

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1)

Limerick Generating Station, Unit 2

DOCKET NUMBER (2)

05000 353

PAGE (3)

1 OF 6

TITLE (4) Unit 2 SCRAM, a Reactor Protection System Actuation, Due to a Failure of a Ball Joint that Connects the Recirculation Pump Motor Generator Set Scoop Tube to the Tube Positioner.

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 NAME	DOCKET NUMBER
12	24	96	96	-- 009 --	0	01	23	97	FACILITY NAME	DOCKET NUMBER
										05000
										05000
OPERATING MODE (9)		1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)							
POWER LEVEL (10)		37%	20.402(b)		20.405(c)		X		50.73(a)(2)(iv)	73.71(b)
			20.405(a)(1)(i)		50.36(c)(1)				50.73(a)(2)(v)	73.71(c)
			20.405(a)(1)(ii)		50.36(c)(2)				50.73(a)(2)(vii)	OTHER
			20.405(a)(1)(iii)		50.73(a)(2)(i)				50.73(a)(2)(viii)(A)	(Specify in
			20.405(a)(1)(iv)		50.73(a)(2)(ii)				50.73(a)(2)(viii)(B)	Abstract below
			20.405(a)(1)(v)		50.73(a)(2)(iii)				50.73(a)(2)(x)	and in Text, NRC Form 366A)

LICENSEE CONTACT FOR THIS LER (12)

NAME

J. L. Kantner - Manager, Experience Assessment, LGS

TELEPHONE NUMBER (Include Area Code)

(610) 718-3400

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

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPDOS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPDOS

SUPPLEMENTAL REPORT EXPECTED (14)

YES

(If yes, complete EXPECTED SUBMISSION DATE)

X NO

EXPECTED SUBMISSION DATE (15)

MONTH

DAY

YEAR

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

At 0608 hours on 12/24/96, an overspeed condition occurred on the 'B' reactor recirculation pump (RRP) and the RRP was manually tripped. At 0613 hours Operations identified that the reactor was operating in the exclusion region of the power/flow map and a manual scram was performed, a Reactor Protection System actuation. All control rods inserted as designed. The cause of the overspeed condition was a failed ball joint which connects the 'B' Motor Generator (MG) set scoop tube to the scoop tube positioner. The ball joint failed from high stress reverse bending fatigue from low amplitude low frequency vibration induced by the fluid coupler. Additional causes were an inadequate diagnosis of a 10/23/94 event, and an inadequate follow-up to GE SIL 355. Corrective actions include installation of vibration monitoring equipment, Unit 1/2 MG set inspections, revisions to appropriate preventive maintenance tasks, the assessment of a design change, and Engineering re-reviews of previous responses to industry experience. A parallel evaluation identified that the manual scram may have been unnecessary since the procedure for determining actual core flow after a RRP trip was conservative, and jet pump instrumentation logic assumes reverse flow in an inactive loop with 1 RRP in service. As a result, the affected procedure will be assessed for revision.

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

Unit Conditions Prior to the Event

Unit 2 was in Operational Condition 1 (Power Operation) operating at approximately 37% power level. Power ascension was in progress following a maintenance outage. There were no systems, structures or components out of service which contributed to this event.

Description of the Event

At 0605 hours on December 24, 1996, when Operations personnel raised core flow to 60 Mlb/hr, the Unit 2 "Alert High Vibration" and "Danger High Vibration" alarms annunciated in the Main Control Room (MCR). A flow increase was observed on the 'B' reactor recirculation pump and the 'B' Motor Generator (MG, EIIS:MG) set scoop tube was locked. Subsequently, the 'B' reactor recirculation pump 'Danger High Vibration' alarm annunciated in the MCR. At 0606 hours Operations personnel entered Operational Transient (OT) procedure OT-104, "Unexpected/Unexplained Reactivity Insertion."

At 0608 hours, an overspeed condition was identified on the 'B' reactor recirculation pump and the pump was manually tripped per procedure OT-104. Procedure OT-112, "Recirculation Pump Trip," was entered to determine the reactor operating point on the power/flow map.

At 0613 hours Operations personnel identified that the reactor was operating in the exclusion region and the reactor was immediately manually scrammed, a Reactor Protection System (RPS, EIIS:JC) actuation.

Following the scram all control rods were verified to be full in, the Main Turbine was tripped, and the reactor feedwater pumps remained in service for reactor level control. At 0629 hours the manual scram signal was reset. An investigation revealed that the transients occurred as a result of failed ball joint on the 'B' reactor recirculation pump 'B' MG set scoop tube control linkage.

A four hour notification was made to the NRC at 0845 hours on December 24, 1996, in accordance with the requirements of 10CFR50.72(b)(2)(ii) since this event resulted in the manual actuation of the RPS. This report is submitted in accordance with the requirements of 10CFR50.73(a)(2)(iv).

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

Repairs to the 'B' reactor recirculation pump MG set scoop tube control linkage were performed, startup activities commenced, and the Unit was synchronized to the grid at 1256 hours on December 25, 1996.

Analysis of the Event

The RPS functioned as designed in response to the manual actuation of the system. All control rods fully inserted as a result of the manual scram initiation. The MCR Shift Supervisor made a conservative decision to take control of the plant and initiate a rapid plant scram after identifying that the reactor was operating in the exclusion region of the power/flow map. Operations personnel controlled the plant shutdown using the appropriate station procedures. There was no release of radioactive material to the environment as a result of this event.

When the 'B' reactor recirculation pump MG set scoop tube control linkage failed, an increase in core flow from 60 Mlb/hr to a peak of 85 Mlb/hr in 10 seconds occurred. Reactor power increased from 38% of rated to a peak of 61% of rated in 8 seconds. Core flow stabilized at 81 Mlb/hr and reactor power at 49% within 20 seconds of the start of the event. This event is bounded by the Recirculation Flow Control Failure - Increasing Flow Event, an analyzed transient classified as an incident of moderate frequency. Initial reactor power and flow conditions for the analyzed transient are chosen to produce the most severe results. The most severe transient occurs when high reactor power and low core flow initial conditions are established (i.e., 57%/40 Mlb/hr) with a fluid coupler speed increase rate of 25% of full speed per second. This event occurred at lower power and higher flow than the analyzed transient (i.e., 38%/60 Mlb/hr) and the fluid coupler speed increase rate was less than 10% of full speed per second. All of these conditions resulted in a milder transient than the analyzed transient.

Cause of the Event

The cause of this event is separated into two parts. First, the causes for the 'B' reactor recirculation pump overspeed condition are addressed. Second, since an evaluation identified that the manual RPS actuation may have been unnecessary, the causes for the RPS actuation are discussed.

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

Causes of the 'B' Reactor Recirculation Pump Transient:

1. 'B' MG set scoop tube control linkage fatigue failure.

The cause of the overspeed condition on the 'B' reactor recirculation pump was a failure of the 'B' MG set scoop tube control linkage. Specifically, the ball joint which connects the MG set scoop tube to the scoop tube positioner failed. Following the failure, the tube retracted from the fluid coupler oil circuit causing the speed on the MG set to increase. The metallurgy analysis of the ball joint concluded that the failure was the result of high stress reverse bending fatigue. Review of Plant Monitoring System computer data recorded during this event indicated low amplitude low frequency vibration of the scoop tube control linkage induced by the fluid coupler prior to the failure.

2. Inadequate diagnosis of the cause for an October 1994 similar event.

On October 23, 1994, a failure of the Unit 2 'B' reactor recirculation pump MG set scoop tube linkage ball joint occurred during a unit startup. During analysis of the 1996 event, a review of data from the 1994 event was performed. The review revealed that this low amplitude low frequency vibration was also present prior to the 1994 ball joint failure. The original cause of the 1994 event was concluded to be a failure of the positioner brake, and the presence of this vibration was attributed to play in the ball joint prior to failure.

3. Inadequate follow-up to the recommendations of General Electric (GE) Service Information Letter (SIL) No. 355 issued in April of 1981.

GE identified low amplitude low frequency vibration of the scoop tube control linkage as a potential problem in 1981 and provided recommended actions in GE SIL No. 355. The SIL recommends contacting the MG set manufacturer if a vibration problem develops in the scoop tube control linkage. The review of this SIL was performed prior to commercial operation of Limerick Generating Station (LGS) Unit 1, which commenced in February of 1986. The review dated August 14, 1984, indicated that LGS personnel were aware of the potential vibration problem addressed in the SIL, however, no follow-up action was initiated to monitor for the vibration problem during start-up and operation. As a result, the review of the SIL was closed and the recommended actions were not implemented at LGS. Also, there was no documented review performed for LGS Unit 2, which commenced commercial operation in February 1990.

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Causes of the Manual RPS Actuation:

1. The procedure OT-112 guidance for determining actual core flow after a pump trip was conservatively inaccurate.

Procedure OT-112 guidance assumes reverse flow conditions in the inactive loop with one pump in service at speeds above 42%. An analysis of the core flow data prior to the 'B' reactor recirculation pump trip indicated that core flow in the inactive loop was actually in the forward direction. Operations personnel, as directed by procedure, used the indicated core flow value to determine the reactor operating point on the power/flow map. This resulted in an indicated entry into the exclusion region of the power/flow map and required an immediate unit scram.

2. The jet pump instrumentation logic assumes reverse flow in an inactive loop with one reactor recirculation pump in service.

The jet pump instrumentation cannot determine flow direction in the inactive loop with one reactor recirculation pump in service. This results in an incorrect indication of core flow when one pump is in service at low speed and core flow is driven by natural circulation.

Corrective Actions**Immediate Corrective Actions:**

The failed ball joint was replaced on the 'B' MG set control linkage and the positioner was successfully tested per Instrumentation and Controls (IC) procedure IC-11-00710, "Checkout of Recirc Scoop Tube Positioner." The control linkage for the Unit 2 'A' MG set positioner was inspected and no similar problems were identified.

Long Term Corrective Actions:

1. General Plant (GP) procedure GP-5, "Normal Plant Operations," will be revised to exclude operation of the Units 1 and 2 MG set scoop tubes in vibration regions as each region is determined. Procedure GP-5 will be revised for Unit 2 prior to startup from the fourth Unit 2 refueling outage (2R04) scheduled to commence on January 31, 1997. The procedure GP-5 revision for Unit 1 is expected to be completed by July 1, 1997. Until these revisions are implemented, Operations personnel will continue to follow procedure OT-112 as written.

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2. Vibration monitoring instrumentation has been installed on the Unit 2 'A' and 'B' MG set scoop tube linkage to determine vibration regions and magnitudes. Instrumentation is expected to be installed on the Unit 1 MG sets by April 1, 1997.
3. The Unit 2 MG set scoop tube control linkages and positioners will be inspected for wear or degradation during the fourth Unit 2 refueling outage (2R04) scheduled to commence on January 31, 1997. The Unit 1 MG set scoop tube control linkages and positioners will be inspected during the next outage of sufficient duration. The equipment will be refurbished as necessary to meet required alignment and clearance specifications, and these inspections will be incorporated into the appropriate Preventive Maintenance Program procedure.
4. An internal inspection of the Unit 2 'B' MG set fluid coupler will be performed during the fifth Unit 2 refueling outage with corrective measures implemented as necessary.
5. A design change will be assessed to resolve the MG set scoop tube control linkage failure problem. This assessment will include an evaluation of the GE SIL 355 recommendations.
6. The LGS Engineering Operating Experience Assessment Program (OEAP) Review Panel, currently in progress, is reviewing previous OEAP responses for applicability.
7. More accurate guidance will be identified for determining actual core flow when operating with one reactor recirculation pump at low speeds. Upon completion of this action, procedure OT-112 will be revised as necessary.
8. A Shift Update Notice, which provides a summary of this event and details concerning the vibration monitoring instrumentation in action no. 2 stated above, has been issued to Operations personnel. Also, this event will be reviewed for inclusion into the appropriate training lesson plans.

Previous Similar Occurrences

A previous similar event occurred at LGS on October 23, 1994, and is described in the Cause Section of this report.