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June 26, 2017  
Serial No. MNS-17-027

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

10 CFR 50.73

Subject: Duke Energy Carolinas, LLC  
McGuire Nuclear Station, Unit 2  
Docket No. 50-370  
Licensee Event Report 370/2017-01, Revision 1  
Nuclear Condition Report Numbers 2102868 and 2102990

Pursuant to 10 CFR 50.73 Sections (a) (1) and (d), attached is Licensee Event Report (LER) 370/2017-01, Revision 1, regarding Unit 2 plant shutdown due to Reactor Coolant System pressure boundary leakage. There are two pressure boundary leaks associated with this LER.

This revision to the LER supersedes the previously submitted LER dated April 24, 2017. The metallurgical laboratory testing and cause analysis for these pressure boundary leaks have been completed. This LER is being submitted in accordance with 10 CFR 50.73(a)(2)(i)(A), the completion of any nuclear plant shutdown required by the plant's Technical Specifications, 10 CFR 50.73(a)(2)(ii)(A), any event or condition that resulted in the condition of the nuclear power plant, including its principle safety barriers, being seriously degraded, and 10 CFR 50.73(a)(2)(i)(B), any operation or condition which was prohibited by the plant's Technical Specifications.

The revision did not affect the significance of the event, which was considered to be of no significance with respect to the health and safety of the public.

There are no regulatory commitments contained in this LER revision.

If questions arise regarding this LER, contact P. T. Vu of Regulatory Affairs at 980-875-4302.

Sincerely,

Steven Capps

IEZZ  
NRR

Attachment

U.S. Nuclear Regulatory Commission  
June 26, 2017  
Page 2

cc: Catherine Haney  
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U.S. Nuclear Regulatory Commission  
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NRC Senior Resident Inspector  
McGuire Nuclear Station



**LICENSEE EVENT REPORT (LER)**

(See Page 2 for required number of digits/characters for each block)

(See NUREG-1022, R.3 for instruction and guidance for completing this form  
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Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Information Services Branch (T-2 F43), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by e-mail to Infocollects.Resource@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

<b>1. FACILITY NAME</b> McGuire Nuclear Station, Unit 2	<b>2. DOCKET NUMBER</b> 05000-0370	<b>3. PAGE</b> 1 OF 5
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**4. TITLE**  
Technical Specification Required Shutdown Due to Reactor Coolant System Leakage

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
02	23	2017	2017	- 01	- 01	06	26	2017	None	05000
									FACILITY NAME	DOCKET NUMBER
									None	05000

<b>9. OPERATING MODE</b>  1	<b>11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)</b>							
	<input type="checkbox"/> 20.2201(b)	<input type="checkbox"/> 20.2203(a)(3)(i)	<input checked="" type="checkbox"/> 50.73(a)(2)(ii)(A)	<input type="checkbox"/> 50.73(a)(2)(viii)(A)				
	<input type="checkbox"/> 20.2201(d)	<input type="checkbox"/> 20.2203(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(ii)(B)	<input type="checkbox"/> 50.73(a)(2)(viii)(B)				
	<input type="checkbox"/> 20.2203(a)(1)	<input type="checkbox"/> 20.2203(a)(4)	<input type="checkbox"/> 50.73(a)(2)(iii)	<input type="checkbox"/> 50.73(a)(2)(ix)(A)				
<b>10. POWER LEVEL</b>  100	<input type="checkbox"/> 20.2203(a)(2)(i)	<input type="checkbox"/> 50.36(c)(1)(i)(A)	<input type="checkbox"/> 50.73(a)(2)(iv)(A)	<input type="checkbox"/> 50.73(a)(2)(x)				
	<input type="checkbox"/> 20.2203(a)(2)(ii)	<input type="checkbox"/> 50.36(c)(1)(ii)(A)	<input type="checkbox"/> 50.73(a)(2)(v)(A)	<input type="checkbox"/> 73.71(a)(4)				
	<input type="checkbox"/> 20.2203(a)(2)(iii)	<input type="checkbox"/> 50.36(c)(2)	<input type="checkbox"/> 50.73(a)(2)(v)(B)	<input type="checkbox"/> 73.71(a)(5)				
	<input type="checkbox"/> 20.2203(a)(2)(iv)	<input type="checkbox"/> 50.46(a)(3)(ii)	<input type="checkbox"/> 50.73(a)(2)(v)(C)	<input type="checkbox"/> 73.77(a)(1)				
	<input type="checkbox"/> 20.2203(a)(2)(v)	<input checked="" type="checkbox"/> 50.73(a)(2)(i)(A)	<input type="checkbox"/> 50.73(a)(2)(v)(D)	<input type="checkbox"/> 73.77(a)(2)(i)				
	<input type="checkbox"/> 20.2203(a)(2)(vi)	<input checked="" type="checkbox"/> 50.73(a)(2)(i)(B)	<input type="checkbox"/> 50.73(a)(2)(vii)	<input type="checkbox"/> 73.77(a)(2)(ii)				
		<input type="checkbox"/> 50.73(a)(2)(i)(C)	<input type="checkbox"/> OTHER	Specify in Abstract below or in NRC Form 366A				

**12. LICENSEE CONTACT FOR THIS LER**

<b>LICENSEE CONTACT</b> P.T. Vu, Regulatory Affairs	<b>TELEPHONE NUMBER (Include Area Code)</b> 980-875-4302
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**13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT**

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
O	BQ	PSX	Sumitomo	Y	B	AB	V	Flowserve	Y

<b>14. SUPPLEMENTAL REPORT EXPECTED</b> <input type="checkbox"/> YES (If yes, complete 15. EXPECTED SUBMISSION DATE)	<input checked="" type="checkbox"/> NO	
<b>15. EXPECTED SUBMISSION DATE</b>		
MONTH	DAY	YEAR

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

On February 23, 2017, at 19:22 hours, with Unit 1 and Unit 2 operating at approximately 100 percent power, operators commenced a Unit 2 shutdown upon discovery of pressure boundary leakage on Unit 2 Safety Injection (NI) pipe upstream of the connection to "D" Reactor Coolant System (NC) Cold Leg. During a containment walk down inspection in Mode 3 on the next day, a pinhole pressure boundary leak was observed in the body of 2NC-30, Pressurizer Spray Bypass Valve.

The cause of the NI pipe leak is thermal fatigue damage caused by NC cross-loop flows. The cause of the 2NC-30 valve leak is a casting flaw attributed to a combination of defects during the manufacturing process that resulted in a through wall pinhole leak in the valve body. The NI pipe with the flaw and the valve with the pinhole leak could have structurally performed their design functions. Therefore, the health and safety of the public were not affected by these events.

Valve 2NC-30, the NI pipe, and leaking B-Loop NI check valves were replaced. Thermal cycling monitoring and mitigation devices were installed on Unit 2 and will be installed on Unit 1 during the next refueling outage.



**LICENSEE EVENT REPORT (LER)  
CONTINUATION SHEET**

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**BACKGROUND**

Applicable Energy Industry Identification [EII] system and component codes are enclosed within brackets. McGuire-specific system and component identifiers are contained within parentheses.

**Safety Injection System [BQ](NI):**

The NI system is designed to provide Emergency Core Cooling for the Reactor Coolant System [AB](NC) in order to prevent fuel clad melting to assure that the core remains in place and substantially intact in case of an accident. Each unit's NI system contains an "A" and "B" train pump that both actuate automatically upon a safety injection signal following low pressurizer pressure or high containment pressure. A common NI header in containment splits into four 1.5 inch nominal diameter lines each going into 2A, 2B, 2C and 2D NC Cold Legs. Each of these NI lines has two check valves and one normally opened upstream isolation valve in series.

**Chemical and Volume Control System [CB](NV):**

The NV system is designed to maintain required water inventory in the NC system; maintain seal-water injection flow to the reactor coolant pumps; control water chemistry conditions; and provide emergency core cooling (part of the system shares piping with the NI system).

The event was reported per 10 CFR 50.72(b)(2)(i) for "The initiation of any nuclear plant shutdown required by the plant's Technical Specifications" and 10 CFR 50.72(b)(3)(ii)(A) for "Any event or condition that results in the condition of the nuclear power plant, including its principle safety barriers, being seriously degraded." An Emergency Notification System report was made to the Nuclear Regulatory Commission (NRC) on February 23, 2017, at 22:01 hours. A Licensee Event Report (LER) is also required due to the condition of a nuclear plant, including its principle safety barriers, being seriously degraded (10 CFR 50.73(a)(2)(ii)(A)), the completion of a nuclear plant shutdown required by Technical Specifications (10 CFR 50.73(a)(2)(i)(A)), and an operation or condition prohibited by Technical Specifications (10 CFR 50.73(a)(2)(i)(B)). The associated Technical Specification is 3.4.13, "Reactor Coolant System Operational Leakage."

The 2D NI pipe was replaced during the spring 2014 Unit 2 refueling outage following discovery of a rejectable indication at the pipe to NC nozzle weld. LER 370/2014-01 was submitted and details this event. Corrective actions included the removal of a valve deemed susceptible to leak-by, which can introduce cold water to the NI pipe in question. This pipe receives an inspection each refueling outage per Electric Power Research Institute's Materials Reliability Program MRP-146, "Management of Thermal Fatigue in Normally Stagnant Non-Isolable Reactor Coolant System Branch Lines." This same pipe was inspected during the fall 2015 Unit 2 refueling outage and no reportable indications were identified.

2NC-30 is a three-quarter inch manually operated, Flowserve, Y-Globe, bellows seal design Pressurizer Spray Bypass Valve. Boron was identified at 2NC-30 while conducting a Mode 3 walk down at full temperature and pressure during the spring 2014 Unit 2 refueling outage. The valve was cleaned and the boron was determined to be from an inactive leak. The valve was examined again during the fall 2015 Unit 2 refueling outage and no leaks were identified.



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No significant structures, systems, or components were out of service at the time of discovery that contributed to the event.

**EVENT DESCRIPTION:**

On February 23, 2017, at 19:22 hours, with Unit 1 and Unit 2 at approximately 100 percent power, operators commenced a Unit 2 shutdown upon discovery of pressure boundary leakage on Unit 2 NI pipe upstream of the connection to "D" NC Cold Leg. Subsequent investigation revealed the source of the leak to be a through wall crack on the inside of a bend in the pipe just upstream of the nozzle to the Cold Leg. The leak was approximately 5.75 inches from the nozzle. The indication was open to the surface for a dimension of approximately 0.6 inch of length.

During a containment walk down inspection in Mode 3 on the next day, a pinhole pressure boundary leak was observed in the body of valve 2NC-30.

The relevant sequence of events, with dates and approximate times of occurrence, is as follows:

- 2/23/17 19:22 Commenced Unit 2 shutdown from 100% upon identification of pressure boundary leakage
- 2/23/17 22:00 Reported to the NRC (Event Number 52573)
- 2/24/17 00:41 Unit 2 entered Mode 3
- 2/24/17 16:11 Identified 2NC-30 leak
- 2/24/17 17:21 Unit 2 entered Mode 5
- 3/2/17 15:56 Completed replacement of 2NC-30
- 3/3/17 10:30 Received NRC's verbal approval for alternative repair of NI pipe (Relief Request 17-MN-001)
- 3/5/17 11:01 Completed NI pipe repair by weld overlay
- 3/8/17 16:46 Unit 2 entered Mode 1

**CAUSAL FACTORS:**

The cause of the NI pipe leak is thermal fatigue damage resulting from NC cross-loop flows. Cross-flow was detected between the 2B NC loop and the 2D NC loop through the shared NI lines. This is an unanticipated mode of thermal cycling that is not addressed by MRP-146 and is different from the cause documented in LER 370/2014-01.

The cause evaluation of the 2NC-30 leak identified the cause as a casting flaw attributed to a combination of defects during the manufacturing process that resulted in a through wall pinhole leak in the valve body. At the leak site, substantial amounts of interdendritic porosity were concentrated near the ID and OD surfaces. In addition, elemental segregation (silicon in particular) was identified, and numerous, short, oxide-filled, intermittent, circumferential cracks were present within, and extending from, the regions of clustered porosity. All of the cracks exhibited features consistent with casting flaws (i.e., they were not service-related). The interdendritic porosity in addition to the random silicon presence allowed the crack to form, creating this unique and isolated casting flaw. The Metallurgical Laboratory analysis and results showed that the valve did not



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have any erosion damage present. Due to the random nature of the casting flaw, there is no implication on extent of condition.

**CORRECTIVE ACTIONS:**

**Immediate:**

1. Replaced valve 2NC-30.
2. Repaired 2D NI pipe using weld overlay.

**Subsequent:**

1. Installed strap-on thermocouples/accelerometer on 2D NI piping to monitor temperature and vibration.
2. Replaced 2D NI pipe.
3. Installed a bleed line off of the common NI header to preclude cross-leakage between the NI pipe connections to the NC loops.
4. Installed temperature monitoring devices on susceptible lines.
5. Replaced 2B NI line check valves.

**Planned:**

1. Install during the next Unit 1 refueling outage thermocouples on key Unit 1 MRP-146 locations to monitor thermal cycling conditions (extent of condition).
2. Install during the next Unit 1 refueling outage a pressure bleed line associated with the Unit 1 common NI header to mitigate the effect of in-leakage to the NI lines (extent of condition).

**SAFETY ANALYSIS:**

The NI line to 2D NC Cold Leg is dedicated for emergency injection only, and it is generally stagnant during normal plant operation. The leak in this line remained small, and an orderly shutdown was performed. The leak was much less than what is considered in the Probabilistic Risk Analysis (PRA) Loss Of Coolant Accident (LOCA) analysis. However, an un-isolable leak in the NC pressure boundary constitutes degradation of a principal safety barrier and is reportable to the NRC.

The finite element analysis results support that if the 1.5 inch NI pipe was subjected to any and all applicable primary design loads – including gravity, LOCA, Safe Shutdown Earthquake inertia and Seismic Anchor Motions – during the time in which it contained the through-wall defect up until the point where it was repaired with weld overlay, the remaining cross-section of the pipe would have remained intact and would not have



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experienced significant plastic deformation. Additionally, had the leak location failed catastrophically, the pipe break would have constituted a LOCA. Breaks at this location are bounded by analyses in the McGuire Updated Final Safety Analysis Report which concludes that they can be handled without core damage.

The pinhole leak in 2NC-30 was a minor pressure boundary leak, it did not impact unit operation, and was a negligible contribution to the NC leakage calculation during unit operation.

**ADDITIONAL INFORMATION:**

A review of the McGuire corrective action program was conducted to determine whether this was a recurring event (i.e., similar event with the same cause code). No reactor coolant system pressure boundary through-body valve leaks due to casting flaws have been documented within the past five years. The cause of the 2014 LER was a legacy issue with leakage through valve 2NI-3 (Unit 2 NC Cold Leg Isolation), which created the thermal stratification condition in the 2D NI line. No instances of thermal fatigue caused by cross-loop flows in NI lines have been documented within the past five years. Therefore, this event is not considered a recurring event.