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10CFR50.73

April 24, 2001
Docket No. 50-353
License No. NPF-85

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

SUBJECT: Licensee Event Report
Limerick Generating Station (LGS) - Unit 2

This LER addresses an inadvertent opening of the 2N Main Steam Relief Valve (MSRV) during a planned Unit 2 shutdown on February 23, 2001. Unit 2 was being shutdown to repair the 2N MSRV due to leakage through the pilot valve seat. The 2N MSRV lifted at 85% power and remained open. A manual reactor scram was initiated as required by Technical Specifications.

Reference:	Docket No. 50-353
Report Number:	2-01-001
Revision Number:	00
Event Date:	February 23, 2001
Discovered Date:	February 23, 2001
Report Date:	April 24, 2001
Facility:	Limerick Generating Station P.O. Box 2300, Sanatoga, PA. 19464-2300

This LER is being submitted pursuant to the requirements of 10CFR50.73(a)(2)(i)(A), 10CFR50.73(a)(2)(i)(B), and 10CFR50.73(a)(2)(iv)(A).

Very truly yours,

Robert C. Braun, Plant Manager

cc: H. J. Miller, Administrator Region I, USNRC
A. L. Burritt, USNRC Senior Resident Inspector, LGS

IE22

NRC FORM 366 (1-2001)

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES 6-30-2001

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LICENSEE EVENT REPORT (LER)

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

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TITLE (4)

Manual scram following MSRV failing open due to erosion and oxidation of the first stage pilot valve disc seating area

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MO	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO	MO	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
										05000
02	23	01	01	001	– 00	04	24	01	FACILITY NAME	DOCKET NUMBER 05000

OPERATING MODE (9)	1
POWER LEVEL (10)	092

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply) (11)

	20.2201(b)		20.2203(a)(3)(ii)		50.73(a)(2)(ii)(B)		50.73(a)(2)(ix)(A)
	20.2201(d)		20.2203(a)(4)		50.73(a)(2)(iii)		50.73(a)(2)(x)
	20.2203(a)(1)		50.36(c)(1)(i)(A)	x	50.73(a)(2)(iv)(A)		73.71(a)(4)
	20.2203(a)(2)(i)		50.36(c)(1)(ii)(A)		50.73(a)(2)(v)(A)		73.71(a)(5)
	20.2203(a)(2)(ii)		50.36(c)(2)		50.73(a)(2)(v)(B)		OTHER
	20.2203(a)(2)(iii)		50.46(a)(3)(ii)		50.73(a)(2)(v)(C)		Specify in Abstract below or in NRC Form 366A
	20.2203(a)(2)(iv)	x	50.73(a)(2)(i)(A)		50.73(a)(2)(v)(D)		
	20.2203(a)(2)(v)	x	50.73(a)(2)(i)(B)		50.73(a)(2)(vii)		
	20.2203(a)(2)(vi)		50.73(a)(2)(i)(C)		50.73(a)(2)(viii)(A)		
	20.2203(a)(3)(i)		50.73(a)(2)(ii)(A)		50.73(a)(2)(viii)(B)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
K. W. Gallogly, Manager – Experience Assessment	(610) 718-3400

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

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
B	SB	RV	T020	Y					

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

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

On February 23, 2001, operators were performing a planned Unit 2 shutdown to repair the 2N Main Steam Relief Valve (MSRV) due to first stage pilot valve seat leakage. During power reduction the 2N MSRV inadvertently lifted and remained open. The cause was a sudden loss of material from the first stage pilot valve due to erosion and oxidation of the Stellite disc material in the area of the seating surface. A manual scram was initiated as required by Technical Specifications (TS). Suppression Pool Cooling was placed in service. The Main Steam Isolation Valves (MSIVs) were manually closed in response to the reactor depressurization but the cooldown rate exceeded the TS limit of 100 Fahrenheit degrees per hour due to the open MSRV. The reactor level response to the scram resulted in a valid low-level signal to the Reactor Protection System (RPS) and Primary Containment and Reactor Vessel Isolation Control System (PCRVICS) systems. Group 2A and 2B isolation valves were in the closed position but received a valid isolation signal from the reactor low-level condition. The 2N and 2M MSRVs were subsequently replaced and Unit 2 was returned to power operation. The SRV Leakage Determination Monitoring Process was revised to provide added margin and improved direction on actions associated with pilot valve leakage.

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NARRATIVE *(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 (OPCON) 1 (Power Operation) at 92% power in end of cycle coastdown, and a planned unit shutdown for Main Steam Relief Valve (MSRV) (EIIS:RV) maintenance was commencing. There were no structures, systems, or components out of service that contributed to this event.

Description of the Event

On February 23, 2001, operators commenced a planned Unit 2 shutdown to repair the 2N MSRV. The 2N MSRV was experiencing pilot valve seat leakage that had been first observed on June 6, 2000. At 21:19 hours, during the power reduction and approximately seven minutes after reaching 85% power, the 2N MSRV inadvertently lifted and remained open.

A manual reactor scram was initiated and all control rods were verified fully inserted. Procedure T-101 "Reactor Control" was entered due to reactor level less than +12.5 inches, an expected result of post-scram level shrink. The low reactor water level condition resulted in a valid actuation signal for the Reactor Protection System (RPS) (EIIS:JC) and Primary Containment and Reactor Vessel Isolation Control System (PCRVICS) (EIIS:JM) Groups 2A and 2B. Both safety functions had been completed prior to the actuation signal. Two loops of Residual Heat Removal (RHR) (EIIS:BO) Suppression Pool Cooling were placed in service as directed by procedure OT-114 "Inadvertent Opening of a Relief Valve"; this is considered a manual actuation of the Containment Heat Removal system. The Main Steam Isolation Valves (MSIVs) (EIIS:ISV) were closed to control the reactor depressurization and cooldown rate; this is considered a manual actuation of PCRVICS in response to an actual plant condition.

This event involved two openings of the 2N MSRV. The first opening duration was 3 hours and 51 minutes (21:19 hours to 01:10 hours) and depressurized the reactor from 1040 psig to 122 psig. The second opening duration was 35 minutes (01:50 hours to 02:25 hours) and depressurized the reactor from 206 psig to 122 psig. Due to the 2N MSRV remaining open, a reactor coolant cooldown rate of 155 degrees F per hour was experienced. The cooldown rate exceeded the TS allowable value of 100 degrees per hour due to the open MSRV. The 2N MSRV was replaced, along with the 2M MSRV which had been experiencing main seat leakage. Unit 2 was restarted and achieved criticality on February 26, 2001 at 07:29 hours.

This event is reportable as a plant shutdown required by Technical Specifications, an actuation of RPS with the reactor critical, a valid actuation of RPS, a valid actuation of Containment Heat Removal, and a valid actuation of PCRVICS. On February 24, 2001, at 01:13 hours, four (4) and eight (8) hour ENS NRC notifications were performed as required by 10CFR50.72(b)(2)(i), 10CFR50.72(b)(2)(iv)(B) and 10CFR50.72(b)(3)(iv)(A). An additional ENS update notification was performed at 08:59 hours with the plant in OPCON 4, 2B RHR Shutdown Cooling Loop in service, reactor coolant temperature less than 200 degrees F and the 2N MSRV reseated.

This event resulted in a plant shutdown required by Technical Specifications, a reactor pressure vessel (RPV) (EIIS:RPV) cooldown rate prohibited by Technical Specifications, manual actuation of RPS, manual actuation of Containment Heat Removal, and automatic actuation of PCRVICS. This LER is being submitted pursuant to the requirements of 10CFR50.73(a)(2)(i)(A), 10CFR50.73(a)(2)(i)(B), and 10CFR50.73(a)(2)(iv)(A).

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

Analysis of the Event

There were no significant safety consequences associated with this event. No radiological release occurred. Operators monitored and controlled plant parameters as required to safely perform a manual shutdown of the plant. Operator actions related to manual scram initiation were in compliance with TS 3.4.2 and were bounded by the design basis transient analysis described in UFSAR Section 15.1.4. The fission product barriers of fuel cladding and primary containment were not challenged. However, the MSRV safety function of maintaining reactor coolant boundary integrity was adversely affected by the failed open MSRV. Since the plant was being shutdown prior to the MSRV actuation, this event did not initiate an additional plant shutdown transient. However, the MSRV actuation complicated the shutdown that was in progress and resulted in a cooldown of the reactor vessel that exceeded the Technical Specification limit. Evaluation of the cooldown determined that the reactor vessel remained within ASME Code and design limits.

The risk associated with the degraded 2N MSRV condition is considered to be not significant. The estimated increase in core damage frequency is small, assuming a risk exposure of less than two months. The availability of key mitigating systems for this risk scenario, specifically Suppression Pool Cooling, was maintained above the values assumed in the Limerick PSA model during the period in question. Based upon data from pre-event monitoring of pilot and tailpipe temperatures, and the post-event failure analysis and testing, the time frame during which the 2N MSRV was degraded to the point of potentially not being able to re-close occurred after December 27, 2000. Further, based upon the metallurgical analysis of the pilot, specifically the assumed erosion phenomenon occurring at the pilot seating surface, the more likely period wherein the 2N MSRV would not have re-closed occurred on or after February 17, 2001, one week prior to the event.

The Limerick MSRVs were changed from a two-stage to three-stage Target Rock design following an event that occurred at Unit 1 on September 11, 1995. Three-stage MSRVs were installed on Unit 2 in April 1999, and the SRV Leakage Determination Monitoring Process was revised at that time. The Monitoring Process was originally based on induced leakage testing of a single three-stage prototype valve. The prototype results indicated that the MSRV would self-actuate at pilot valve leakage of 25 lbm/hr, and could fail to reseat at 15 lbm/hr leakage. The failure to reseat criterion was later lowered to a leakage value of 11 lbm/hr following increased interaction and extensive discussions with the vendor in the month preceding the event. The pilot temperature associated with the 11 lbm/hr leakage criterion was 471 degrees F, and remained bounded by the existing monitoring process.

Temperature between the first and second pilot stages was regularly monitored for the 2N MSRV beginning on June 6, 2000 after tailpipe temperature increased and the pilot baseline temperature of 527 degrees F began to decrease. A decreasing trend continued during the ensuing six months, with pilot temperature falling below 500 degrees F on December 27,2000. Preparations were made for an outage at that point, in anticipation of a continued trend in increased pilot leakage. Pilot temperature continued to be closely monitored over the next seven weeks. The criterion for initiating a plant shutdown was a pilot temperature of 475 degrees F. Pilot temperature trended around 490 degrees in that period; however, on February 17, 2001 the temperature sharply dropped to 478 degrees where it remained until the event.

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The sharp drop in temperature one week prior to the event is attributed to the erosion occurring at the valve disc seating area. Metallurgical examinations confirmed that the valve seating surface sustained steam damage at two diametrically opposed locations. The erosion weakened and removed dendrites of Stellite from the disc over time. Examination of seat areas indicated oxidation depth up to 5 mils in the damaged areas. Further, the measured as-found pilot valve leakage for the failed 2N MSRV was 39 lbm/hr. Additional induced leakage testing after the event confirmed the original temperature versus flow correlation, and therefore the leakage that existed prior to the event was below that required to cause the valve to self actuate or stick open. Due to pilot valve disc erosion, the 2N MSRV was found to repeatedly lift at pressures less than rated reactor pressure. The large as-found leakage combined with the metallurgical evidence support a conclusion that a sudden loss of material occurred.

Unrelated to the cause of this event, an in-place inspection of the failed 2N MSRV revealed that four of sixteen studs were missing from the outlet flange. No evidence of steam leakage through the outlet flange was identified. A computation determined that the structural integrity of the outlet flange bolted connection was maintained. The evaluation revealed that the studs loosened as a result of inadequate torque for the installed gasket. All fourteen Unit 2 MSRV outlet flange studs were inspected for proper torque. Most of the fasteners were found with torque less than specified in the associated maintenance procedure, and were re-tightened to a higher value and mechanically restrained. Unit 1 was shutdown on March 9, 2001 and all fourteen Unit 1 MSRV outlet flanges were also re-tightened to a higher torque value and mechanically retrained.

Cause of the Event
The step change in leakage on February 23, 2001 was caused by a sudden loss of material from the first stage pilot valve due to erosion and oxidation of the Stellite disc material in the area of the seating surface. The SRV Leakage Determination Monitoring Process did not consider all possible failure mechanisms.

Corrective Actions Completed
The 2N and 2M MSRVs were replaced on Unit 2. The SRV Leakage Determination Monitoring Process was revised prior to Unit 2 restart to provide added margin and improved direction on actions associated with pilot valve leakage.

Corrective Actions Planned
Additional testing and analysis are being conducted in conjunction with the manufacturer. The results will be incorporated into the SRV Leakage Determination Monitoring Process by September 1, 2001.

Previous Similar Occurrences
Limerick Generating Station Unit 1 LER 1-95-008 reported an inadvertent opening of 1M MSRV that occurred on September 11, 1995. This MSRV actuation was also due to steam erosion of the pilot valve seat. However, this event involved a two-stage MSRV rather than a three-stage MSRV that is the subject of the current report.

Failed Component Data
Manufacturer: Target Rock
Model number: 9867F