ATTACHMENT 7

Analytical Predictions of Neutron Noise Caused by Boiling and Control Rod Vibrations

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We have made many significant accomplishments this year:

- installed and tested 2-D space dependent kinetics code
- developed a system to extract ENDFB kinetics data
- analyzed BWR neutron noise due to boiling
- analyzed PWR control rod vibrations
- provided NRC with review of other modeling efforts

We concluded that,

- further calculational effort is needed to complete determination of anomaly detection sensitivity
- automated surveillance system will provide inportant information

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A major effort this year has been to install and test a 2-D space-dependent neutron kinetics code.

- previous studies have shown point kinetics invalid
- no production codes are currently available
- convergence is generally difficult to obtain
- tabulated energy dependent kinetic data is difficult to obtain

The 2-D kinetics code provides a tool to enhance our understanding of reactor noise.

We can calculate

* effects of burnup on anomaly detection sensitivity
* neutron noise due to complex vibrations
* boiling effects
* space dependence of neutron noise

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We have performed numerical and analytical studies of BWR boiling noise. These studies were important to PWR modeling efforts.

- We better understand how to model several anomalies
- We gained a feeling for key physical processes relating anomalies to detector response.
- We can quantitatively determine the detector "field of view" for anomalies.

Our results indicate:

- 1-D BWR axial neutronic models with homogenized cross sections do not preserve physical processes of boiling detection
- in-core detector field of view is relatively large in the raidial direction.
- analytical studies confirm our numerical results

The analytical study utilized the Feinburg-Galanin Source/Sink Method (Neutron Wave Method)

The results were:

- in-core detector response is a superposition of damped waves propagating through the moderator and fuel
- neutron waves propagating thorough the moderator dominate the detector response
- the effect is not observed when fuel and moderator are homogenized
- effect is independent of the number of neutron energy groups assumed

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The analytical studies confirm numerical 1-D and 2-D results

* in-core detector response is primarily determined by changing shielding characteristics of the system

* the radial direction is most important in calculating detector response to boiling

* 1-D axial models with homogenized fuel and moderator incorrectly predict detector response

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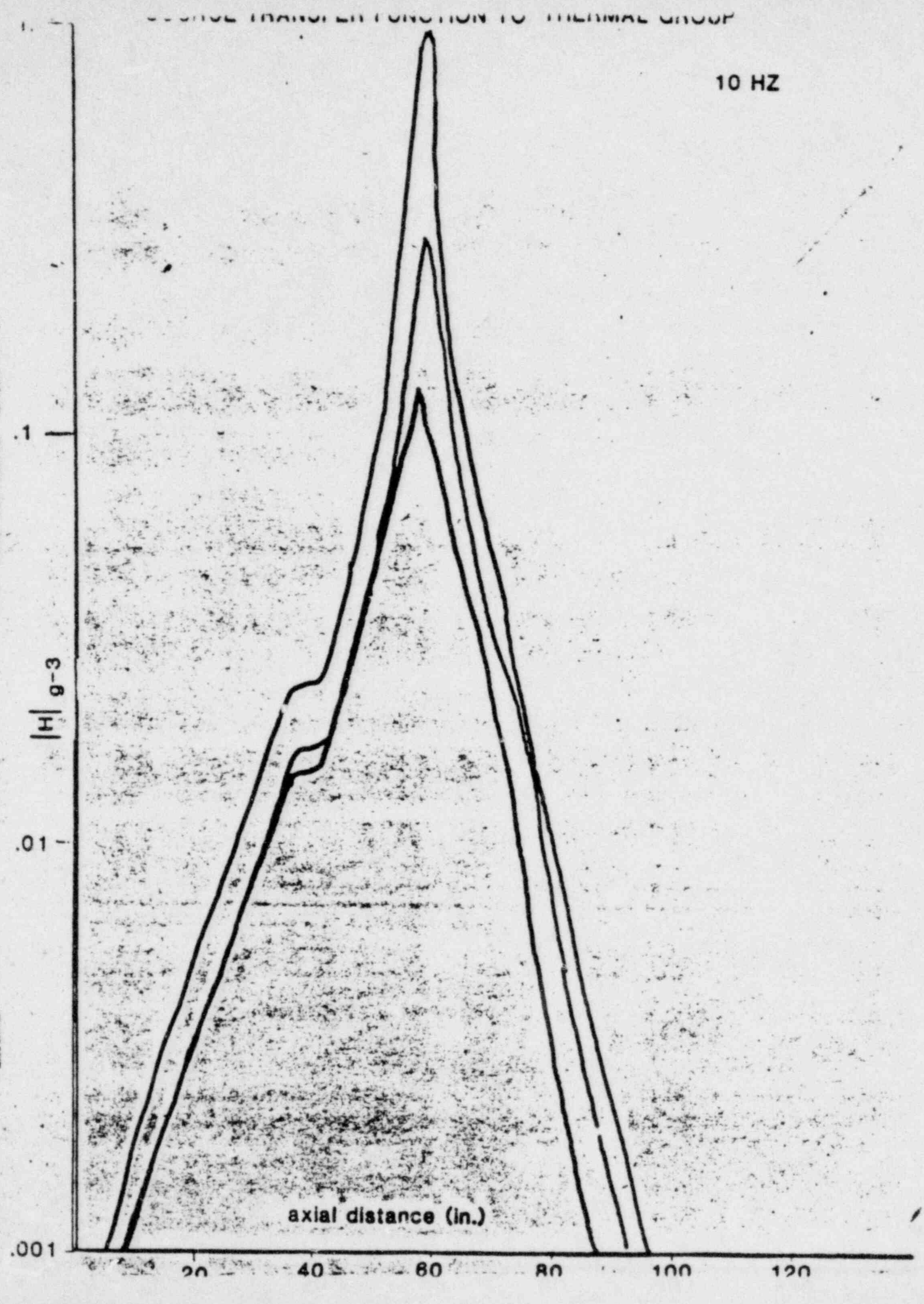

10 HZ
|H| g-3
1.
.1
.01
.001
axial distance (in.)
20
40
60
80
100
120

We also modeled the ex-core detector response to a vibrating PWR control rod assembly.

- we assumed a "new" core
- the control assembly was at the center of the core
- we assumed a vibration of 10Hz
- we compared the predicted response to our PWR signature library

We concluded:

- a vibration might not be detected using ex-core detectors

- detection sensitivity probably depends on burnup

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2-D KINETICS CALCULATION
RESULTS

THERMAL SOURCE LOCATION	ATTENUATION (10 HZ)
1 CORE CENTER	1.19×10^4
4 INTERMEDIATE	1.29×10^3
7 EDGE	7.1×10^1

In FY-81 we will continue to assess the sensitivity of detecting LWR anomalies with neutron noise.

* PWR and BWR in-core vibrations
* burnup
* coolant boiling
* core coolant level

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