NRC Form 366
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/88

LICENSEE EVENT REPORT (LER)

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Sequoyah, Unit 2	0 5 0 0 0 3 2 8	1 OF 0 8

TITLE (4)
Loosening Of Gland Seal Bolts On Speed Increaser Lube Oil Pumps Causes A Potential Inoperability Of Both Unit 2 Centrifugal Charging Pumps

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
0 2	1 2	8 8	8 8	0 0 5	0 1	0 4	0 8	8 8	Sequoyah, Unit 1	0 5 0 0 0 3 2 7
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OPERATING MODE (9)		THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
4		20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)
POWER LEVEL (10)	0 0 0	20.405(a)(1)(i)	50.36(c)(1)	XX 50.73(a)(2)(v)	73.71(c)
		20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)
		20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
		20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
		20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
Tom Rogers B. E. Kilgore, Plant Operations Review Staff	AREA CODE 6 1 5 8 1 0 - 7 0 8 7

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	XX NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single space typewritten lines) (16)

On February 12, 1988, at approximately 1133 EST, smoke was discovered coming from the speed increaser unit for the 2A-A centrifugal charging pump (CCP). Immediately, the 2B-B CCP was started, and the 2A-A CCP was stopped. Upon disassembly of the 2A-A CCP speed increaser, much of the internals were found damaged. Further investigation found the two gland seal (GS) retaining bolts inside the speed increaser lube oil pump (SILOP) backed out allowing the GS to loosen. The GS being loosened caused reduced oil flow to the speed increaser internals and ultimate damage. The 2B-B and 1B-B SILOPs were inspected, and the same GS bolts as on the 2A-A pump were found loosened. The cause of the bolts backing out was determined to be lack of a periodic adjustment of the GS bolts. It was discovered during investigation that the original SILOPs for 2A-A, 2B-B, and 1B-B CCPs had been replaced with incorrect SILOPs. The original 1A-A SILOP was not replaced with an incorrect SILOP. The replacement SILOPs had been ordered using an incorrect part number in April 1985. The replacement SILOPs for 1B-B, 2A-A, and 2B-B were rated for 900 rpm and incorporated a compression packing seal which requires periodic adjustment as the packing wears. The original SILOPs were rated for 1,800 rpm and incorporated a mechanical seal which does not require adjustment. The major cause of this event was that the replacement SILOPs for 1B-B, 2A-A, and 2B-B were the wrong SILOPs that incorporated the packing seal, and no program was in place to periodically tighten the gland bolts. The 2A-A SILOP was replaced with an 1,800 rpm pump on February 15, 1988, and two new pumps (1,800 rpm) were procured for 1B-B and 2B-B and installation was completed on March 7, 1988. The 1A-A SILOP mechanical GS bolts were insepcted on April 7, 1988, and found to be satisfactory. To prevent recurrence, TVA has a new procurement program in place which provides additional independent review/verification of all plant initiated procurement documents.

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

This revision is being submitted to provide an update of completed corrective actions and a restatement of the event analysis.

DESCRIPTION OF EVENT

On February 12, 1988, at approximately 1133 EST with unit 2 in mode 4 (0 percent power, 350 psig, 247 degrees F) and unit 1 in mode 5 (0 percent power, 4 psig, 123 degrees F), smoke was discovered coming from the speed increaser unit on the 2A-A (unit 2, train "A") CCP (EIIS Code BQ). Immediately, the 2B-B (unit 2 train "B") CCP was started, and the 2A-A CCP was shut down. The CCPs are utilized in the boron injection system for reactivity control and in the emergency core cooling system (ECCS) (EIIS Code BQ). Both pumps are required to be operable in modes 1 through 4 by the plant technical specifications (TSs). Since unit 2 was in mode 4 at the time, the action statement for TSs 3.1.2.2 and 3.1.2.4 were complied with immediately. This involved restoring both charging pumps to operable status within seven days or bring the unit to cold shutdown within the next 30 hours.

Disassembly of the 2A-A CCP speed increaser box was started later the same night, and upon disassembly, much of the internals were found damaged. Upon further investigation of the cause, it was discovered that the two gland seal retaining bolts inside the speed increaser lube oil pump had backed out with one bolt completely disengaged from the bolt hole and lying in the bottom of the pump casing. The lube oil pump is mounted on the side of the speed increaser and is driven by the speed increaser low speed shaft. The pump recirculates oil in the speed increaser to lubricate the internal moving parts and to serve as a cooling medium in removing heat. The lube oil pump is a rotary gear type and incorporates a gland seal to seal around the shaft. The seal is provided to isolate the pump internal pressure from the external atmosphere.

The bolts being backed out allowed the gland seal to loosen and not provide the seal in which it was designed to perform. After evaluation of the pump design and discussions with the supplier (Westinghouse), it is theorized that the loosening of the gland seal allowed air to be drawn in, via the speed increaser housing, mixing with the oil and/or allowed oil from the pump to be forced through the loosened gland seal bypassing the normal flow path to the speed increaser internals. These conditions caused reduced oil flow to the speed increaser internals and ultimate damage to the internals. The speed increaser internals were replaced as necessary, and the lube oil pump was replaced with one from a spare speed increaser unit. After reassembly, postmaintenance tests were performed on the 2A-A CCP and speed increaser unit, and the pump was returned to operable status at 1857 EST on February 15, 1988.

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

As additional preventive actions, the 2B-B (unit 2, train B) CCP was tagged out of service on February 17, 1988, to inspect the lube oil pump gland seal for a similar condition. Upon disassembly, the gland seal bolts were also found backed out similarly to the train A pump. The bolts were retightened and a locktite sealant installed to prevent the bolts from loosening again during operation. Concurrence was obtained from Westinghouse that this would be an acceptable method for securing the bolts.

The 2B-B CCP was declared operable at 0500 EST on February 18, 1988. After evaluation of the similar condition on both unit 2 CCPs, it was determined that this condition alone could have prevented the fulfillment of this system's safety function. At 1218 EST on February 19, 1988, NRC was notified by phone of this condition in accordance with 10 CFR 50.72, paragraph b.2.iii. As further preventive measures, work requests (WRs) were prepared to inspect the speed increasers lube oil pumps on both unit 1 CCPs (WR B257714 for 1A-A and WR B257712 for 1B-B). On February 24, 1988, the oil pump for 1B-B was removed, and the gland seal bolts were found only fingertight. The bolts were retightened and locktite sealer applied. The 1B-B speed increaser was also disassembled, and no damage was noted.

CAUSE OF EVENT

The cause of the 2A-A CCP speed increaser internals damage is attributed to the lube oil pump gland seal bolts backing out and subsequent loosening of the gland seal. This condition ultimately caused reduced oil flow to the speed increaser internals.

An immediate investigation was also initiated to determine the cause of the gland seal bolts backing out. Westinghouse was consulted about this event, and no other conditions of this nature had been reported by other customers.

Past vibration level charts on the speed increaser unit were reviewed, and no abnormal vibration levels were noted that should have caused the bolts to loosen. A 35 mil axial vibration was noted on the 2B-B speed changer in mid January 1988, but this condition was not considered to be the root cause of the bolts backing out since this vibration was only found on one pump/speed changer unit. The main cause of this vibration was found to be a misalignment of the electric motor to speed increaser low speed shaft coupling and was corrected on January 14, 1988.

Maintenance records were reviewed, and no records were found to indicate that any maintenance had been performed on the internals of the pumps that could have contributed to the bolts loosening. However, maintenance records did indicate that all (1A-A, 1B-B, 2A-A, 2B-B) the lube oil pumps had been replaced with complete new pumps on different occasions. At the time of each replacement, it was thought that the replacement pumps were identical to the original lube oil pumps. However, after further investigation and conversations with the manufacturer, it was discovered that some of the replacement pumps used on past occasions were not the correct type pump for this application. It was discovered that two different pumps are made in this style. One pump is rated for 900 rpm maximum speed and typically incorporates a compression packing-type seal which requires occasional adjustment of the gland bolts as the packing wears. The other pump is rated for 1,800 rpm maximum speed and typically incorporates a mechanical-type seal which does not require any periodic adjustment. The oil pumps in this application are driven at approximately 1,800 rpm by the speed increaser low speed shaft. The original lube oil pumps were the 1,800 rpm rating and incorporated the mechanical seal. An inspection was performed on all the speed increasers (1A-A, 1B-B, 2A-A, 2B-B) to determine which pumps were in place at the time of this event. The speed increaser for 1A-A CCP was the only one incorporating the correct lube oil pump (1,800 rpm). The other three (1B-B, 2A-A, 2B-B) had the incorrect lube oil pump (900 rpm). According to the manufacturer, the only structural difference between the two pumps is the type of internal gears used and the type of seal. The 900 rpm rated pump uses spur-type gears internally which have teeth radially arrayed on the rim parallel to the axis and typically incorporate a compression packing seal. The 1,800 rpm rated pumps incorporate helical-type (spiral) gears and typically incorporate a mechanical seal. Using the 900 rpm rated pumps in this application presents two problems (1) the type of gears used in the 900 rpm pump may not be able to adequately pump the oil when being driven at 1,800 rpm and some cavitation may occur and (2) the compression packing seal used in these pumps requires occasional adjustment as the packing wears. The major cause in this event was the fact that the wrong pumps were being used on the speed increasers for 1B-B, 2A-A, and 2B-B CCPs that incorporated the compression packing seal. Maintenance section did not have a program in place to periodically adjust the gland bolts as the packing wears because it was not known that a compression packing was used. This allowed the packing wear to go undetected, and driving the pumps at a higher speed than the rating caused the packings to wear quicker than normal. Ultimately, this condition allowed the gland and gland bolts to loosen. The incorrect pumps being used was caused by maintenance personnel using an incorrect part number when ordering replacement pumps in April 1985. Even though the 1,800 rpm requirement was noted on the purchase contract, the part number for the 900 rpm pump was listed, and the 900 rpm pump was received. Since the lube oil pumps were originally supplied as an integral part of the speed changer units, minimal literature was available specifically for the lube oil pumps. In 1985, the process of ordering parts consisted of a quality assurance review of the maintenance engineer's purchase request. A technical evaluation with an independent review was not included in the program.

ANALYSIS OF EVENT

This event is being reported under 10 CFR 50.73, paragraph a.2.v, as a condition that alone could have prevented the fulfillment of a safety function that is needed to shut down the reactor and maintain it in a safe shutdown condition or to mitigate the consequences of an accident.

The similar condition of the gland seal bolts being backed out on both unit 2 CCPs and on one unit 1 CCP is a condition that alone could have prevented the fulfillment of the CCPs safety function. The CCPs are required as part of the boron injection system to ensure negative reactivity control is available.

During modes 1 through 4, both CCPs are required to ensure adequate shutdown margin during a cooldown to 200 degrees F, when an assumed single failure is considered. The CCPs provide shutdown margin by injecting the boron injection tank contents into the RCS. The consequences of a cooldown from a main steam line break (MSLB) has been analyzed in the Sequoyah Final Safety Analysis Report (FSAR). The analysis assumed end of core life at no load with equilibrium xenon conditions at the time of a MSLB. Upon recognizing the MSLB by the reactor protection system and the emergency safety feature actuation system, a reactor trip is assumed to occur with the most positive reactive rod cluster assembly stuck in the fully withdrawn position. The single failure assumed is one that would cause a CCP failure, and thus, the boron injection tank contents are assumed to be injected into the RCS by the redundant train. This analysis has shown that a return to criticality occurs following the reactor trip until the boron from the boron injection tank enters the core region. This analysis showed however that peak core levels would be well below the nominal full power level, the lowest departure from nucleate boiling ratio would be greater than 1.30, and the maximum linear heat rate would be less than 10 kw/ft. However, if both CCPs failed during a postulated MSLB, the boron injection tank contents would not be injected and therefore, would place the core in a condition outside of the FSAR analysis. During an actual event, there are additional sources of boron available that are not given credit in the FSAR analysis. These other sources of boron include the ECCS water supply in the refueling water storage tank, the upper head injection system, and the cold leg accumulators. A power increase would also be limited due to the effects of the moderate temperature coefficient and the doppler coefficient as heat is generated from the fission process. The plant conditions existing at the time the smoking speed increase was discovered was not conducive to a return to criticality condition from a cooldown event, however, because of the existing boron concentration in the RCS. The boron concentration has been maintained in both units at approximately 2,000 ppm during the current shutdown period. A boron concentration of 2,000 ppm provides the adequate shutdown margin to preclude the reactor from attaining criticality from a cooldown occurrence. Operating boron concentrations would be less than 1,200 ppm dependent upon the time of core life.

In modes 1 through 3, both CCPs are required, and in mode 4 one CCP is required for ECCS. Emergency core cooling capability is required in modes 1 through 4 in the event of a loss of coolant accident (LOCA). The CCPs are utilized in the high head injection phase of ECCS for RCS pressures above approximately 1,400 psig at which time the safety injection (SI) pumps can be utilized. If a small break LOCA occurred at full operating pressure and the CCPs were not available, then the operator could depressurize the RCS if necessary, via the pressurizer spray system or by opening the pressurizer power operated relief valves, to achieve 1,400 psig RCS pressure where the SI pumps could be utilized for emergency core cooling.

Therefore, assuming worst-case condition of both CCPs being inoperable, even at full operating conditions, alternate means would have been available to provide a means of obtaining a safe shutdown and to mitigate the consequences of an accident. Even though the potential existed for both CCPs to become inoperable, one pump was maintained in operation at all times on both units since the discovery of the condition on the 2A-A CCP.

CORRECTIVE ACTIONS

Immediate corrective actions were to replace the 2A-A CCP speed increaser lube oil pump and retighten the gland bolts on the lube oil pumps for 2B-B and 1B-B. Locktite sealant was applied to the gland bolts on all three pumps. Also, the speed increaser internals were inspected and replaced as necessary for the three same CCPs. Condition Adverse to Quality Reports (CAQRs) (SQP 880161 and SQP 880188) were also initiated to document the problems identified in this report and track the resolutions.

Immediately upon discovery of the incorrect pumps being procured in April 1985, an inspection was performed to determine which type of pumps were in place at the time of this event and which type was installed on 2A-A during the recent (February 15, 1988) replacement. It was discovered that at the time of this event, only the speed increaser lube oil pump for 1A-A CCP was the correct type (1,800 rpm). The other three (1B-B, 2A-A, 2B-B) were the incorrect type (900 rpm) for this application and incorporated the compression packing seal. However, the new pump installed February 15, 1988, on the 2A-A unit was the correct type pump (1,800 rpm) because it had been removed from a spare speed increaser unit. Therefore, at present, only the 1B-B and 2B-B speed increasers still have the incorrect lube oil pumps installed. Since the 1B-B speed increaser was still disassembled for inspection and unit 1 only requires one CCP in mode 5, immediate operability of the 1B-B pump was not a concern. An immediate operability evaluation of 2B-B CCP was performed which included consulting Westinghouse (the speed increaser supplier). After evaluation, it was determined that the 2B-B CCP is capable of performing its intended safety-related function until new 1,800 rpm rated pumps could be procured (expected maximum duration of two weeks). This determination was made with concurrence from Westinghouse based on past adequate operating time of the 900 rpm pumps and with the requirement of special monitoring to be initiated on the speed increaser parameters (vibration, bearing temperature, and oil analysis) when the pump is running.

This special monitoring was initiated immediately on the 2B-B CCP speed increaser to provide indication of degraded performance. If indications of degraded performance are noted based on margins provided by Division of Engineering (DNE), the CCP will be declared inoperable and the appropriate Limiting Condition for Operation (LCO) action complied with. This evaluation was documented on a Safety Evaluation form (B25 880302 579) performed by DNE and a Justification for Continued Operation (JCO) form as part of CAQR SQP 880188.

Two new 1,800 rpm rated lube oil pumps were ordered on an emergency basis and the installation of them on the 1B-B and 2B-B speed increasers was completed on March 7, 1988. These pumps were installed under WRs B257712 and B247090.

Westinghouse has been consulted on the 1,800 rpm lube oil pumps to determine if preventive maintenance is required on the mechanical seal gland package to ensure loosening of the gland seal does not occur. Westinghouse does not recommend any preventive maintenance on these type seals and a review of their operating history by Westinghouse did not indicate that preventive maintenance is required. Therefore, an inspection of the mechanical seal gland bolts will not be incorporated into the preventive maintenance program.

To prevent recurrence, TVA has a new procurement program in place which provides additional independent review/verification of all procurement documents initiated in the plant. The procurement process is provided in SQA-45, "Procurement of Materials, Components, Spare Parts, and Service," and TI-110, "Procurement of Replacement Items for Use In Permanent Equipment, Systems and Structures," approved on October 19, 1987. The Contract Engineering Group (CEG) performs this function by reviewing all plant initiated reorder procurement documents against the current design specifications. The CEG technical review includes a verification of part numbers provided by the requesting organization against the latest controlled drawing and/or the vendor manual. This verification is then independently reviewed by an engineer and approved by a CEG manager before the procurement package is submitted to the Quality Assurance organization for their review. The latest revision (revision 29) of SQA-45, "Procurement of Materials, Components, Spare Parts, and Services," also requires additional identifying specifications on all purchase request documents which are reviewed in the same manner as the part numbers. Also, Maintenance Instruction (MI)-12.3.1, "Centrifugal Charging Pump Speed Increaser Inspection and Maintenance," was revised on March 30, 1988, to add instructions for verifying the correct lube oil pump when making replacements.

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ADDITIONAL INFORMATION

Centrifugal Charging Pump Speed Increaser - Westinghouse High Speed Gear Drive Model Su-1023-8X.

Speed Increaser Lube Oil Pump (1,800 rpm rating) - Westinghouse Style 159A422G28, Manufactured by Browne & Sharpe Co., Part Number 713920-3 (No. 2S).

Speed Increaser Lube Oil Pump (900 rpm rating) - Browne & Sharpe Co., Part Number 713902-1 (No. 2).

There have been no previous reportable occurrences involving the CCPs speed increaser units.

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TENNESSEE VALLEY AUTHORITY
Sequoyah Nuclear Plant
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April 11, 1988

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Gentlemen:

TENNESSEE VALLEY AUTHORITY - SEQUOYAH NUCLEAR PLANT UNIT 1 AND UNIT 2 - DOCKET NOS. 50-327 AND 50-328 - FACILITY OPERATING LICENSE DPR-78 AND DPR-79 - REPORTABLE OCCURRENCE REPORT SQRO-50-328/88005 REVISION 1

The enclosed licensee event report revision provides an update of completed corrective actions and a restated event analysis. This event was previously reported in accordance with 10 CFR 50.73, paragraph a.2.v, on March 8, 1988.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

S. J. Smith
Plant Manager

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