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ENCLOSURES: Encl:(A) entitled "H.B. Robinson Unit 2 Cycle 4 Reload Application Response to NRC Staff Request for Addl Info"

Encl.(B) entitled XN-75-57 Revision 1 entitled "H.B. Robionson Unit 2 LOCA Analyses Using the ENC Wren Based PWR ECCS Evaluation Model(Sept. 26, 1975 Version) dated 11-9-75"

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Regulatory Docket File

Carolina Power & Light Company

November 13, 1975

FILE: NG-3514(R)

SERIAL: NG-75-2040

RECEIVED NOV 20 1975 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

Mr. Benard C. Rusche, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

RE: H. B. ROBINSON UNIT NO. 2
DOCKET NO. 50-261
FACILITY OPERATING LICENSE NO. DPR-23

Dear Mr. Rusche:

Carolina Power & Light Company (CP&L) submits five (5) copies of Exxon Nuclear Company, Inc. (ENC) Report XN-75-57, Revision 1, "H. B. Robinson Unit No. 2 LOCA Analyses Using the ENC WREM Based PWR ECCS Evaluation Model (September 26, 1975 Version)." Thirty-five (35) copies of XN-75-57, Revision 1, are being transmitted directly to the NRC by ENC.

Report XN-75-57 has been revised in response to your Staff's request for additional analyses to identify trends related to break spectrum. Additional large break calculations were performed using the September 26, 1975 version of the ENC PWR evaluation model with updated system information. Additional split break analyses and small break analyses were also performed.

Carolina Power & Light Company also submits responses to two questions from your Staff on rod bowing and core flow instability effects as Enclosure A to this letter.

This submittal includes three signed originals of the transmittal letter and 37 copies, 40 copies of Enclosure A, and five (5) copies of XN-75-57, Revision 1.

DOCKETED USNRC NOV 20 1975 MAIL SECTION DOCKET CLERK

Yours very truly,

N. B. Bessac
N. B. Bessac
Manager
Nuclear Generation

RLM/nja

Sworn to and subscribed before me this 13th day of November, 1975.

Marilyn V. Pease
Notary Public

My Commission Expires: October 19, 1980

13217

336 Fayetteville Street • P. O. Box 1551 • Raleigh, N. C. 27602

ENCLOSURE A

Received w/Ltr Dated 11-13-75

H. B. ROBINSON UNIT 2

CYCLE 4 RELOAD APPLICATION

Response to NRC Staff

Request for Additional Information

Question 1

Provide a discussion of hydraulic core flow instability effects, which considers the flow resistance differences existing between ENC and Westinghouse fuel.

Response

In order to assure stable thermal hydraulic operation of the H. B. Robinson reactor, a stability analysis was performed to determine the onset of flow instability and to show the margin between operating conditions and the onset of flow stability. A flow instability requires that the pump supply or demand curve cross the system resistance curve at more than one point. Figure 1 illustrates both the stable and unstable operating conditions. Since the pump curve in the reactor has a negative slope, the maintenance of a positive slope ($dP/dG > 0$) on the resistance curve over the operating range is sufficient to prevent a flow instability.

An analysis was performed to determine ΔP versus G (resistance) curves for the hot channel for both ENC and W fuels. A peaking power was applied to the channel to give a total heat flux factor of 2.62 as defined in Reference 1. The core power was held constant (rated core power = 2300 MW_t) as recommended by Bailey, et. al.[2] and ΔP versus G curves were obtained at various system pressures. The results are shown in Figure 2. Note that the onset of flow instability occurs ($dP/dG < 0$) at about 1000 psia for the ENC design and 750 psia for the W design. Since reactor trip occurs at 1850 psia, the core is adequately protected from flow instabilities caused by a reduction in operating pressure. The onset of instability at constant pressure (2250 psia) and powers greater than 100% power was studied. However, no instability could be shown at powers up to 250% normal for either fuel design. Since the overpower set point is 100%, adequate protection of the core is maintained.

Question 2

Provide analysis of the rod bowing effect for the ENC fuel. The analysis should include the amount of rod bow expected for the ENC fuel and the effect of the expected rod bow on the calculation of the ENC heat flux.

Response

The maximum rod bow expected for the ENC fuel is such that rod-to-rod contact is not predicted to occur over the irradiation life of the fuel. A small amount of rod bow is predicted: i.e., ∿ 20 mils after

---

(1) H. B. Robinson Unit 2 Cycle 4 Reload Fuel Licensing Data Submittal XN-75-38.

(2) Bailey, N. A., et. al., Instabilities in Two Phase Flow Systems AERE R6456 (1971).

the first cycle, $\sim$ 30 mils after the second cycle, and $\sim$ 40 mils at the discharge exposure. The predicted rod bow for the ENC fuel is less than the rod bow predicted for the fuel currently charged to the H. B. Robinson core for the following reasons:

- The ENC fuel has a thicker clad than the existing fuel which increases its structural strength.

- The ENC grid spacer provides a 5 point rather than a 6 point rod contact (existing grid design) and thus there is less axial thrust.

- The ENC grid spacer provides a wider span between support dimples than the existing grid thus it provides increased rotational restraint.

A review of available critical heat flux data which address the subject of rod bowing[1,2] and its effect on critical heat flux indicate the following trends:

- The effect of a bowed rod to contact on critical heat flux (CHF) in PWR bundles is to reduce the CHF above a certain pressure dependent heat flux threshold, which is generally above normal operating conditions in PWRs.[1]

- The effect of a small isolated blockage can, for some conditions, slightly increase CHF. In any case, no deleterious blockage effect on CHF is indicated.[2]

The fact that a blockage could actually result in an improvement in CHF was explained on the basis of crossflow about the blockage. The concept of inhanced CHF performance due to crossflow was justified through reference to the fact that heated tubes which were cooled by crossflow showed a much higher CHF (by a factor of 2 to 3) for a comparable parallel flow tube bank. This evidence allows the supposition that a bowed rod which is not in contact with adjacent rods (or any other rod) might have a higher CHF than a comparable unbowed rod because of the increased crossflow about the rod caused by the bowing.

This evidence indicates that any CHF penalty related to rod bow is probably bounded by the CHF penalty accompanying rod bow for which rod contact exists. Based on the results presented in Reference 1, a correlation was developed to describe the data (See Equation 2 of Reference 1). Application of the correlation to H. B. Robinson operating conditions, no rod bow penalty is calculated for the hot assembly at 112% of rated power. Thus, it is concluded that no penalty even if rod-to-rod contact were predicted would be calculated for the ENC fuel bundle.

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(1) K. W. Hill, et. al., "Effect of a Rod Bowed to Contact on Critical Heat Flux in Pressurized Water Reactor Rod Bundles," ASME 75-WA/HT-77.

(2) K. W. Hill, et. al., "Effects on Critical Heat Flux of Local Heat Flux Spikes or Local Flow Blockage in Pressurized Water Reactor Rod Bundles," ASME 74-WA/HT-54.

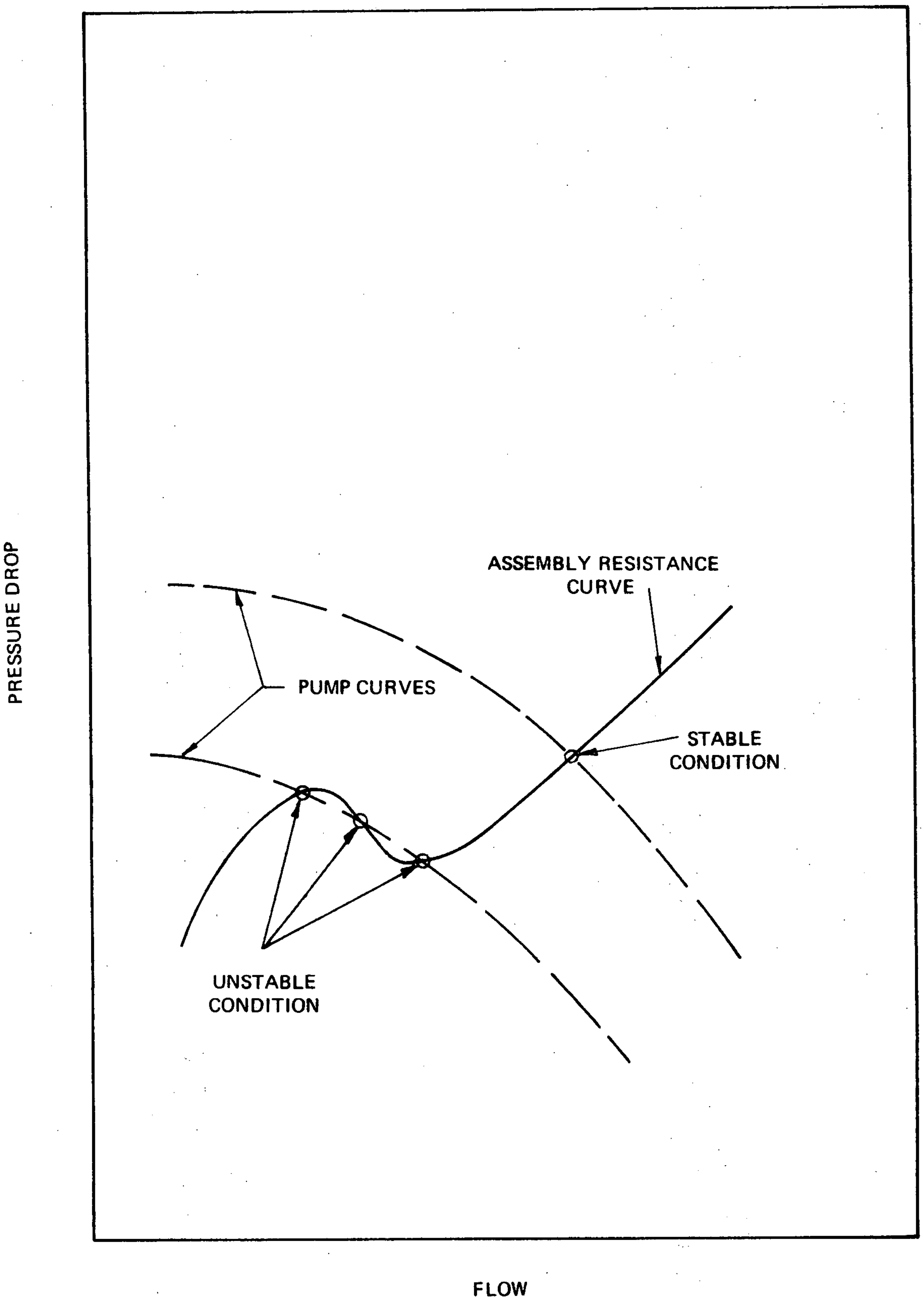

Figure 1: SCHEMATIC OF ONSET OF STABLE AND UNSTABLE FLOW CONDITIONS

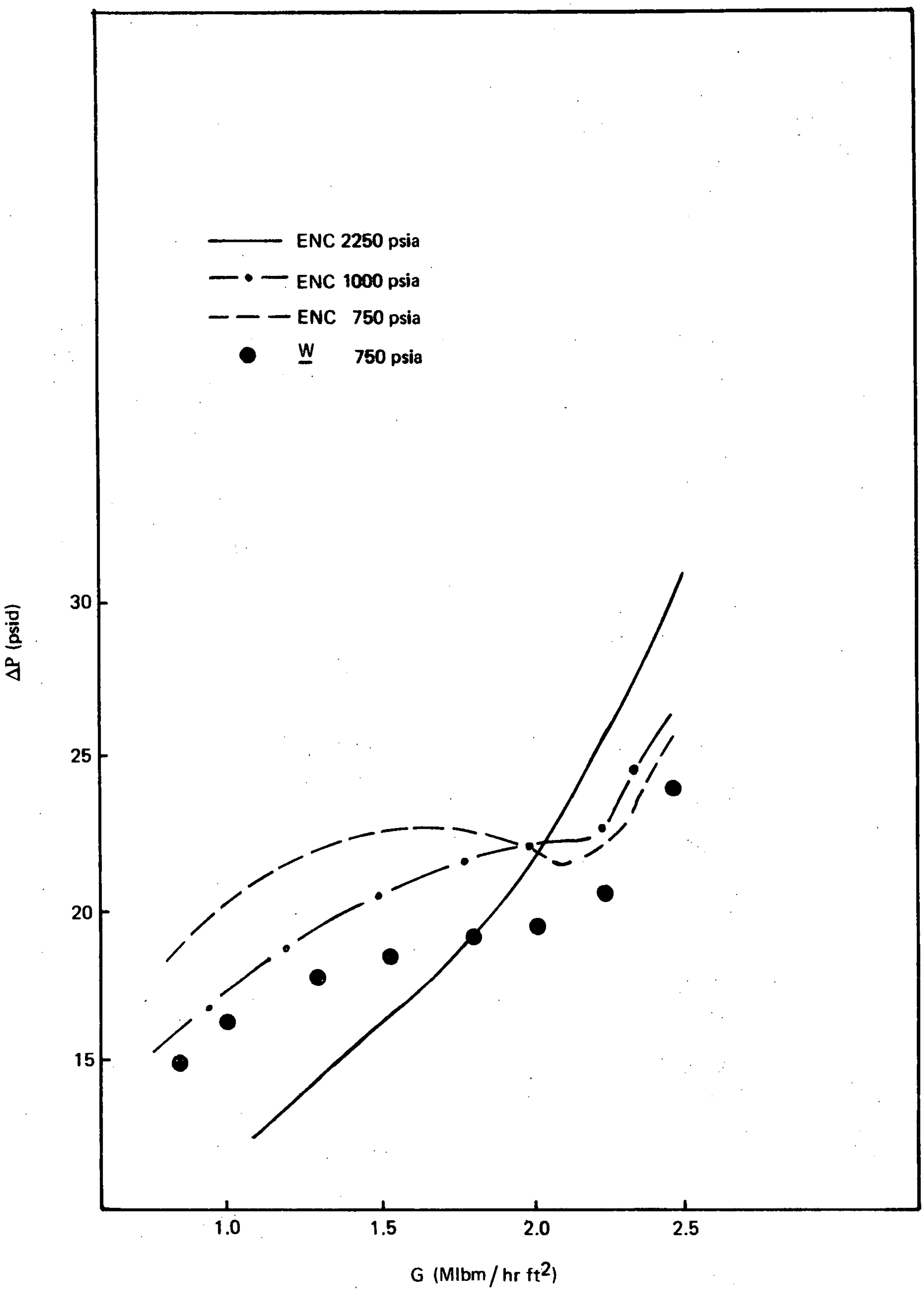

Figure 2: **ONSET OF FLOW INSTABILITIES FOR HBR, ENC AND W FUEL**

EXXON NUCLEAR COMPANY, Inc.

2101 Horn Rapids Road, Richland, Washington 99352

PHONE: *(509) 946-9621*

50-261

November 17, 1975

Mr. Bernard C. Rusche, Director
Office of Nuclear Reactor Regulations
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Rusche:

Subject: XN-75-57, Revision 1, "H. B. Robinson Unit No. 2 LOCA Analyses Using the ENC WREM Based PWR ECCS Evaluation Model (September 26, 1975 Version)," November 9, 1975

Enclosed are thirty-two (32) copies of the subject document. These documents contain the results of the LOCA analyses in conformance with the requirements of 10CFR50.46 using the Exxon Nuclear WREM based ECCS model as approved by the NRC for application to H. B. Robinson.

This document has been transmitted to you by CP&L as per their letter of November 13, 1975. Eight copies of this document were transmitted to the Staff earlier by Exxon Nuclear and five copies were enclosed with CP&L's transmittal letter.

Sincerely,

DE Clark/for

G. F. Owsley, Manager
Reload Licensing

GFO:lp

Enclosures (32)

Copy to:
Mr. D. N. Bridges (NRC)
Mr. Bobby Mayton (CP&L)

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