NRC Form 366
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/85

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
McGuire Nuclear Station - Unit 2	0 5 0 0 0 3 7 0	1 OF 0 7

TITLE (4) REACTOR TRIP ON STEAM GENERATOR LOW LOW LEVEL

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 5 0 0 0
0 1	1 5	8 6	8 6	— 0 0 1	— 0 1	0 4	1 9	8 8		0 5 0 0 0

OPERATING MODE (9)	1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
POWER LEVEL (10)	0 8 0	20.402(b)	20.405(c)	XX 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 (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	
	AREA CODE	
STEVEN E. LeROY, LICENSING	7 0 4	3 7 3 - 6 2 3 3

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)	X NO				

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

On January 15, 1986 at 1149, the Unit 2 reactor tripped from 80% power as a result of low low level in Steam Generator (S/G) "A". The S/G low low level was caused by reduced main feedwater (CF) flow after CF pump turbine 2A tripped at 1147 on low condenser vacuum. When the feedwater pump turbine tripped, a runback of the turbine and reactor was initiated. The loss of condenser vacuum was due to a malfunction of two valves in the vacuum priming system associated with CF pump 2A. The condenser of CF pump 2B turbine was also affected resulting in a loss of turbine speed and a reduction of pump discharge pressure. S/G levels decreased through the transient until the automatic reactor trip setpoint on S/G A was reached. The main turbine automatically tripped when the reactor trip was initiated since reactor power was greater than 48%. Unit 2 was in Mode 1 at 100% power when CF pump turbine 2A tripped and at 80% power when the reactor/turbine trips occurred. Plant systems responded as expected for the transient. After the reactor trip, the two subject valves were cleaned, repaired, reinstalled, and returned to service. Also, a permanent drain line was added to both units on one valve per condenser to allow continuous water flow from the vacuum priming valve to the floor drain to prevent this type of transient.

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☆U.S.GPO:1984-0-454-481/18759

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

On January 15, 1986, at 1149, the Unit 2 reactor tripped from 80% power as a result of low low level in Steam Generator (S/G) "A". The S/G low low level was caused by reduced main feedwater (CF) [EIIS:SJ] flow after CF pump turbine 2A tripped at 1147 on low condenser vacuum. When the feedwater pump turbine tripped, a runback of the turbine and reactor was initiated. The loss of condenser vacuum [EIIS:SH] was due to a malfunction of two valves in the vacuum priming system [EIIS:TF] associated with CF pump 2A. The condenser of CF pump 2B turbine was also affected resulting in a loss of turbine speed and a reduction of pump discharge pressure.

S/G levels decreased through the transient until the automatic reactor trip setpoint on S/G A was reached. The main turbine [EIIS:TA] automatically tripped when the reactor trip was initiated since reactor power was greater than 48%.

Unit 2 was in Mode 1 at 100% power when CF pump turbine 2A tripped and at 80% power when the reactor/turbine trips occurred. Plant systems responded as expected for the transient.

After the reactor trip, the two subject valves were cleaned, repaired, reinstalled, and returned to service. Also, a permanent drain line was added to both units on one valve per condenser to allow continuous water flow from the vacuum priming valve to the floor drain to prevent this type of transient.

BACKGROUND:

The Condenser Cooling Water system (RC) uses raw water from Lake Norman to remove heat from steam exhausted from the turbines associated with the main condenser and the condensers of the feedwater pumps. RC water is pumped through the tubes of the condensers, and steam is exhausted to the shell of the condenser.

The Vacuum Priming System continuously removes air from the cooling water lines, condenser waterboxes, and other heat exchangers that operate under a vacuum on the cooling water side. Two vacuum lines are connected to the waterboxes of each main feedwater pump turbine condenser. These lines tie to the Vacuum Priming System header which is connected to a tank and two vacuum pumps. During normal operation, two vacuum priming valves (one in each of the two lines to the waterboxes) are aligned to the tank, and at least one pump is running.

The vacuum priming valves open whenever air enters the waterbox. Air is removed until the waterbox is full of water up to the priming valve. The valve is then closed by a float and does not pass water. The Main Vacuum System (VZ) [EIIS:SH] maintains the condensers under vacuum for proper steam exhausting from the turbine. Vacuum is maintained on the main turbine condenser and the feedwater pump turbine condensers by the use of common piping and condensate steam air ejectors.

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

DESCRIPTION OF EVENT:

On January 15, 1986, Unit 2 was operating at 100% reactor power with a turbine load of 1220 MWe when a feedwater transient occurred resulting in a reactor trip on low low Steam Generator (S/G) level. Sometime prior to the transient, two vacuum priming valves stuck closed resulting in the inability of the vacuum priming system to maintain a watersolid waterbox on the main feedwater (CF) pump 2A turbine condenser. After inspection, one valve was found to have stuck closed due to an accumulation of sludge from the lake water preventing mechanical operation. The other valve also contained a sludge buildup, a broken connecting rod (which disconnected the valve internals from the float), and a piece of foreign material preventing flow. It cannot be determined exactly when the valves failed. One valve probably failed earlier, but the system was not affected until sometime after the second valve failed. An air bubble then formed in the waterbox and grew in size until it restricted the flow of cooling water through the tubes of the condenser. As a result, the condenser was unable to cool the turbine exhaust and condenser shell side pressure increased (vacuum decreased). The turbine exhaust is normally maintained at vacuum and the turbine was automatically tripped when the vacuum reached its low/trip setpoint. When the feedwater pump turbine tripped, a runback of the main turbine and reactor was initiated. The control room operator placed the reactor's Rod Control System [EIIS:AA] in automatic (Rod Control was in manual due to testing). The control rods began to insert reducing reactor power to 80% and the turbine load to 700 MWe.

At some point during the CF pump 2A turbine condenser vacuum transient an expansion diaphragm ruptured on the turbine shell opening it to the atmosphere. Because the CF pump turbine condenser - as well as the main turbine condenser - are connected by drain piping, the loss of vacuum on the CF pump 2A turbine condenser affected the performance of the CF pump 2B turbine condenser resulting in a loss of turbine speed and a reduction of pump discharge pressure. S/G levels decreased throughout the transient until the reactor trip setpoint on S/G A was reached and the reactor tripped at 1149. The turbine tripped as designed when the reactor trip was initiated since reactor power was greater than 49%.

After the trip, Duke Power personnel attempted to feed the S/Gs with CF pump 2B until it was discovered that an expansion diaphragm had ruptured. At this point, CF pump 2B was shutdown and the S/Gs were fed with auxiliary feedwater (CA). Due to both CF pumps turbine condensers being open to atmosphere, the main turbine condenser vacuum began to decrease. The condenser vacuum reached the condenser block setpoint which closed all condenser dump valves requiring the use of the S/G PORVs to maintain the reactor temperature, Tavg. The PORVs were manually opened until the main condenser vacuum was isolated from the CF pumps vacuum and condenser vacuum was reestablished. The condenser steam dump valves were then available and were used to control reactor temperature, Tavg. The PORVs were then manually closed.

There was no release of radiation and no personnel injuries as a result of the event.

A review of past Licensee Event Reports revealed another incident where Unit 2 tripped due to a loss of feedwater pump turbine condenser vacuum (LER 370/84-34). The loss of vacuum in this incident was due to a different cause. Therefore, the subject event is considered an isolated incident.

CORRECTIVE ACTION:

Immediate: Duke Power personnel took appropriate action to stabilize the plant after the reactor trip.

Subsequent: A work request was written to inspect/repair the subject vacuum priming valves.

The subject valves were inspected and repaired.

A temporary drain line was installed in both Units from the vacuum priming valves to the floor drain in order to assure continuous flow during plant operation.

A permanent drain line was added to both Units on one valve per condenser to allow continuous water flow from the vacuum priming valves to the floor drains while in service to prevent an air bubble from forming in the waterbox.

The drain lines are checked twice per day by Duke Power personnel for continuous flow to ensure the valves do not clog without being detected.

Planned: The need for a periodic maintenance program concerning the vacuum priming valves will be evaluated.

SAFETY ANALYSIS:

The reactor tripped as required on low-low level in S/G 2A, and the reactor was shutdown by rod insertion. Residual heat was removed by main feedwater and auxiliary feedwater [EIIS:BA] to the atmosphere and to the condenser. When main feedwater was lost, auxiliary feedwater (CA) delivered flow as required. Both motor driven CA pumps and the turbine driven CA pump started as expected. Each pump delivered flow as required. When the main condenser was lost, the PORVs were used as needed to remove residual heat. Adequate core cooling was maintained at all times. The reactor pressure boundary was not challenged. No safety injection was initiated or required. There was no release of radioactivity as a result of this event.

TRANSIENT ASSESSMENT:

Pressurizer pressure peaked at 2319 psig during the runback, below the nominal PORV setpoint (2335 psig). No PORVs opened. Pressure then was decreased as the pressurizer spray flow increased and Tavg started to drop. Pressurizer pressure dropped to minimum of 2005 psig post-trip before recovering. Pressure had recovered above the no-load target of 2235 psig about 17 minutes after the reactor trip.

Tavg peaked at 592 degrees-F pre-trip during the load reduction. Temperature then decreased as the power dropped and the steam dump valves relieved steam. Following the reactor trip, temperature fell immediately to approximately 560 degrees-F. Temperature then decreased slowly to its minimum of 541 degrees-F about 16 minutes after the trip. Temperature began to recover once Auxiliary Feedwater (CA) was secured. CA was restored a few minutes later but at a lower flow rate. Temperature had recovered to 550 degrees-F 28 minutes after the reactor trip.

Pressurizer level increased pre-trip as Tavg rose, peaking at 70%. Level then decreased with Tavg. Following the reactor trip, pressurizer level fell immediately to about 38%. Level then slowly decreased along with Tavg. Level reached a minimum of 18% about 13.5 minutes post-trip. Letdown was not isolated. At this time the operators started a second centrifugal charging pump to help recover level. The pump was run for about 3 minutes. Level was about 32% 16 minutes after the reactor trip. There was no emergency boration flow during this event.

Steam pressure rose pre-trip during the load reduction. The bank 1 and 2 steam dump valves opened to control Tavg. Steam pressure peaked at approximately 1086 psig pre-trip. Steam pressure began to increase a second time prior to the reactor trip once the bank 2 steam dump valves began to close. Steam pressure peaked post-trip at 1129 psig in steam generator C. This is within the PORV operating band. PORV's opened as designed. Steam pressure fell post-trip as CA was being fed at a high rate. Pressure decreased to a minimum of 938 psig. Pressure began to recover once CA was secured. The rate of increase slowed when CA was restored. Pressure had recovered to approximately 1020 psig 16 minutes after the reactor trip.

Steam generator level decreased pre-trip as main feedwater flow decreased. Following the trip of the A CF pump, feedwater flow decreased more than normal due to the high backpressure on the B CF pump turbine. The flow was insufficient to maintain S/G levels, and the unit tripped when level dropped to the low-low level trip setpoint.

Following the reactor trip all four steam generator levels went offscale low. The motor driven CA pumps initiated at the time of the reactor trip and fed the S/Gs. The turbine driven CA pump started shortly thereafter as the second generator level went low-low. All three pumps were feeding the steam generators within one minute of receipt of the autostart signals. CF isolated on reactor trip with low Tavg. The B CF pump went into recirculation. Level returned on-scale approximately 7 minutes after trip. CA was secured approximately fifteen minutes after the reactor trip. Level had recovered above 25% in all four steam generators at that time. After the CF pump was secured and the S/Gs were again fed with CA by the motor driven pumps, level returned to the no-load target (38%) in all 4 S/Gs about 28 minutes after the trip.

Having both CF pump turbine condensers open to the atmosphere eventually affected main condenser vacuum. Vacuum was lost at about 12:18. Loss of vacuum required the PORVs to be opened for Tavg control. The CF pump condensers were isolated from the main condenser several minutes later. Main condenser vacuum was then established, making the steam dumps available. The PORVs were then shut. Other than the loss of main condenser vacuum, all systems responded as expected.

There were no personnel injuries, personnel overexposures, or releases of radioactive material as a result of this event.

This event is considered to be of no significance with respect to the health and safety of the public.

SUPPLEMENTAL INFORMATION:

On November 5, 1987 at 0646, the Unit 2 Reactor tripped because of a low-low level in Steam Generator 2B. The Main Turbine tripped because of the Reactor Trip. Operations personnel determined that an air bubble from a Unit 1 heat exchanger had migrated from Unit 1 to Unit 2 through crossover piping to the Unit 2 CF Pump Turbine 2B Condenser Waterbox. The air bubble caused a loss of cooling efficiency in the condenser resulting in a low vacuum in the CF Pump Turbine 2B Condenser. CF Pump Turbine 2B tripped initiating a Reactor/Turbine Runback (the Digital Electro Hydraulic Turbine Control system did not respond correctly) and the Reactor tripped on a Steam Generator 2B Low-Low Level signal. Mechanical Maintenance personnel had inadvertently left a vent valve closed on a Unit 1 Containment Spray heat exchanger during air sparging. An air bubble leaked through the closed heat exchanger isolation valves and migrated to the CF Pump 2B Condenser Waterbox.

During 1987, Mechanical Maintenance personnel performed the air sparging operation by isolating the heat exchanger and opening the heat exchanger vent valve. Because of personnel error, the vent valve was left closed during air sparging on November 5 and the air leaked by the isolation valves. The air migrated to the CF Pump Turbine 2B Condenser Waterbox which resulted in the Unit 2 Reactor Trip.

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

During the investigation of the November 5, 1987 Reactor Trip, Performance personnel stated that the possibility existed that a similar air sparge was in progress when the January 15, 1986 Reactor Trip occurred. Further discussion with Performance personnel confirmed that Performance personnel were air sparging a Unit 1 Containment Spray heat exchanger on the day of the 1986 Reactor Trip.

In 1986, Performance personnel performed the air sparging operation by injecting air into the normal water flow to the heat exchanger. The purpose was to agitate the "mud" in the heat exchanger and flush it out the normal flow path.

In all likelihood, the air sparging operation in progress on January 15, 1986 was the root cause for that Reactor Trip. Although the vacuum priming valves were inoperable, the formation of the air bubble was probably aggravated by the air sparging operation. If the vacuum priming valves were operable, they may not have removed the air fast enough to prevent the loss of vacuum in the condenser; therefore, a Reactor Trip would probably still have occurred.

The corrective actions resulting from the November 5, 1987 Reactor Trip should prevent the air sparging process from causing Reactor Trips in the future.

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HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

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April 18, 1988

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

Subject: McGuire Nuclear Station, Unit 2
Docket No. 50-370
Licensee Event Report 370/86-01-01

Gentlemen:

Pursuant to 10CFR 50.73 Sections (a)(1) and (d), attached is Licensee Event Report 370/86-01-01 concerning a Reactor Trip on Steam Generator Low Low Level. This revision is being submitted to provide supplemental information discovered during a Reactor Trip in 1987 that pertained to this 1986 event. This report is being submitted in accordance with 10CFR 50.73(a)(2)(iv). The supplemental information begins on page 6 of the report. This event is considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

Hal B. Tucker

Hal B. Tucker

SEL/259/jgc

Attachment

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