NRC FORM 195 (2-76)

U.S. NUCLEAR REGULATORY COMMISSION

NRC DISTRIBUTION FOR PART 50 DOCKET MATERIAL

DOCKET NUMBER: 50-331

FILE NUMBER:

TO: Mr Lear

FROM: Iowa Elec Light & Pwr Co
Cedar Rapids, Ia
L LWU

DATE OF DOCUMENT: 6-18-76

DATE RECEIVED: 6-22-76

☒ LETTER ☒ ORIGINAL ☐ COPY ☒ NOTORIZED ☒ UNCLASSIFIED

PROP

INPUT FORM

NUMBER OF COPIES RECEIVED: 3 signed

DESCRIPTION

Ltr re our 5-17-76 ltr.....trans the follow:
(Notarized 6-18-76)

PLANT NAME: Duane Arnold

ENCLOSURE

Summary of possible effects on long term heat removal capabilities from potential RHR (LPCI) pump runout conditions following a postulated LOCA.................

(40 cys encl rec'd)

FOR ACTION/INFORMATION — SAFETY — ENVIRO 6-23-76 ehf

SAFETY		ENVIRO	
ASSIGNED AD:		ASSIGNED AD:	
✓ BRANCH CHIEF:	Lear (5)	BRANCH CHIEF:	
✓ PROJECT MANAGER:	Paulson	PROJECT MANAGER:	
✓ LIC. ASST.:	Parrish	LIC. ASST.:	

INTERNAL DISTRIBUTION

✓ REG FILE	SYSTEMS SAFETY	PLANT SYSTEMS	ENVIRO TECH
✓ NRC PDR	HEINEMAN	TEDESCO	ERNST
✓ I & E (2)	SCHROEDER	BENAROYA	BALLARD
✓ OELD		LAINAS	SPANGLER
✓ GOSSICK & STAFF	ENGINEERING	IPPOLITO	
MIPC	MCCARY		SITE TECH
CASE	KNIGHT	OPERATING REACTORS	GAMMILL
HANAUER	SIHWEIL	STELLO	STEPP
HARLESS	PAWLICKI		HULMAN
		OPERATING TECH	
PROJECT MANAGEMENT	REACTOR SAFETY	✓ EISENHUT	SITE ANALYSIS
BOYD	ROSS	✓ SHAO	VOLLMER
P. COLLINS	NOVAK	✓ BAER	BUNCH
HOUSTON	ROSZTOCZY	✓ SCHWENCER	J. COLLINS
PETERSON	CHECK	✓ GRIMES	KREGER
MELTZ			
HELTEMES	AT & I	SITE SAFETY & ENVIRO	
SKOVHOLT	SALTZMAN	ANALYSIS	
	RUTBERG	DENTON & MULLER	

EXTERNAL DISTRIBUTION

✓ LPDR: Cedar Rapids, Ia	NATL LAB	BROOKHAVEN NATL LAB
✓ TIC	REG. V-IE	ULRIKSON (ORNL)
✓ NSIC	LA PDR	
ASLB	CONSULTANTS	
✓ ACRS 16 ~~HOLDING~~/SENT TO LA Parrish		

CONTROL NUMBER: 6293

IOWA ELECTRIC LIGHT AND POWER COMPANY

General Office

CEDAR RAPIDS, IOWA

LEE LIU
VICE PRESIDENT – ENGINEERING

June 18, 1976
IE-76-937

RECEIVED
JUN 22 1976
U.S. NUCLEAR REGULATORY COMMISSION
Mail Section

Mr. George Lear, Chief
Operating Reactors Branch 3
Division of Operating Reactors
Nuclear Regulatory Commission
Washington, D.C. 20555

50-331

Dear Mr. Lear:

In response to your letter dated May 17, 1976 we are submitting a summary of possible effects on long term heat removal capabilities from potential RHR (LPCI) pump runout conditions following a postulated LOCA.

The analysis has shown that the Duane Arnold Energy Center will not experience RHR pump cavitation or pump runout resulting in damaging motor overloading following a postulated LOCA.

Three signed originals and 37 copies of this letter and attachment are transmitted herewith. This letter and its attachment are true and accurate to the best of my knowledge and belief.

Iowa Electric Light and Power Company

By: [signature]
Lee Liu
Vice President, Engineering

LL/HWS/ms
Attachment
cc: H. Shearer
D. Arnold
J. Newman
J. Shea (NRC)
L. Root
File A-107
A-225
E-17

Subscribed and Sworn to before me on this 18th day of June, 1976.

[signature]
Notary Public in and for the State of Iowa.

Wendy Rodenhizer
NOTARY PUBLIC
STATE OF IOWA
Commission Expires
September 30, 1976

DOCKETED
USNRC
JUN 22 1976
U.S. NUCLEAR REGULATORY COMMISSION
Mail Section

6293

POTENTIAL RHR (LPCI) PUMP RUNOUT
EVALUATION SUMMARY

I. INTRODUCTION

The Nuclear Regulatory Commission (NRC) letter dated May 17, 1976 identified that pump runout conditions could occur in certain situations where the RHR (LPCI) pumps discharge to flow paths with too little system flow resistance. Operation of the RHR (LPCI) pumps under this condition could result in damage to the pumps due to cavitation and/or motor overload. The Duane Arnold Energy Center is in the category of BWR-3 and BWR-4 plants with unmodified Loop Selection Logic Systems. The following situations could potentially result in RHR (LPCI) pump runout conditions and a subsequent reduction or loss of long term heat removal capability following a postulated loss-of-coolant accident (LOCA) for this category of plant.

1. Four LPCI pumps injecting into a broken recirculation loop from a single Loop Selection Logic System (LSLS) failure.

2. Four LPCI pumps injecting into both recirculation loops simultaneously, with one loop broken, from a single LSLS failure.

3. Operation with three pumps providing flow (one pump inoperable as allowed per Technical Specification) to the unbroken loop, with the single failure of a recirculation loop discharge valve to close.

4. Other conditions as may be identified in the evaluation.

II. EVALUATION

An evaluation was performed on the Duane Arnold Energy Center RHR System to determine possible effects on long term heat removal capabilities. With respect to the above potential RHR runout conditions, no other situations were found to be more severe than conditions one through three, above.

A. Loop Resistance

Resistance calculations were performed on the RHR - Recirculation piping network to determine the loop with highest RHR pump runout potential. The following network configurations were evaluated with respect to their associated potential RHR runout conditions:

1. Condition No. 1

   a) RHR Pumps Operating A, B, C, D
   b) Recirculation Loop B broken
   c) All RHR pumps injecting into B recirculation loop

2. Condition No. 2

   a) RHR Pumps Operating A, B, C, D
   b) Recirculation Loop B broken
   c) All four RHR pumps simultaneously injecting into Recirculation Loops A & B (cross-tie open).

3. Condition No. 3

   a) RHR Pumps Operating B, C, D
   b) Recirculation Loop A broken
   c) B, C, & D RHR pumps injecting into intact Recirculation Loop B
   d) Recirculation Loop B discharge valve fails to close.

In conditions 1 through 3 the resistance in the RHR pump discharge lines was found to be lowest when injecting into B recirculation loop.

In condition 3 the A RHR pump was found to have the lowest relative suction resistance and the highest relative discharge resistance. This would present the least cavitation runout potential of any of the four RHR pumps. The A RHR pump was therefore assumed to be inoperable (as per Technical Specifications).

B. <u>RHR Pump, Cavitation</u>

After selecting the piping configuration presenting the greatest potential for runout, the potential for cavitation was evaluated for each RHR pump with respect to conditions 1 through 3 above. The calculated Net Positive Suction Heads (NPSH) for each case are listed in the following table along RHR pump requirements. These calculations were performed in accordance with Nuclear Regulatory Guide 1.1.

(CONTINUED ON PAGE 3)

RHR (LPCI) PUMP NET POSITIVE SUCTION HEAD

Parameter*	PHR Injection Pumps A	C	B	D	Comment
Condition No. 1					
flowrate, GPM	6140	6331	6482	6448	no cavitation
total head, ft.	255	255	245	245	
avail. NPSH, ft.	24.3	22.3	27.2	24.1	
required NPSH, ft.	10	11	12	12	
Condition No. 2					
flowrate, GPM	6425	6625	6552	6517	no cavitation
total head, ft.	221	221	211	211	
avail. NPSH, ft.	22.8	20.7	26.7	23.5	
required NPSH, ft.	11	12	12	12	
Condition No. 3					
flowrate, GPM	N/A	6643	6151	6119	no cavitation
total head, ft.	N/A	221	265	265	
avail. NPSH, ft.	N/A	27.4	27.9	25.0	
required NPSH, ft.	N/A	13	10	10	

*Heads are in feet of water at 62.4 $\#/FT^3$

In each of the above cases, adequate NPSH was maintained for each RHR pump precluding cavitation.

Note: 1. Assumptions used in calculating the resistance in the RHR pump suction lines maximized the line resistance.

2. In condition 3 the A pump was conservatively assumed to fail. If the B, C or D pump was assumed to be inoperable, the potential for cavitation in the three remaining pumps would be less severe.

C. RHR Pump Motor Overload

Each RHR pump was evaluated for potential motor overload for the three conditions evaluated. The maximum calculated values for motor current and allowable times at current are summarized below:

Condition	Maximum Motor Current	Maximum Allowable Time at Max. Motor Current
1, 2, 3	$<$ 1.20 of rated	25 minutes

The worst case of motor current occurs in Condition 2. The motor current will remain less than 1.20 times rated. The continuous motor service factor is 1.15. Design motor data allow the motor to remain at the 1.20 value for 25 minutes before corrective action is necessary. Motor current loads for conditions 1 and 3 are less severe.

Note: 1. Assumptions used in calculating the resistance in the RHR pump discharge lines minimized the line resistance.

2. If a broken A recirculation loop were assumed for conditions 1 and 2 or an intact A recirculation loop were assumed in condition 3, the potential for RHR pump motor overload would be less.

3. No credit was taken for reactor pressure vessel water level after core reflood. This would increase system backpressure, with corresponding reductions in system flow and motor current in conditions 2 and 3.

III. CONCLUSION

In the above evaluation summary of potential RHR (LPCI) pump runout conditions it was found that adequate available NPSH was maintained to preclude pump cavitation. It was also determined that RHR (LPCI) pump motor current would not exceed design limits for 25 minutes allowing sufficient time for an operator to take corrective action. Therefore, it has been determined that the long term cooling potential for the Duane Arnold Energy Center will not be lost or decreased from potential RHR pump runout conditions following a postulated LOCA. This conclusion is based on a set of conservative assumptions which were used in the evaluation.