

# ACCELERATED DISTRIBUTION DEMONSTRATION SYSTEM

## REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

ACCESSION NBR:8803070020 DOC.DATE: 88/02/29 NOTARIZED: NO DOCKET #  
 FACIL:50-261 H.B. Robinson Plant, Unit 2, Carolina Power & Light C 05000261  
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SUBJECT: LER 87-026-01:on 871030,potential for RHR pump failure due to inadequacy in design discovered.

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U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMB NO. 3150-0104

EXPIRES: 8/31/88

## LICENSEE EVENT REPORT (LER)

FACILITY NAME (1) H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2										DOCKET NUMBER (2) 0 5 0 0 0 2 6 1				PAGE (3) 1 OF 0 6		
TITLE (4) POTENTIAL FOR RESIDUAL HEAT REMOVAL PUMP FAILURE DUE TO AN INADEQUACY IN DESIGN																
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)			
1	0	8	8	0	2	0	1	0					0 5 0 0 0			
THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)																
OPERATING MODE (9)		N														
POWER LEVEL (10)		1 0 0														
		20.402(b)				20.405(c)				50.73(a)(2)(iv)				73.71(b)		
		20.405(a)(1)(i)				50.36(c)(1)				X 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)(ii)				50.73(a)(2)(viii)(A)						
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		20.405(a)(1)(v)				50.73(a)(2)(iii)				50.73(a)(2)(x)						
LICENSEE CONTACT FOR THIS LER (12)																
NAME David Crook, Senior Specialist - Regulatory Compliance										TELEPHONE NUMBER AREA CODE 810 331 831-1117 19						
COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)																
CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPD		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPD						
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ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

On October 30, 1987, licensee review of a situation at a plant of similar vintage Nuclear Steam Supply System (NSSS) design as H. B. Robinson Unit No. 2 determined that the potential for degraded recirculation flow the the Residual Heat Removal (RHR) pumps (low head Safety Injection (SI) pumps) may exist. The NSSS designer had identified two concerns recently involving the potential for a loss of discharge flow for one pump with two pumps in operation, and, the potential for insufficient miniflow capacity for one pump operation. These concerns were identified as also potential for the high head SI pumps. The licensee's Plant Nuclear Safety Committee held session and determined that further evaluation was required. In addition, Plant emergency operating procedures were immediately revised to preclude pump damage during conditions with no discharge flowpath. The miniflow capacity issue was referred to the NSSS designer for evaluation. The licensee notified the Nuclear Regulatory Commission at 1625 hours, pursuant to 10CFR50.72(b)(2)(iii). On November 17, 1987, I&E Notice 87-59 was issued regarding the two NSSS design concerns. The final NSSS evaluation report will be discussed in a Supplemental Report to this Licensee Event Report. Neither potential concern has been of impact to Plant safety or the health and safety of the public since, historically, systems have functioned as required. This report is submitted pursuant to 10CFR50.73(a)(2)(v).

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## LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMB NO. 3150-0104

EXPIRES: 8/31/88

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H. B. ROBINSON S. E. PLANT, UNIT NO. 2	05000261	87	026	01	02	OF	06

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

I. DESCRIPTION OF EVENT

On Friday, October 30, 1987, the potential for degraded recirculation flow for the Residual Heat Removal (RHR) pumps<sup>1</sup> was identified by the licensee during review of a similar situation discovered at another plant of the same vintage Nuclear Steam Supply System (NSSS) design.<sup>2</sup>

In an October 26, 1987 letter, the NSSS designer for H. B. Robinson Unit No. 2 described two RHR pumps miniflow configuration design concerns. The first concern involved the potential for "dead-heading," (i.e., no discharge flow path), one of the two pumps in system designs having a miniflow line common to two low head Safety Injection (SI) pumps.<sup>1</sup> The second concern involved whether the installed miniflow capacity was adequate for a single RHR pump in operation. Both issues were based on an evaluation of RHR pumps at a particular plant of similar NSSS design, but the concerns may also exist for other plants configured with a common recirculation flowpath or with a miniflow sized solely upon fluid temperature rise considerations. In addition, the concerns could also apply to high head SI pumps.<sup>3</sup>

The RHR pumps' miniflow line diverts part of the pumps' discharge flow back to the pumps' suction to ensure the pumps do not overheat or vibrate excessively during surveillance testing or when the Reactor Coolant System (RCS)<sup>4</sup> pressure exceeds the pump shutoff head during the Emergency Core Cooling System (ECCS)<sup>5</sup> injection phase of SI. Whenever two centrifugal pumps operate in parallel, there may be a tendency for one to perform slightly better than the other. This difference is inconsequential at moderate to high flow conditions. There is, however, a tendency during operation of one pump on miniflow to dead-head the parallel pump under low flow conditions.

Figure 1 provides a flow diagram of the RHR pump miniflow recirculation system at H. B. Robinson Unit No. 2.

<sup>1</sup>EIIS Codes: System - BP; Component - P; Manufacturer - 1075. The RHR pumps are the low head Safety Injection pumps.

<sup>2</sup>EIIS Codes: System and Component - Not available; Manufacturer - W120. Robinson Unit No. 2 is a three-loop Pressurized Water Reactor nuclear power plant in commercial operation since March 1971.

<sup>3</sup>EIIS Codes: System - BQ; Component - P; Manufacturer - W318.

<sup>4</sup>EIIS Codes: System - AB; Component - Not available; Manufacturer - W120.

<sup>5</sup>EIIS Codes: System and Component - Not available; Manufacturer - W120.

## LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

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TEXT (If more space is required, use additional NRC Form 306A's) (17)

The NSSS designer for H. B. Robinson Unit No. 2 has described the concerns as involving a "potential safety item." The NSSS design for H. B. Robinson Unit No. 2 has determined the length of time an RHR pump may run under dead-headed conditions. With the Refueling Water Storage Tank (RWST)<sup>6</sup> maximum temperature as 100 degrees Fahrenheit and pump suction pressure as 26.5 pounds per square inch absolute (psia), the pump could operate dead-headed for up to 10.4 minutes without pump degradation or damage. Regarding the second issue, the pump manufacturer has, according to the NSSS designer, recommended a minimum recirculation flowrate of 500 gallons per minute (gpm) for each pump to ensure safe continuous pump operation on miniflow. This flowrate envelopes both thermal rise and pump vibration considerations.

The licensee's Plant Nuclear Safety Committee (PNSC) convened on October 30, 1987, in special session to review the potential concerns regarding the RHR pump recirculation design configuration and applicability to H. B. Robinson Unit No. 2. The PNSC determined that the conditions may be applicable and warranted additional evaluation and resolution.

The licensee notified the Nuclear Regulatory Commission of a four-hour non-emergency event at 1625 hours on October 30, 1987, pursuant to 10CFR50.72(b)(2)(iii).

## II. CAUSE OF EVENT

The potential for the stronger RHR pump to dead-head the weaker due to a common miniflow recirculation configuration and the potential for insufficient miniflow recirculation for even one RHR pump are due to inadequacies in the original design based on today's criteria.

## III. ANALYSIS OF EVENT

The RHR pump miniflow recirculation design basis assumed that the two pumps have equal flow/head curves and that each would achieve a flow of about 250 gpm while both were operated simultaneously. The estimated flow for a single pump operating only on miniflow would be between 400 and 500 gpm, although this value was never explicitly calculated by the NSSS designer. The assumed flowrates were considered conservatively high estimates when calculating the minimum required low head SI flowrates since the pump vendor required only 100 gpm based on thermal rise.

At present, however, the pump vendor recommends a minimum flow of 50 gpm for each pump to prevent excessive vibration and pump binding caused by heatup of the recirculated fluid. In addition, if the RHR pump performance is not equal for pumps sharing a common miniflow path, the stronger pump may dead-head the weaker. This can be determined by evaluating relative pump strengths and the miniflow piping resistance. Based on calculations by the NSSS designer, however, a duration of 10.4 minutes continuous run with one RHR pump dead-headed will result in no pump degradation or damage.

<sup>6</sup>EIIS Codes: System - BQ; Component - ##?TK; Manufacturer - W120.

## LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

U.S. NUCLEAR REGULATORY COMMISSION

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

Since the NSSS designer identified the potential problem, the actual flowrates for both the "A" and "B" RHR pumps while on miniflow recirculation have been calculated by licensee Performance Engineering personnel for H. B. Robinson Unit No. 2. The two pumps have approximate flowrates of 367 gpm and 320 gpm, respectively. The 500 gpm flowrate is based on continuous run with no resultant pump degradation. Shorter run times may be acceptable with less flow.

The NSSS designer has been contacted to provide further evaluation into the potential concerns as they may apply to the specific RHR pump miniflow recirculation configuration at H. B. Robinson Unit No. 2. Initial indications are that the concern for the "A" pump potentially dead-heading the "B" pump does not apply, based on historical data from prior years of surveillance testing which requires the pumps to run on miniflow recirculation for up to 30 minutes with no apparent pump degradation. The concern regarding a flow of 500 gpm in accordance with the pump vendor recommendations may not be of consequence and a 300 gpm flowrate may be satisfactory and sufficient for pump reliability. Using known minimum flowrates for the RHR pumps, the NSSS designer will identify and evaluate various operating modes and times under which the pumps are anticipated to run.

The potential concerns have been determined not to apply to the high head SI pump design configuration at H. B. Robinson Unit No. 2. Each of the three SI pumps has a 3/4-inch recirculation line with an orifice prior to connecting to a common 2-inch line. Each pump recirculates 37 gpm which satisfies the normal recirculation flowrate of 100 gpm for the three pumps.

There has been no impact on safety and no threat to the public health. Historically, systems have functioned as required. In addition, one RHR pump is sufficient to remove residual heat and ensure core cooling. However, in the event of pump damage due to the condition as described, the Plant would be dependent on only one RHR pump with no redundancy.

On November 17, 1987, the Nuclear Regulatory Commission issued I&E Notice No. 87-59 regarding potential RHR pump loss. The notice resulted from recent information from the same NSSS designer concerning the minimum flow recirculation line configuration for RHR pumps which also function as low pressure safety injection pumps. The NSSS designer had notified all utilities with a similar NSSS design of two concerns regarding the design of the miniflow recirculation for RHR pumps (low head SI pumps). The concerns are discussed earlier in this report.

According to the I&E Notice, a small break loss-of-coolant accident causes an SI signal to be generated. This starts both RHR pumps and, for some plants, circulates coolant through a common miniflow recirculation line until the RCS is depressurized to below the pump shutoff head: the point at which the pumps can deliver coolant to the RCS. The flow resistance of the miniflow line is great enough that during recirculation the RHR pumps are operating close to their shutoff head and even modest degradation of one pump can result in it being dead-headed by the other pump. The Notice recommends that the emergency operating procedures require that a dead-headed pump be stopped. To avoid loss of safety margin, it is important that this action be taken before pump damage is sustained.

## LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

U.S. NUCLEAR REGULATORY COMMISSION

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TEXT (If more space is required, use additional NRC Form 365A's) (17)

The NSSS designer has indicated, according to the I&C Notice, that traditionally the design criteria for miniflow lines have been based on the need to limit the temperature rise in the pumped liquid and pump casing. However, that design criteria should include consideration of the potential for pump operation at conditions close to the pump shutoff head. The traditional design values have been for only five percent to 15 percent of pump design flow, while some pump manufacturers are advising minimum flow capacities of 25 percent to over 50 percent of best efficiency flow for extended operation.

#### IV. CORRECTIVE ACTION

Immediate correction active was taken on October 30, 1987. The emergency operating procedures were changed to ensure that one RHR pump is secured when two RHR pumps are operating following an automatic start signal and RCS pressure is above the pump shutoff head.<sup>7</sup> The revision is based on information provided through the Plant NSSS Owners Group.<sup>8</sup>

A Supplemental Report will be submitted to update this Licensee Event Report upon completion of further evaluation into the potential concerns and their applicability to H. B. Robinson Unit No. 2. This Supplement will provide information on the planned corrective actions to address the concerns, as applicable.

#### V. ADDITIONAL INFORMATION

##### A. FAILED COMPONENT IDENTIFICATION

There were no failed components associated with this event. The potential for failure of the weaker RHR pump while both pumps are on miniflow recirculation would be due to an inadequacy in original design as compared to today's requirement for minimum flow has been precluded by a change to emergency operating procedures.<sup>9</sup> The potential for pump degradation and failure due to insufficient flowrate while on miniflow recirculation is still under evaluation.<sup>9</sup>

The following details are provided for information.

RHR pumps "A" and "B" are Ingersoll-Rand Cameron Pump Division, Type W, Model 8x20 W, vertical, single stage, centrifugal pumps, each driven by a 300 horsepower, 1777 revolutions per minute (rpm), 60 cycle, vertical, 410 Volt AC motor, Frame No. 506-UPZ; John Crane Shaft Seal Type 1. The pumps have a design pressure of 600 pounds per square inch gauge (psig) and a design temperature of 400 degrees Fahrenheit.

The RHR System is a Westinghouse NSSS design.

<sup>7</sup>Plant Operating Manual End Path Procedure Foldout A, Revision 2 of 10/30/87.

<sup>8</sup>Westinghouse Owners Group (WOG)

<sup>9</sup>Cause Code - B.

## LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

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

SI pumps "A", "B", and "C" are Worthington Corporation, Type 3WTS-811, multi-stage, diffuser-type, centrifugal pumps, each driven by a Westinghouse Type A squirrel-cage, 350 horsepower, 3600 rpm, 60 cycle, 460 Volt AC motor.

The SI System is a Westinghouse NSSS design.

B. SIMILAR PREVIOUS EVENTS

There are no known prior LERs concerning a potential design deficiency with regard to the RHR miniflow recirculation configuration.

C. SUPPLEMENT REPORT - FINAL NSSS SUPPLIER EVALUATION

The evaluation performed by the NSSS supplier for H. B. Robinson Unit No. 2 was completed on December 29, 1987, and a report was submitted to CP&L. This report evaluated the adequacy of the installed miniflow circuit for single RHR pump operation. The following operating events were considered within the scope of the evaluation:

- Recirculation to assure adequate boron mixing with the RHR loop prior to RHR initiation during Plant shutdown.
- RHR pump surveillance program.
- Automatic pump start following an SI signal while RCS pressure remains above the shutoff head 1) with; and 2) without an assumed single failure.

The estimated operating minimum flow conditions for each event were identified within the evaluation.

A separate calculation was performed for the operating event with automatic pump start following a SI signal while RCS pressure remains above the RHR pump shutoff head without a single failure. Based on this calculation, it was estimated that the RHR pumps can operate at zero flow (dead-head condition) for 9.3 minutes before the pump begins to cavitate.

Based on H. B. Robinson RHR pump operating conditions, the following conclusions were made:

1. Flowrates of 300 gpm for each RHR pump are sufficient to prevent flashing from occurring in the pump and excessive pump wear during intermittent operation.
2. An estimated 9.3 minutes are available for operator action before a dead-headed (zero flow) RHR pump begins to cavitate.

Based on these conclusions, H. B. Robinson Emergency Operating Procedures have been revised to reflect a nine minute time limit for operator action to preclude pump damage from zero flow operation.



**Carolina Power & Light Company**

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FEB. 29 1988

Robinson File No: 13510C

Serial: RNP/88-0607  
(10 CFR 50.73)

United States Nuclear Regulatory Commission  
Attn: Document Control Desk  
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H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2  
DOCKET NO. 50-261  
LICENSE NO. DPR-23  
LICENSEE EVENT REPORT 87-026 REVISION 1

Dear Sir:

The enclosed Licensee Event Report (LER) is submitted in accordance with the Licensee Event Report System of 10 CFR 50.73 and the recommendations of NUREG-1022 and Supplements No. 1 and 2. The original LER of November 29, 1987, stated that the NSSS designer for H. B. Robinson had been contacted to provide further evaluation of the RHR Pump Miniflow recirculation capacity applicable for the H. B. Robinson configuration. This supplement to the LER provides additional information concerning the results of that evaluation and subsequent corrective action. This supplemental LER, Revision 1, should replace all existing copies of the original report.

Very truly yours,

R. E. Morgan  
General Manager  
H. B. Robinson S. E. Plant

RDC:jch

Enclosure

cc: Dr. J. N. Grace  
Mr. L. N. Garner  
INPO

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