuitous because one of the designated fire brigade members had decided earlier to go to the engine room and assist in shutting down the engine and did not go to the fire brigade assembly area.

Overall, operator response was appropriate, and neither caused nor contributed to the failure. Poor communications conditions and limited remote indications limited the control room operators' understanding of what had happened. As a result, their efforts to plan, coordinate, and control the response to the diesel problem resulted in unnecessarily having people in a hazardous location. Operator performance contributed to a delay in shutting down the engine, but did not affect the outcome. Condition Report 04-3260 was written to address the operator knowledge issues. Condition Report 03-18103 was the primary corrective action program document used to address this event.

3.2 Root-Cause Assessment, Corrective Actions, and Generic Applicability (Charter Item 3, 4, 8 and 9)

a. Inspection Scope

The team reviewed the scope and processes used by the licensee personnel to identify the root cause of the failure. The team evaluated the licensee personnel's ongoing efforts to assess common mode failure potential and extent of condition for the other standby diesel generators.

The team evaluated the results of nondestructive examination performed by the licensee personnel at the site and the Energy Development Center for applicability to the root cause of this event. The team observed the performance of ultrasonic examination performed on all connecting rods of the remaining five standby diesel generators to verify operablity, as well as the nondestructive examination performed on the remaining Standby Diesel Generator 22 connecting rods to help determine the extent of condition.

The team held discussions with the licensee's root-cause investigation team that was charged with defining the problem, collecting evidence, and performing a fault-tree analysis. The licensee's team was augmented with industry consultants. The team reviewed sequence of events, operator performance, operating experience in the industry, as well as the mechanical and metallurgical issues associated with this event.

The team examined the engine parts and failure locations. The results of these observations were compared with the licensee personnel's evaluation of the sequence of events and root-cause determination. The team reviewed the results of the licensee personnel's analyses of fuel and lube oil, the maintenance history of Standby Diesel Generator 22, plant computer data, performance monitoring data, and engine operating logs. The plant operator, who was operating the engine locally, was interviewed to determine whether unusual sounds, vibrations, or operating parameters existed prior to the failure. The team reviewed material examination records to determine whether the installed parts were the proper material and had the required properties. Fasteners and the associated bearings/joints were examined to determine whether loss of pre-loading was involved.

The team reviewed industry operating experience to see if there was a history of similar failures or existing preventive action recommendations for this failure mechanism. The team also reviewed the 1989 failure of a connecting rod in Standby Diesel Generator 22 for similarities in root cause, common failure modes, and the scope and effectiveness of corrective actions.

b. Findings and Observations

Root-Cause Assessment

The licensee's root-cause evaluation team used a fault-tree analysis method, which was appropriate for evaluating an equipment failure. This is not a method, however, that is useful in evaluating human performance aspects of an event. This aspect was part of the root-cause assessment, but was not performed using a formal root-cause evaluation technique. The root-cause assessment was not as rigorous in evaluating human performance as it was with the equipment failure, and identified no issues or recommendations in this area. As discussed in Section 3.1 above, the team identified a number of observations related to human performance.

The team also noted that with respect to the methodology, the root-cause assessment was not completely rigorous. In using the fault-tree methodology, discreet causes are hypothesized, and then each possibility is evaluated based on available evidence. The licensee personnel's evaluation did not consider the possibility of multiple or contributing causes. Also, the licensee personnel did not attempt to examine the full scope of the damage and reconcile the individual elements with the expected chain of events to ensure that all the causes were identified.

The licensee personnel placed appropriate priority on identifying a failure cause and using that information to assess the potential for common mode failure among the remaining standby diesel generators. This involved a considerable effort in performing metallurgical examinations and evaluations at an offsite lab. The interim basis for concluding that the other standby diesel generators were not affected was documented and presented to appropriate operations personnel. However, the team noted that the licensee did not follow their normal administrative procedures and write a Tracking Limiting Condition for Operation to track the issue until a final determination was complete. This was discussed with the operations manager, but it involved a departure from a local administrative process rather than a regulatory requirement.

The licensee personnel concluded that the root cause of the failure was high cycle, low stress fatigue made possible by pre-existing microcracking below the surface at a location of stress concentration. This conclusion was factually supported with scientific evidence. However, the mechanism that induced the microcracking (a high-energy process such as tool chatter) and the presumption that it occurred at the time of manufacturing were considered by the team as best-estimate information, since there was no evidence to either confirm or refute these theories. The team reviewed the manufacturing processes for the connecting rods, and they did not appear to include a process where tool chatter would have occurred and gone undetected. The ability to date the crack initiation is limited, although the crack propagation clearly went back for years. Fatigue theory was used to date the initiation back to near the time of manufacture, and this appeared reasonable.

Fatigue is a cumulative damage phenomenon. It is caused by repeated cyclic load applications, none of which is sufficient by itself to cause failure. The crack initiates and progresses over time until the remaining uncracked cross section can no longer support the operating stresses. At that time, complete failure occurs due to overload of the remaining uncracked cross section. In this case, a cyclic load was applied once each firing cycle (two revolutions) when compressive stresses were applied from piston firing, and tensile stresses were applied at the top of the exhaust stroke as the mass of the unloaded piston must quickly reverse direction at top dead center.

The licensee was able to use a finite-element stress analysis performed following the 1989 Standby Diesel Generator 22 connecting rod failure to assess this failure. This analysis demonstrated that the ligament between the master and articulated rod bearings is an area of stress concentration, although the stresses were within the material capabilities with a suitable factor of safety for fatigue considerations. However, post-failure examinations identified that the material had a small volume with a large number (estimated to be hundreds to thousands) of extremely small cracks. These cracks were located just below the bearing bore surface on the main bearing side of the ligament. Some of the microcracks grew together during 2100 hours of operation (over 20 million stress cycles), and then propagated across the cross-section of the ligament. This long time to fail was unusual, since experience with fatigue would normally indicate that a fatigue failure would occur within about 10 million stress cycles if it were going to occur at all.

The team independently assessed the cause of the primary failure in Standby Diesel Generator 22 using the fault tree developed by the root-cause team and their consultants. Inspection team members examined engine parts that had been installed in the No. 9R and 9L positions. These included pistons, cylinders, water jackets, connecting rods, bearings, and engine casing parts. The team looked for evidence of wear, excessive heating, deformities, cracks, etc. Indications of secondary damage were evident in many of these parts. However, there was no evidence (besides the fracture surface) of pre-existing problems. There was no heat damage due to inadequate lubrication, unusual wear or scratches, deformed guide holes, etc. Fracture surfaces showed clear signs of failure due to overload in every case except the master connecting rod, which showed signs of fatigue failure.

The team noted that the bolts connecting both piston pins to their respective connecting rod were not holding the pin in contact with the rods. In each case, there was nearly a ½-inch gap. These were required to be torqued to 1200 ft-lbs, and should not have been loose. The team noted that the licensee's root-cause investigation had not identified this condition or identified a failure mechanism associated with bolting issues. The team questioned whether this condition was a result of the event or a possible cause. The root-cause team reconvened to evaluate this condition.

The bolts were removed and analyzed. They were determined to have elongated about 3/8-inch. The bolts were the correct material within the nominal properties. The material was determined to have enough ductility to have yielded in this fashion. The licensee concluded that this was a result of the event, rather than a condition that initiated the event. Evidence in support of this included the fact that under-torqued bolts have been known to cause failures within a few hours of initial operation, while these bolts had not been disturbed in years. Also, elongation of the bolts during operation would have caused the pistons to contact the firing deck at the top of each stroke; while both pistons had some head damage, the firing decks did not, so the piston damage must have been due to event-related relocation (both pistons and both cylinder liners received major damage). The team agreed with the conclusion that the piston pin bolts were elongated as a result of the event, rather than a cause.

The inspection team reviewed the results of the licensee’s analyses of fuel and lube oil. The team reviewed the maintenance history of Standby Diesel Generator 22, plant computer data, performance monitoring data, and engine operating logs, which contained no indication of a problem or negative trend. The plant operator who was operating the engine locally was interviewed to determine whether unusual sounds, vibrations, or operating parameters existed prior to the failure. There were no indications that anything was abnormal until the failure occurred suddenly. The lack of abnormal noises and vibrations would eliminate the possibility of loss of large parts. The team reviewed material examination records to determine whether the installed parts were the proper material and had the required properties, and no unexplained results were identified (there were some explainable deviations due to the progression of the event, which were clearly results rather than causes). Fasteners and the associated bearings/joints were examined to determine whether loss of pre-loading was involved, and no problems were identified - each bolt that failed was due to sudden overloading. There was no evidence of foreign material intrusion in examinations of components or in oil, although there was water in the oil after the event, which is explained by the damaged water jackets. All generator parameters and engine auxiliaries were performing as expected based on data review.

The engine was not subjected to either overspeed or overload conditions. Overheating was in evidence in most moving parts of the engine, but not in No. 9R or 9L. This was because the initial failure in this location damaged the main lube oil supply header, so no pressure was available to supply oil to the loads, and water was mixing with the oil reducing the lubricating properties, so the loads became overheated while the engine continued to run. The No. 9R and 9L bearings did not show evidence of heating because they had already disassembled themselves before the loss of lube oil occurred.

The test procedure in use had been revised 2 months earlier. The team reviewed the scope of procedure changes in the preceding 12 months, and none was substantive. The team determined that the operating procedure and philosophy were consistent with the recommendations of both the vendor and the users group. South Texas Project was actively involved in the Cooper-Bessemer Owner’s Group with the goal of maximizing the reliability of their standby diesel generators.

Corrective Actions

The licensee personnel removed the standby diesel generator and sent it offsite to be repaired under their Appendix B maintenance program. At the same time, the engine and generator were to be fully inspected and refurbished. The engine casing was repaired. The cracked shaft was replaced and its alignment optimized. Maintenance personnel replaced 9 of the 10 connecting rods with new and refurbished rods. Each of the rods being installed in the refurbished engine was inspected by enhanced visual, florescent magnetic particle, eddy current, and phased array ultrasonic examination techniques. The bearing bore surfaces were machined to optimize the surface condition and eliminate possible crack initiation sites. Technicians implemented an improved bolt torquing method in order to improve bearing pre-load and provide an even stress distribution in the connecting rods. The licensee planned to perform periodic nondestructive re-examination of the connecting rods (approximately every 500 run-hours) until the rods were past the period of susceptibility to fatigue crack initiation.

During the course of the repair work, some permanent changes were made. These included enlarging bearing bores, changing tolerances, and changing torquing techniques. These changes were outside the intended scope of this inspection, but were of interest as part of the corrective actions for this event. These modifications will be reviewed prior to Standby Diesel Generator 22 returning to service as part of the baseline inspection under Inspection Procedure 77111.17B, "Permanent Plant Modifications."

Generic Applicability

The team noted that the protection mechanisms against this type of failure are proper design, material selection, and post-fabrication nondestructive examination. Since these microcracks were not detectable (either because they were too small or because they were too far below the surface), and no periodic inspections are required, recommended, or performed by the industry, this failure mechanism could exist in other engines.

Thirty-six of the 55 Cooper-Bessemer KSV engines were used in nuclear emergency diesel generator applications. The average nuclear-application engine had about 2100 run-hours at the time of this inspection, based on data from MPR Associates. This means that there is a possibility that a similar condition could exist and failure could occur. However, it is expected that after about 1100 run-hours, an engine would have sufficient load cycles to have completed the incubation period and start to develop a detectable crack (if the right nondestructive examination technique were used). As a crack in this location propagates, the licensee's finite element stress analysis indicated that the stress at the crack tip drop, but crack growth rate increases. In many fatigue failures, the crack tip stresses increase, so crack propagation would be faster. The low propagation rate, combined with the limited nuclear-application engine operating profile combined to cause the crack formation and propagation to occur over a very long period. However, some non-nuclear experience tended to reinforce this experience.

From the non-nuclear applications for KSV engines, the run-hours were orders of magnitude higher. However, very few connecting rod failures were reported. Of those, a dredge experienced four connecting rod failures in three of its engines. The locations of the failure initiation points were similar, and the failures were attributed to high cycle fatigue. In each case, no detectable metallurgical flaw was observed, so the initiation point was presumed to be minor surface conditions. These failures occurred during a 2½ year period. One of the failure reports noted that the failure occurred after 45,500 run-hours, and 3,000 run-hours after an engine overhaul. If these failures were truly similar to the Standby Diesel Generator 22 failure, it could be concluded that a very small discontinuity could develop into a crack and ultimate fatigue failure over a long period of time. This would reinforce the evidence that the Standby Diesel Generator 22 crack grew slowly over an unusually long period of time.

The team concluded that similar failures in other Cooper-Bessemer KSV engines in the nuclear industry could occur. Other engines in use at nuclear facilities had an average number of run-hours that was very close to the run-hours on Standby Diesel Generator 22 when it failed. The crack initiated and propagated over a considerable length of time, and would have been detectable for a period of years if nondestructive examinations were performed. However, periodic examinations of connecting rods were not part of the vendor-recommended maintenance program for these engines. The licensee has shared information regarding the connecting rod failure with other nuclear facilities owning KSV engines through the Cooper-Bessermer owners group.

3.3 Determination of Extent of Condition (Charter Items 4 and 7)

a. Inspection Scope

The team reviewed the licensee personnel's new procedures developed for the nondestructive examination on the emergency diesel generator connecting rods. The team reviewed the qualifications for the personnel performing the examinations and observed the examination process to verify that it was capable of consistently detecting flaws of the type and location of concern. The team also reviewed the metallurgical analysis report for the failed connecting rod and examinations performed on the other connecting rods from Standby Diesel Generator 22.

b. Findings and Observations

Introduction

The licensee aggressively developed a nondestructive examination technique to verify that no macroscopic cracks existed in other connecting rods. These inspections were promptly completed in each of the connecting rods, eliminating concerns about the potential for a common failure mode in the other five engines.

Nondestructive Examinations

To determine whether a potential for a common mode of failure existed in other standby diesel generator connecting rods, technicians performed ultrasonic examination with a phased array probe to examine the critical portions of all of the connecting rods from each of the six standby diesel generators. This used the same method that was developed and utilized by South Texas Project for the bottom mounted instrument nozzle examinations performed in Unit 2. The same probe element was used although modified slightly. The probe is a 31-element array probe mounted on a polymer wedge. The only modification made to the probe was a shortening of the polymer wedge to ensure optimum angle for the examination of the area of interest on the connecting rods.

To qualify the examination methodology, technicians created demonstration test indications in a spare connecting rod that were similar in size, location, and geometry to the crack observed in the failed connecting rod. These indications were then utilized to refine and qualify their examination technique. The inspector observed the qualification of the instruments and the operators, which demonstrated that the simulated flaws could be consistently detected. On December 18 and 19, 2003, the team observed the inspection of all of the remaining connecting rods from Standby Diesel Generator 22, as well as the inspection of the connecting rods in Standby Diesel Generators 21 and 23 in Unit 2 and 11, 12, and 13 in Unit 1. No cracks or flaws were identified.

On January 21, 2004, the team reviewed the metallurgical analysis for the failed connecting rod. The inspector observed analytical samples from the failed rod under high magnification in both visual and electron microscopes. These samples clearly displayed classic striations indicative of cyclic fatigue. The analysts also pointed out additional microcracks and deposits that resulted from the continued operation after loss of lubrication.

Based on the examination of the in service connecting rods and the failure analysis of the failed rod the licensee personnel concluded that the fatigue failure was an isolated occurrence and that the remaining in-service rods were free of cracks. This eliminated the concern that there was a potential for common mode failure of standby diesel generators from the failure mechanism. The team concluded that the licensee’s examinations were thorough and that the conclusions drawn were reasonable.

3.4 <u>STP and Industry Operating Experience and Potential Precursors</u> (Charter Item 3)

a. Inspection Scope

The team reviewed industry operating experience to see if there was a history of similar failures in emergency diesel generators or existing preventive action recommendations for this failure mechanism. This included experience outside the nuclear industry for the Cooper-Bessemer KSV-16 and KSV-20 engines (same design, but 16 and 20 cylinder variants, respectively).

b. Findings and Observations

The team reviewed documentation on the 1989 failure of Standby Diesel Generator 22. That failure involved a high-cycle fatigue failure of the ligament between the master and articulated connecting rod bearings also, but in the No. 4 position. The failure occurred with only 634 run-hours on the engine, 10 hours into a 24-hour run. This failure was preceded by loud noises shortly before failure, and the engine successfully tripped automatically without loss of lubrication. Parts were ejected in a very similar way to the current failure. However, analyses by multiple independent sources concluded that the initiation site was an improperly drilled and repaired lubrication hole that created a stress riser. As a defect clearly created (and documented) by the manufacturing process, the licensee personnel's corrective actions were limited to confirming that his condition did not exist in the other connecting rods onsite.

The team reviewed industry operating experience. Fifty-five Cooper-Bessemer KSV engines were manufactured. Of these, 36 entered service in the nuclear power industry. The ones remaining in service have an average of about 2100 run-hours, which matches the run-hours for Standby Diesel Generator 22. At South Texas Project, Standby Diesel Generator 22 had the largest number of run-hours. Among the nuclear engines, only the two failures in Standby Diesel Generator 22 and one other were reported. The one at another station involved improper drilling also. Among non-nuclear KSV engines, the operating history has far more run-hours, with several failures on three engines in a dredge. These failures occurred with considerable more run-hours on the engines. Although the locations of initiation and failure by fatigue were similar, no metallurgical defects were found. The owner implemented corrective actions to inspect and surface-harden the connecting rods to make them more resistant to crack initiation.

3.5 <u>Preventive Maintenance Program and Maintenance History</u> (Charter Items 5 and 6)

a. Inspection Scope

The team reviewed the licensee's program for performance monitoring and preventive maintenance of the standby diesel generators, including inspection and assessment techniques, scope, periodicity, trending, and the results of past inspections. The team reviewed records of the licensee personnel's implementation of the Cooper-Bessemer Owners Group recommendations including changes made to the vendor's maintenance manual.

b. Findings and Observations

The team reviewed changes that the licensee personnel had made to the vendor's maintenance recommendations to see if these changes played a role in the failure. Some of these inspections are incorporated by reference as Technical Specification Surveillance Requirements. The changes eliminated the 18-month and 20-year periodic inspections. Many of the inspection requirements were transferred to the 5-year and 10-year inspections. However, some 18-month and 20-year requirements were deleted in favor of performance monitoring techniques. The team concluded that these changes were approved by the vendor. The team also verified that the maintenance practices were in agreement with Section 8.3.1.1.4.8 the Updated Final Safety Analysis Report.

The team reviewed results from the licensee's semiannual engine monitoring program for Standby Diesel Generator 22 and two other engines for comparison. This program trended lube oil analysis results (metal, water, viscosity, and pH), combustion monitoring, and vibration monitoring. The performance monitoring included trending of exhaust temperatures, lube oil temperatures, start times, and system engineer walkdown results. The team noted that there were no indications in the monitoring program results which could have been indicative of a failure to Standby Diesel Generator 22.

The team reviewed maintenance history records for all six standby diesel generators at the South Texas Project, including the previous connecting rod failure event in Standby Diesel Generator 22 that occurred in 1989. The team determined that there were no failure trends, or unusual or repetitive failures. The safety system performance indicators for unavailability of the station's standby diesel generators were Green, although these had a trend of being consistently close to the Green-White threshold. This was primarily due to performing maintenance on line, rather than being related to a high failure rate.

The team looked for maintenance activities in Standby Diesel Generator 22, which disassembled the connecting rods, since these activities had the potential to induce damage that could be the starting point for fatigue cracking. The team identified no evidence of abnormalities in the records, and the only connecting rods disassembled since the 1989 event were the three affected by repairs (which did not include the one that failed in the current event).

No findings of significance were identified.

3.6 Post-Maintenance Testing (Charter Item 10)

a. Inspection Scope

The team evaluated the licensee's planned post-maintenance testing to demonstrate the operability and reliability of the repaired standby diesel generator. The scope of the testing was compared with vendor manual recommendations, technical specifications, Regulatory Guide 1.9, IEEE 387, and the post-repair testing performed following the 1989 event for demonstrating operability and reliability of the standby diesel generator.

The team reviewed the scope of the work packages performed to assess whether the post-maintenance testing scope was also appropriate for the work performed.

b. Findings and Observations

The licensee planned an extensive testing program prior to returning Standby Diesel Generator 22 to service. The team concluded that the testing planned was in conformance with vendor recommendations for testing new engines. It was also in conformance with IEEE 387 and Regulatory Guide 1.9 for testing and establishing adequate reliability of new engines. Additionally, the team concluded that the licensee planned to perform all surveillance tests and inspections required for standby diesel generators that applied to the circumstances.

The team reviewed the planned scope for each work package associated with refurbishing Standby Diesel Generator 22 and compared this to the post-maintenance checks specified in the work package and the licensee personnel's post-maintenance testing program. The team concluded that the tests were adequate, and consistent with the post-maintenance testing program. The team also reviewed the scope of the planned performance monitoring and concluded that it was appropriate and consistent with their past practices.

The team reviewed only the testing plan prior to completion of the work. This was done with the recognition that the actual work scope and testing could change somewhat. The resident inspectors will observe the actual testing on a sample basis as part of the regular baseline inspection program. Also, in monitoring the extent of damage from this event and the subsequent repair effort, the NRC recognized that some of the repair activities involved some permanent changes from the original design. Regional inspectors will review these changes as part of the baseline Permanent Plant Modifications inspection.

3.7 Enforcement

No violation of regulatory requirements occurred.

4. OTHER ACTIVITIES

4OA6 Meetings, Including Exit

On March 4, 2004, the team presented the inspection results by telephone to Mr. G. Parkey and other members of his staff who acknowledged the findings. The team confirmed that all proprietary information reviewed during this inspection were returned to the licensee personnel.

ATTACHMENT 1

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee personnel

T. Bowman, Manager, Systems Engineering
K. Coates, Maintenance Manager
H. Danhardt, Root-Cause Evaluator
J. Flores, Plant Operator
A. Gorman, Reactor Operator, Operations
J. Harris, Reactor Operator
S. Head, Licensing Manager
K. House, Supervisor, Plant Design Engineering
M. Howell, Unit Supervisor, Operations
B. Jeniewein, Supervisor, Systems Engineering
M. Lashley, Supervisor, Performance Engineering
J. LeValley, Project Manager
M. McBurnett, Nuclear Safety Assurance Manager
W. Morris, Shift Technical Advisor, Operaitons
S. Patel, Senior Engineer
A. Proctor, Plant Operator and Fire Brigade Leader, Operations
D. Rencurrel, Operations Manager
K. Richards, Manager, Outages and Projects
R. Rohan, Plant Operator, Operations
M Ruvalcaba, Supervisor, Systems Engineering
W. Stillwell, Supervisor, Risk Assessment
S. Thomas, Manager, Engineering Projects
J. Winters, Root-Cause Evaluator
D. Zink, System Engineer

Licensee Consultants

A. Lambert, Lambert Enterprises
M. O'Connell, MPR Associates, Inc.
L. Swanger, Failure Analysis Associates
J. Winney, MPR Associates, Inc.

NRC personnel

R. Gramm, Section Chief, Office of Nuclear Reactor Regulation
V. Hodge, Office of Nuclear Reactor Regulation
D. Jaffee, Project Manager, Office of Nuclear Reactor Regulation
G. Morris, Office of Nuclear Reactor Regulation
J. Rajan, Office of Nuclear Reactor Regulation

LIST OF DOCUMENTS REVIEWED

Condition Reports:

03-18103
03-18159
03-18252
CROE 03-18103-11

Condition Report Engineering Evaluation 03-18103-12

Station Problem Report 890833, “SDG #22 Thrown Rod Incident”

Procedures

0POP04-ZO-0008, “Fire/Explosion,” Revision 8

0POP02-DG-0002, “Emergency Diesel Generator 12(22), Revision 40

0POP01-ZO-0006, Extended Allowed Outage Time,” Revision ???

0PSP03-DG-0002, “Standby Diesel Generator 12(22) Operability Test,” Revision 25

0PSP04-DG-0002, “Standby Diesel Generator 5 Year Inspection,” Revision 9

0PSP15-DG-0004, “Standby Diesel Generator #22 System Functional Pressure Test,” Revision 3

0PGP03-ZA-0091, “Configuration Risk Management Program,” Revision ???

0PGP03-ZA-0506, Conduct of Tests or Evolutions Requiring Additional Controls, Revision ???

2TEP07-DG-0005, Standby Diesel Generator 22 Return To Service Testing, Revision 0

0OOI01-OL-0005, “Operations Logs - Diesel Generator,” Revision 11 for SDG-22 run on 12/9/03

Historical Maintenance Records

WAN 156391, 5 year inspection - 0PSP04-DG-0002, “Standby Diesel Generator 5 Year Inspection,” Revision 9, May 2003

WAN 108531, 18 month inspection - 0PSP04-DG-0001, “Standby Diesel Generator 18 Month Inspection,” Revision 19, January 1999

WAN 63640, 18 month inspection - 0PSP04-DG-0001, “Standby Diesel Generator 18 Month Inspection,” Revision 16, April 1997

WAN 94006220, 18 month inspection - 0PSP04-DG-0001, "Standby Diesel Generator 18 Month Inspection," March 1994

WAN 890055335, Maintenance Package - Diesel Generator Ejected Rod, November 28, 1989

Engine semi-annual performance monitoring results:

Standby Diesel Generator 22	5/3/03 and 2/4/03
Standby Diesel Generator 21	9/10/03 and 5/20/03
Standby Diesel Generator 12	8/13/03 and 1/29/03

Maintenance Work Documents for the Engine Repair/Refurbishment (by Work Authorization Number)

269185	266415	264804	264798	266176	267069
266862	266416	265239	265436	265955	267075
267141	266417	264954	265437	265141	267063
267067	266418	265434	265675	265238	267142
265442	266419	265439	267921	267076	267064
264794	266420	265435	232048	265443	265219
265676	266421	265429	265138	265433	267072
233582	266422	265438	265135	267071	267068
265603	266424	265432	265232	267066	265450
268312	263836	265430	265246	267074	266270
256496	265604	265431	265137	265220	237400
265293	265215	265440	264071	267062	237205

Engineering Reports

HL&P letter ST-HL-AE-3422, "Final Special Report Regarding A Diesel Generator Valid Failure on November 28, 1989," dated April 18, 1990

Materials Technology Report Number MT-2558, "Investigation of Diesel Generator Engine Connecting Rod Failure at South Texas Project Unit 2," dated December 13, 1989

APTECH Engineering Services Report AES 89121166-1Q-1, "Significance of Over-drilled Oil Holes on Fatigue Life of the KSV-4-2A Connecting Rod in the Standby Diesel Engines at South Texas Project," dated March 1990

Cooper-Bessemer Applied Mechanics Report AM-1852-C-1A, "Finite Element Analysis of KSV-4-2A Master Connecting Rod," dated February 26, 1990

Battelle Laboratories Report, "Failure Analysis of the KSV-4-2A Mater Connecting Rod," dated February 27, 1990

"Failure of the Number Four Master Connecting Rod in the Starboard Main Engine of the DREDGE WHEELER," by Dr. Stanford A. Smith, Jr., June 29, 1992

Metallurgical Analysis Report of Connecting Rod Number Four in the Starboard Main Engine of the Dredge Wheeler, by Scientific Testing Laboratories, Inc., dated June 17, 1992

Metallurgical Analysis Report of Connecting Rod Number Three in the Starboard Main Engine of the Dredge Wheeler, by Scientific Testing Laboratories, Inc., dated January 18, 1991

“Analysis of Dredge Wheeler Starboard Dredge Engine Failure,” By Preventive Maintenance Services, Inc., dated January 25, 1991

“Failure of the Connecting Rods in the Cooper-Bessemer KSV Engines on the Dredge Wheeler,” by Dr. Stanford A. Smith, Jr., dated October 28, 1993

“Inspection of the Starboard Dredge Engine on the Dredge Wheeler,” by Dr. Stanford A. Smith, Jr., dated January 14, 1991.

Trip Report by John Horne, Manager, Nuclear and Analytical Engineering, Cooper Energy Services, to the Dredge Wheeler, dated May 1, 1993

Summary of Operating Hours and Starts C-B Model KSVs in Nuclear Service

Trip Report to Cooper-Bessemer Reciprocating for Review of ESF Diesel Generators Manufacturing Records South Texas Project Electric Generating Station, December 14, 1989

Miscellaneous Documents:

Regulatory Guide 1.9, “Selection, Design, Qualification, and Testing of Emergency Diesel Generator Units Used as Class 1E Onsite Electric Power Systems at Nuclear Power Plants,” Revision 3

IEEE Standard 387-1995, “IEEE Standard Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations”

Proposed Emergency Change to Technical Specification 3.8.1.1, December 15, 2003

Supplement 1 to Proposed Emergency Change to Technical Specification 3.8.1.1, December 18, 2003

Vendor Manuals

Cooper Bessemer KSV Technical Manual for Nuclear Standby Applications
VTD-C634-0003, Revision 0, Section 2, “General Data”

Cooper Bessemer KSV Technical Manual for Nuclear Standby Applications
VTD-C634-0017, Revision 0, Section 10, “Piston and Connecting Rods”

Cooper Bessemer KSV Technical Manual for Nuclear Standby Applications
VTD-C634-0006, Revisions 0 and 3, Section 15, “Reliability Checking and Maintenance Inspections”

ATTACHMENT 2

SPECIAL INSPECTION CHARTER

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TEXAS 76011-4005

December 12, 2003

MEMORANDUM TO: Neil F. O'Keefe, Senior Reactor Inspector

FROM: Dwight D. Chamberlain, Director
Division of Reactor Safety

SUBJECT: CHARTER FOR THE NRC SPECIAL INSPECTION TEAM AT SOUTH TEXAS PROJECT - REVIEW OF LICENSEE ACTIONS RELATED TO THE FAILURE OF STANDBY DIESEL GENERATOR NO. 22

On December 9, 2003, Standby Diesel Generator No. 22 experienced a significant mechanical failure during testing that resulted in ejection of a connecting rod. Standby Diesel Generator No. 22 previously experienced a significant mechanical failure on November 28, 1989, that also resulted in ejection of a connecting rod from a different cylinder. The cause of the failures may or may not be similar. Because of the potential generic implications, the potential that the failures may be repetitive and the risk significance of the diesel failure along with a potential for a common mode failure mechanism, a special inspection team is being chartered. Although the risk significance of the failure of a single diesel generator may be low at South Texas Project, the uncertainties associated with the cause and the potential generic implications, including the possibility for a common mode failure, result in the potential for greater risk significance. These considerations warrant a special inspection team review. You are hereby designated as the team leader.

A. Basis

On December 9, 2003, control room operators at South Texas Project, Unit 2, were conducting a monthly surveillance on Standby Diesel Generator No. 22. At 10:18 a.m. (CST) the diesel reached full load. A trouble alarm at 10:38 a.m indicated that the diesel had less than 5 psi lube oil pressure and the output breaker had tripped open. Control room operators attempted unsuccessfully to shut the diesel down from the control room. Equipment operators in the diesel room also attempted unsuccessfully to shut down the diesel using the local emergency stop pushbuttons. The equipment operators then successfully shut the diesel down by shutting off the fuel supply to the diesel. Because of reports of smoke in the diesel room, the fire brigade responded but reported that they found no flames. The licensee staff reported that the diesel had ejected part of a piston, the articulating rod, and other parts from the No. 9 right cylinder.

During a conference call conducted December 10, 2003, between the licensee, NRR, and Region IV, the licensee stated their intent to identify the root cause of the failure, and to evaluate the extent to which the condition could affect the remaining standby diesels at South Texas Project.

A special inspection team will be dispatched to better understand the cause of the diesel failure, the extent of the condition, the potential generic implications, and the corrective actions proposed by the licensee.

A preliminary risk analysis performed by a Senior Reactor Analyst resulted in an estimated Incremental Conditional Core Damage Probability greater than 1 E-06.

B. Scope

Specifically, the team is expected to perform data gathering and fact-finding in order to address the following:

1. Develop a chronology of diesel failure and operator response.

2. Review and assess the adequacy of operator response to the emergency diesel failure.

3. Review the licensee's root and probable cause determination for completeness and accuracy including review of any relevant plant-specific and industry (foreign and domestic) operating experience, including previous diesel failures.

4. Review the circumstances associated with the diesel failure to identify potential common failure modes and generic safety concerns.

5. Review records associated with the maintenance history for the diesel generators at South Texas Project, including previous mechanical failures.

6. Review the licensee's program for periodic monitoring and maintenance of the standby diesels, including inspection and assessment techniques and scope, periodicity, and the results of past inspections.

7. Review and assess the adequacy of the licensee's evaluation of extent-of-condition as it relates to the other standby diesels in Units 1 and 2.

8. Review and assess the licensee's prompt and long-term corrective actions to address the root and probable causes of the condition. Assess the adequacy of repair activities and independently verify information submitted in support of NRC review of any regulatory relief requests.

9. If applicable, review and assess the corrective actions for past similar failures, including vendor recommended actions to prevent such failures.

10. Review and assess the licensee’s planned testing program to confirm the operability of No. 22 Standby Diesel Generator following repair activities.

C. Team Members

- Neil O’Keefe, Team Leader
- Gilbert Guerra, Resident Inspector

D. Guidance

This memorandum designates you as the special inspection team leader. Your duties will be as described in Inspection Procedure 93812, "Special Inspection." The team composition has been discussed with you directly. During performance of the special inspection activities assigned to them, designated team members are separated from their normal duties and report directly to you. The team is to emphasize fact finding in its review of the circumstances surrounding the event, and it is not the responsibility of the team to examine the regulatory process. Safety concerns identified that are not directly related to the event should be reported to the Region IV office for appropriate action.

You should notify the licensee and the team should begin inspection activities on or before December 15, 2003, based on the licensee’s schedule of activities. You should conduct an entrance meeting with the licensee at the appropriate time at the site. A report documenting the results of the inspection, including findings and conclusions, should be issued within 30 days of the exit meeting conducted at the completion of the inspection. While the team is active, you will provide periodic status briefings to Region IV management.

This Charter may be modified should the team develop significant new information that warrants review. Should you have any questions concerning this Charter, contact Dwight Chamberlain, Director, Division of Reactor Safety, at (817) 860-8180.

Distribution:
S. Collins, DEDO
A. Boland, OEDO
D. Jaffee, NRR
J. Dyer, NRR
R. Gramm, NRR
M. Thadani, NRR
B. Sheron, NRR
D. Wessman, NSIR
R. Zimmerman, NSIR
H. Miller, RI
L. Reyes, RII
J. Caldwell, RIII
B. Mallett, RIV
T. Gwynn
D. Chamberlain
A. Howell III
G. Good
M. Satorius
W. Johnson
C. Marschall
N. O'Keefe
W. Maier
V. Dricks
H. Berkow, NRR
T. Reis, NRR
S. Richards, NRR
M. Tschiltz, NRR
A. Markley, NRR

ADAMS: X Yes ☐ No Initials: _DDC_
X Publicly Available ☐ Non-Publicly Available ☐ Sensitive X Non-Sensitive

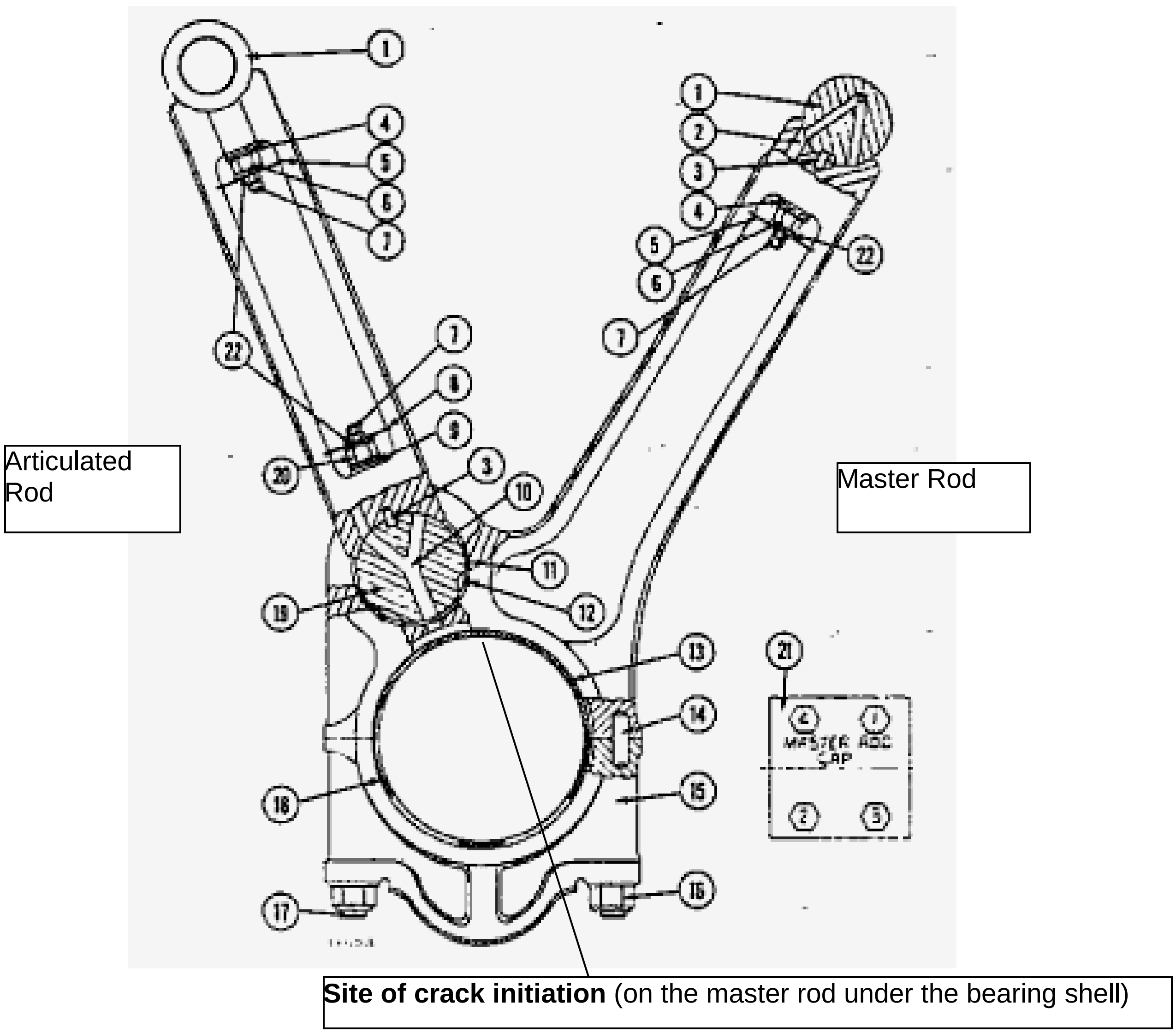
DOCUMENT: S:\DRS\South Texas Special.wpd

C:EMB	D:DRP	RA	D:DRS	
CSMarschall	ATHowell	BSMallett	DDChamberlain	
/RA/	/RA/	/RA/	/RA/	
12/12/03	12/12/03	12/12/03	12/ /03	

OFFICIAL RECORD COPY T=Telephone E=E-mail F=Fax

<u>ATTACHMENT 3</u>

Diagram of Connecting Rod



1. Piston Pin	13. Bearing Shell, Top
2. Oil Passage	14. Dowel (2)
3. Dowel (3)	15. Rod Cap
4. Washer (4)	16. Locknut (4)
5. Bolt Lock (4)	17. Stud (4)
6. Pin Bolt (4)	18. Bearing Shell Bottom
7. Drake Nut (4)	19. Art. Rod Pin
8. Bolt Lock (2)	20. Rod Pin Bolt
9. Washer (2)	21. Bearing Cap (Nut Tightening Sequence)
10. Oil Passage	22. Washer
11. Bushing	
12. Dowel Pin (4)	