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10 CFR 50.73

January 18, 2011  
BW110006

U. S. Nuclear Regulatory Commission  
ATTN: Document Control Desk  
Washington, DC 20555-0001

Braidwood Station, Units 1 and 2  
Facility Operating License No. NPF-72 and NPF-77  
NRC Docket No. STN 50-456 and STN 50-457

Subject: Licensee Event Report 2010-007-00 – Potential Loss of Residual Heat Removal System Safety Function in Mode 4 When Aligned for Shutdown Cooling Due to Potential for Flashing or Voiding of Coolant During a Shutdown Loss of Coolant Accident

The enclosed Licensee Event Report (LER) is being submitted in accordance with 10 CFR 50.73, "Licensee event report system," paragraphs (a)(2)(i)(B), (a)(2)(v)(B), and (a)(2)(vii). On November 19, 2010, it was identified that there were several occurrences where both residual heat removal (RH) trains were aligned for shutdown cooling with the reactor coolant system at a temperature that could potentially cause RH system voiding during a shutdown loss of coolant accident. 10 CFR 50.73(a) requires an LER to be submitted within 60 days following discovery of the event. Therefore, this report is being submitted by January 18, 2011.

There are no regulatory commitments contained in this letter. Should you have any questions concerning this submittal, please contact Mr. Ronald Gaston, Regulatory Assurance Manager, at (815) 417-2800.

Respectfully,



Amir Shahkarami  
Site Vice President  
Braidwood Station

Enclosure: LER 2010-007-00

cc: NRR Project Manager – Braidwood Station  
Illinois Emergency Management Agency – Division of Nuclear Safety  
US NRC Regional Administrator, Region III  
US NRC Senior Resident Inspector (Braidwood Station)  
Illinois Emergency Management Agency - Braidwood Rep

# LICENSEE EVENT REPORT (LER)

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

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 FOIA/Privacy Section (T-5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet 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.

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**4. TITLE**  
Potential Loss of Residual Heat Removal System Safety Function in Mode 4 When Aligned for Shutdown Cooling Due to Potential for Flashing or Voiding of Coolant During a Shutdown Loss of Coolant Accident

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
11	19	2010	2010	007	00	01	18	2011	Braidwood Station Unit 2	05000457
									FACILITY NAME	DOCKET NUMBER
									N/A	N/A

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

**12. LICENSEE CONTACT FOR THIS LER**

FACILITY NAME Ronald Gaston, Regulatory Assurance Manager	TELEPHONE NUMBER <i>(Include Area Code)</i> (815) 417-2800
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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
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

<b>14. SUPPLEMENTAL REPORT EXPECTED</b> <input type="checkbox"/> YES <i>(If yes, complete 15. EXPECTED SUBMISSION DATE)</i> <input checked="" type="checkbox"/> NO	<b>15. EXPECTED SUBMISSION DATE</b>	MONTH N/A	DAY N/A	YEAR N/A
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**ABSTRACT** *(Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)*

In November 2009, Westinghouse issued Nuclear Safety Advisory Letter (NSAL) 09-8, "Presence of Vapor in Emergency Core Cooling System/Residual Heat Removal System in Modes 3/4 Loss-of-Coolant Accident Conditions." This NSAL clarifies the guidance provided in a previous document, and was issued to ensure consideration of the significantly reduced elevation head present when the residual heat removal (RH) system supply is transferred from the refueling water storage tank (RWST) to the emergency core cooling system (ECCS) recirculation sump.

An evaluation confirmed that the temperature limit currently applied at Braidwood to the RH system for alignment for ECCS injection was sufficient when aligned to the RWST, but could result in flashing of liquids in the hot leg suction lines when the RH system is transferred to the ECCS recirculation sump. The evaluation concluded that the RH temperature must be reduced to eliminate the potential for flashing of hot water within the isolated hot leg suction piping during transfer to the ECCS recirculation sump.

On November 19, 2010, a review identified four occurrences (two on Unit 1 and two on Unit 2) in the past three years where both RH trains were placed into operation prior to reaching Mode 5 (<= 200 degrees F).

The cause of this event was the failure to consider bounding conditions when calculating the temperature limit to prevent flashing in the RH system. Corrective actions include implementation of a standing order for RH to address the new temperature limits for these conditions, revise the associated operating and emergency procedures to reflect the more restrictive temperature limits, and revise Technical Specification Bases 3.5.3, "ECCS – Shutdown," to reflect the new temperature limit.

There were no actual safety consequences impacting plant or public safety as a result of the event.

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**NARRATIVE**

**Background:**

In 1993, Westinghouse issued Nuclear Safety Advisory Letter (NSAL) 93-004, "RHRS Operation as Part of the ECCS During Plant Startup." Westinghouse NSAL-93-004 identified a potential concern associated with steam flashing of hot water in the residual heat removal (RH) [BP] system suction piping when the RH system is transferred from shutdown cooling mode (SDC) to the emergency core cooling system (ECCS) mode with the lower pressure refueling water storage tank (RWST) aligned as the RH system water source. Braidwood Station determined that the RWST elevation head was sufficient to prevent flashing of water less than 260 degrees Fahrenheit (F) in the RH system suction piping. The station review of NSAL-93-004 resulted in precautions and venting guidance being implemented as recommended into station procedures to prevent flashing of hot water trapped in the RH system piping during realignment to the RWST.

In November 2009, Westinghouse issued NSAL-09-8, "Presence of Vapor in Emergency Core Cooling System/Residual Heat Removal System in Modes 3/4 Loss-of-Coolant Accident Conditions." This NSAL clarifies the previous guidance provided in NSAL-93-004 to ensure the affected facilities take into consideration the significantly reduced elevation head present when the RH system supply is transferred from the RWST to the ECCS recirculation sump.

**A. Plant Operating Conditions Before the Event:**

Event Date: November 19, 2010

Unit: 1                      MODE: 1                      Reactor Power: 100 percent  
 Unit: 2                      MODE: 1                      Reactor Power: 100 percent

Unit 1 Reactor Coolant System [AB]:                      Normal operating temperature and pressure  
 Unit 2 Reactor Coolant System:                              Normal operating temperature and pressure

**B. Description of Event:**

No structures, systems or components were inoperable at the start of this event that contributed to the event.

On February 9, 2010, as a result of a review of NSAL-09-8, it was determined that while it appeared that controls had been established to adequately address the new concerns presented under NSAL-09-8, the basis for the 260 degree F temperature limitation and 15-hour cooldown time previously imposed by the procedures could not be readily ascertained. Therefore, an engineering evaluation was initiated to confirm the temperature and time limits previously implemented were acceptable, and to confirm the conclusion that the limits established in response to NSAL-93-004 appropriately address the NSAL-09-8 concerns.

The engineering evaluation confirmed that the 260 degree F limit currently applied to the RH system for alignment for ECCS injection is sufficient to prevent flashing/voiding in RH system piping when aligned to the RWST but could result in flashing of liquids in the hot leg suction lines, when the RH system is transferred to the ECCS recirculation sump. This potential exists due to the elevation differences between the RH lines at the containment penetrations and the expected containment sump level combined with the postulated containment pressure at the established 260 degree F limit. The evaluation concluded that the RH system temperature must be reduced to 200 degrees F in order to eliminate the potential for flashing of hot water within the isolated hot leg suction piping during transfer to the ECCS recirculation sump. This information affects the manner in which the RH system will be required to be operated in Mode 3 ( $\geq 350$  degrees F) and Mode 4 (350 degrees F > T-average > 200 degrees F).

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Administrative controls were implemented at Braidwood Station to address the RH issue:

- During RCS cooldown at least one train of RH will be aligned for injection until RCS temperature is < 200 degrees F. (Mode 5)
- During RCS heatup at least one train, preferably both, will be aligned for injection prior to raising RCS temperature >= 200 degrees F. (Mode 4)

On November 19, 2010, the review of the past three years was performed to determine if Braidwood may have operated with both trains of RH shutdown cooling in service in Mode 4 (above 200 degrees F). Four occurrences were identified where both RH trains were placed into operation prior to reaching Mode 5 (<= 200 degrees F):

- October 12, 2009, Unit 2 refueling outage. The second train of RH was placed in SDC at 0527; Mode 5 occurred at 0532 (2 trains in SDC for 5 minutes with RCS > 200 degrees F)
- March 30, 2009, Unit 1 refueling outage. The second train of RH was placed in SDC at 0551; Mode 5 occurred at 0608 (2 trains in SDC for 17 minutes with RCS > 200 degrees F)
- April 21, 2008, Unit 2 refueling outage. The second train of RH was placed in SDC at 0745; Mode 5 occurred at 0805 (2 trains in SDC for 20 minutes with RCS > 200 degrees F)
- October 1, 2007, Unit 1 refueling outage. The second train of RH was placed in SDC at 0510; Mode 5 occurred at 0538 (2 trains in SDC for 28 minutes with RCS > 200 degrees F)

These conditions represent an event or condition that could have prevented fulfillment of a safety function. Therefore, this event is being reported pursuant to 10 CFR 50.73(a)(2)(i)(B), any operation or condition which was prohibited by Technical Specifications; 10 CFR 50.73(a)(2)(v)(B) as a condition that could have prevented the fulfillment of a system's safety function; and 10 CFR 50.73(a)(2)(vii), any event where a single cause or condition caused two independent trains to become inoperable in a single system.

**C. Cause of Event**

The cause of this event was the failure to consider bounding conditions when calculating the temperature limit to prevent flashing in the RH system.

Based on the history of this industry issue, deficiencies existed in the original RH system design and system operating guidance provided by the equipment manufacturer. Contributing to this was that the Braidwood historical review of NSAL-93-004 was less than adequate in that the review did not address the full scope of the issue when it was originally evaluated in 1994.

**D. Safety Consequences:**

There were no actual safety consequences impacting plant or public safety as a result of this event. This issue addressed the potential for the development of steam voiding in the RH pump suction shutdown cooling piping of the RH system if the RH system had to be transitioned from shutdown cooling to the ECCS mode due to a LOCA occurring in Modes 3 or 4 at temperatures above 200 degrees F (Modes 3 and 4).

The potential exists for flashing/steam voiding of an RH system hot leg suction line if the RH system is aligned for ECCS recirculation, following termination of shutdown cooling with an RH temperature that exceeds 200 degrees F, and suction of the RH system is transferred to the ECCS recirculation sump during a LOCA. Therefore, this is considered a safety system functional failure.

In the event that the RH system became inoperable, abnormal and emergency procedures exist that provide guidance to immediately secure any RH pumps aligned for shutdown cooling to prevent pump damage, to restore core cooling through alignment of a high head safety injection pump [BQ] in injection mode, and restoration of the medium head safety injection pumps [BQ] if necessary. Existing procedures also include steps to vent and refill the

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**NARRATIVE**

RH loops if necessary. In Modes 3 or 4, at least one charging (CV) [CB] pump is available and would be aligned to the RWST. Additionally, the steam generators would be available with auxiliary feedwater providing a heat sink to aid in decay heat removal.

When this issue was first identified by Westinghouse in NSAL-93-004, Westinghouse performed an Assessment of Safety Significance. Referencing prior work documented in WCAP-12476, "Evaluation of LOCA during Mode 3 and Mode 4 Operation for Westinghouse NSSS," which looked at the probabilities of a LOCA in Modes 3 or 4 and available guidance for actions to cope with a shutdown LOCA, Westinghouse concluded that this issue was not risk significant in regard to large LOCAs in Mode 3 and the relative risk was not much different whether or not flashing occurs in Mode 4. In the more recently issued NSAL-09-8, Westinghouse states that the conclusion of the previous safety significance assessments for this issue was based on the low risk of this event. This conclusion remains valid since no new information changes this condition. The consequences of RH system failure due to suction flashing in Modes 3 or 4 remained bounded by the core damage consequences of the Mode 1 LOCA events. This is because of the reduced pipe break probability due to the relatively low temperatures and pressure that exist for the majority of time the plant is in these modes. It is also reflective of the time the plant is in these modes, which is very short relative to the time it is in Mode 1. Therefore, the risk significance of this event is considered to be low.

**E. Corrective Actions:**

The corrective actions include:

- A standing order was implemented for the RH system to establish controls that ensure at least one train of RH be aligned for injection when RCS temperature is > 200 degrees F.
- Revise the associated operating and emergency procedures to reflect the more restrictive 200 degrees F temperature limit for restoration/alignment of an RH Train for ECCS injection following termination of shutdown cooling.
- Revise Technical Specification Bases 3.5.3, "ECCS – Shutdown," to reflect the new temperature limit.

**F. Previous Occurrences:**

There have been no previous, similar Licensee Event Reports identified at the Braidwood Station.

**G. Component Failure Data:**

<u>Manufacturer</u>	<u>Nomenclature</u>	<u>Model</u>	<u>Mfg. Part Number</u>
N/A	N/A	N/A	N/A