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BASE NEUTRON NOISE IN PWRs*

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HIGHLIGHTS

Considerable activity[1,2] has been devoted in recent years to the use of neutron noise for investigation of problems in pressurized-water reactors (PWRs). The investigators have found that neutron noise provides an effective way to monitor reactor internal vibrations such as vertical and lateral core motion; core support barrel and thermal shield shell modes, bending modes of fuel assemblies, and control rod vibrations. However, noise analysts have also concluded that diagnosis of a problem is easier if baseline data for normal plant operation is available. Therefore, we have obtained ex-core neutron noise signatures from eight PWRs to determine the similarity of signatures between plants and to build a base of data to determine the sources of neutron noise and thus the potential diagnostic information contained in the data.

Preliminary analysis of the frequency spectra of the neutron noise shows spectra features that can be identified with coolant temperature fluctuations, fuel bundle vibrations, core support barrel-pressure vessel relative motion; vibrations induced by the primary coolant pumps and core support barrel shell mode vibrations. The frequencies and amplitudes of these contributions to the neutron noise vary from plant-to-plant and during a fuel cycle. Even so, neutron noise associated with anomalous core support barrel motion can be recognized because it has higher amplitude and different spectral content than any of the signatures obtained in the baseline data acquisition-program.

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In summary we conclude that: (1) ex-core neutron noise contains information about the vibration of components in the pressure vessel; (2) baseline signature acquisition can aid understanding of plant specific vibration frequencies and provide a bases for diagnosis of future problems if they occur; and (3) abnormal core support barrel vibration can most likely be detected over and above the plant-to-plant signature variation observed thus far.

REFERENCES

1. J. A. Thie, "Core Motion Monitoring", *Nucl. Technology*, 45, 5-45 (1979).
2. G. Kosály, "Noise Investigations in Boiling-Water and Pressurized-Water Reactors", *Prog. in Nucl. Energy*, 5, 149 (1980).

DISCLAIMER

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BASELINE NEUTRON NOISE ON PWRs

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PRESENTED BY D. N. FRY
AT THE NINTH WATER REACTOR SAFETY RESEARCH MEETING,
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GAITHERSBURG, MARYLAND

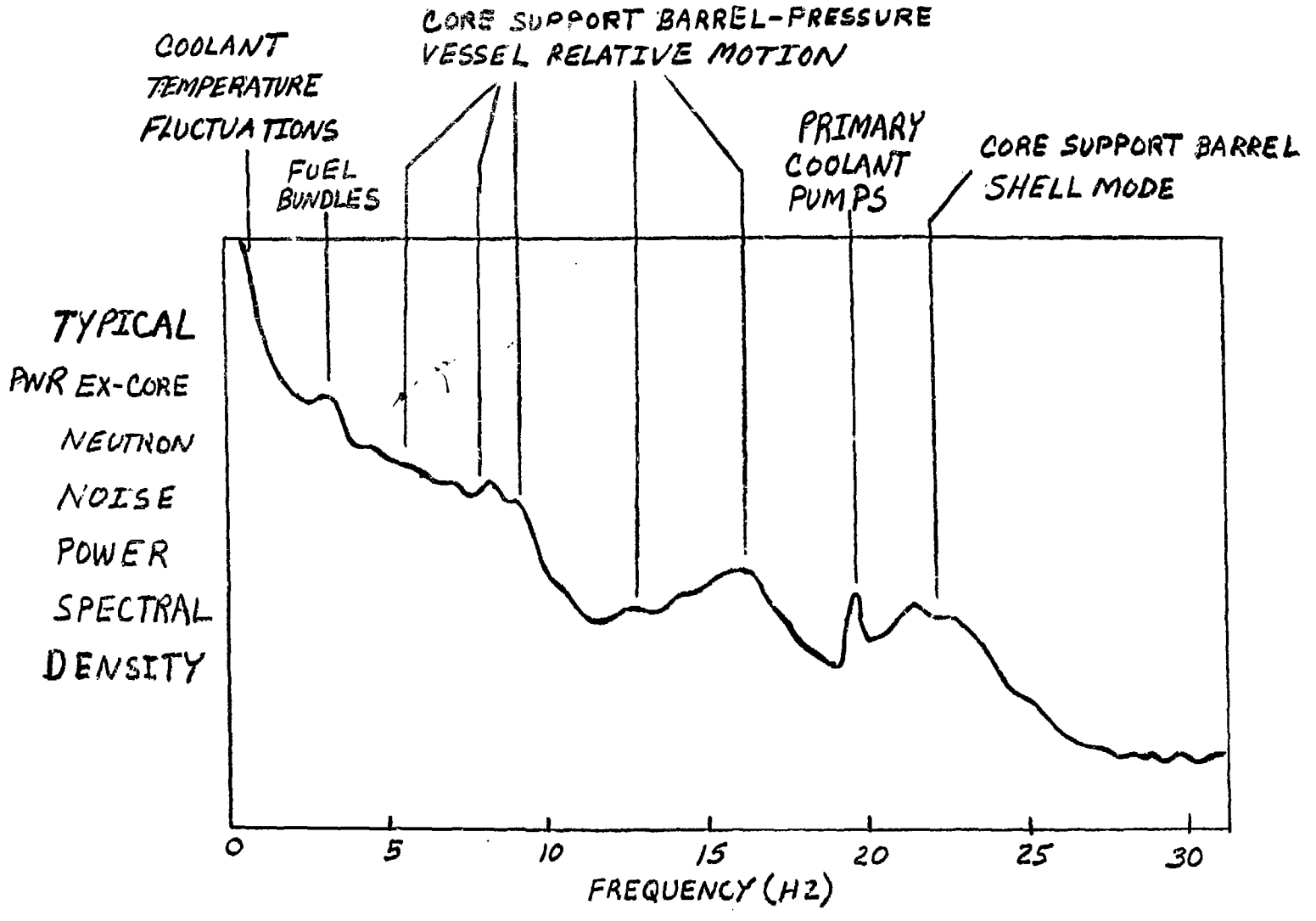
WHAT IS NOISE ANALYSIS?

OBTAINING INFORMATION ABOUT A PROCESS OR SYSTEM COMPONENT FROM THE ANALYSIS OF FLUCTUATIONS IN THE PLANT PROCESS VARIABLES

FOR EXAMPLE

SMALL FLUCTUATIONS IN REACTOR POWER MAY INDICATE A LOOSE AND VIBRATING CONTROL ROD

EX-CORE NEUTRON NOISE CONTAINS INFORMATION ABOUT THE PWR CORE



NEUTRON NOISE ANALYSES HAS BEEN USED TO DIAGNOSE MECHANICAL VIBRATIONS OF CORE COMPONENTS IN NUCLEAR PLANTS

- LOOSE CORE BARREL IN PWR
- VIBRATING INSTRUMENT TUBES IN BWR
- CORE MOTION IN GCR
- CONTROL RODS IN FBR

DIAGNOSIS OF A PROBLEM IS EASIER IF
PREVIOUS BASELINE DATA IS AVAILABLE

THEREFORE

THE OBJECTIVES OF OUR PROGRAM ARE TO:

- DETERMINE IF PWR EX-CORE NEUTRON NOISE SIGNATURES ARE SIMILAR IN DIFFERENT PLANTS

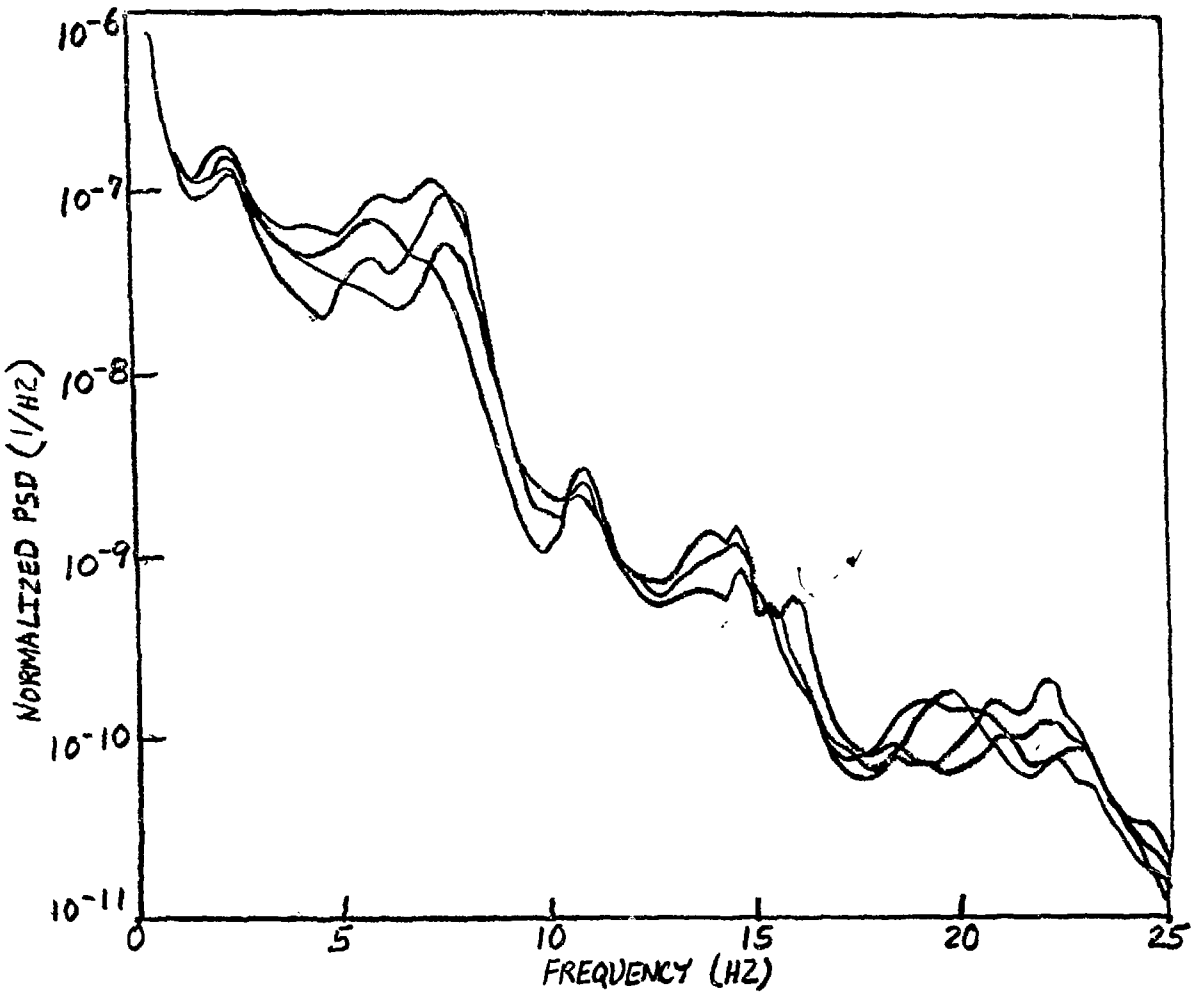
AND

- DETERMINE THE VARIATION OF EX-CORE NEUTRON SIGNATURES IN A PWR OVER THE FIRST FUEL CYCLE

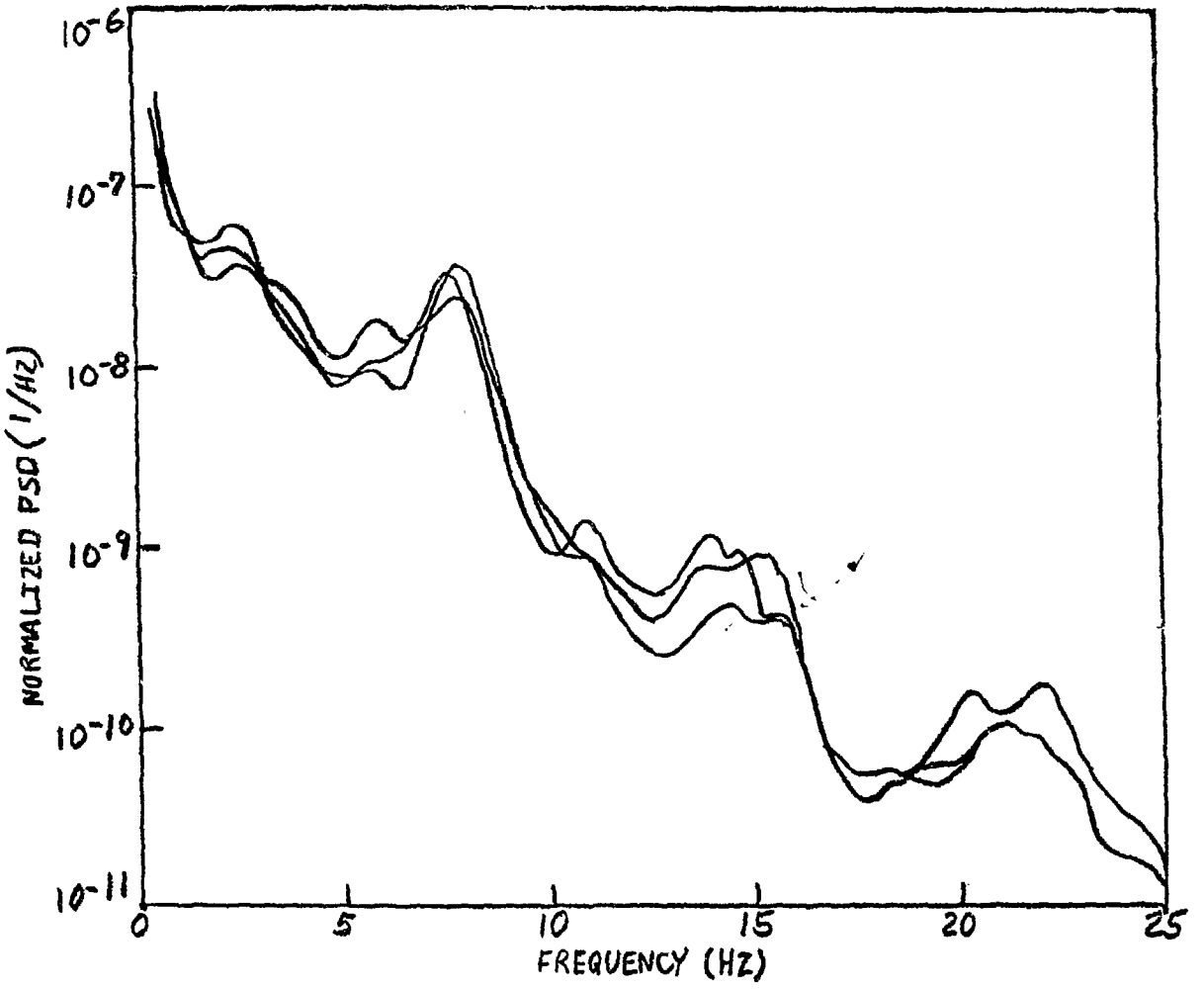
WE HAVE OBTAINED SIGNATURES FROM

- CALVERT CLIFFS 1
- CALVERT CLIFFS 2
- H. B. ROBINSON
- ANO-1
- ANO-2
- TROJAN
- SEQUOYAH-1
- BORSSELE

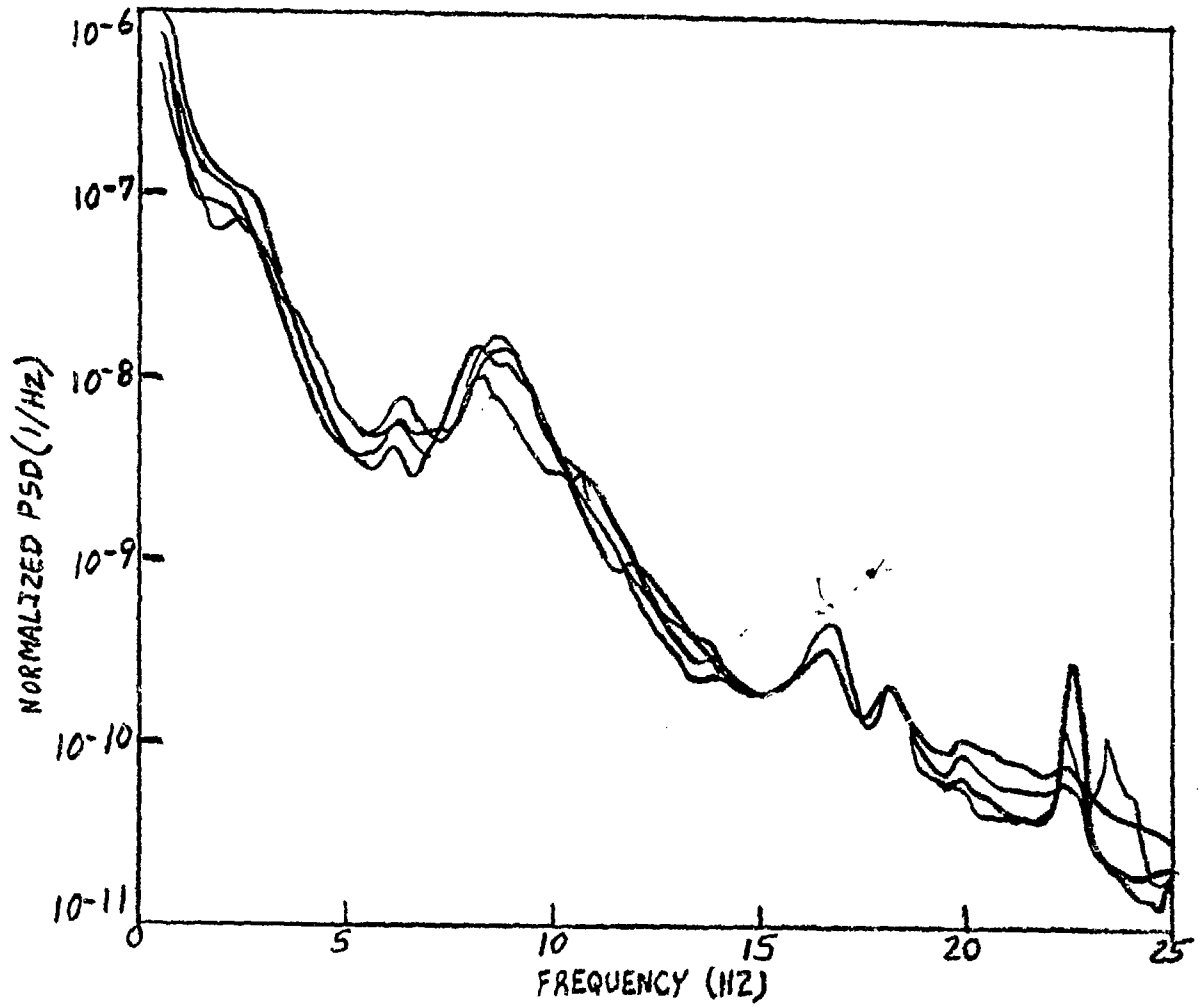
CALVERT CLIFFS-1 NEUTRON NOISE SIGNATURES



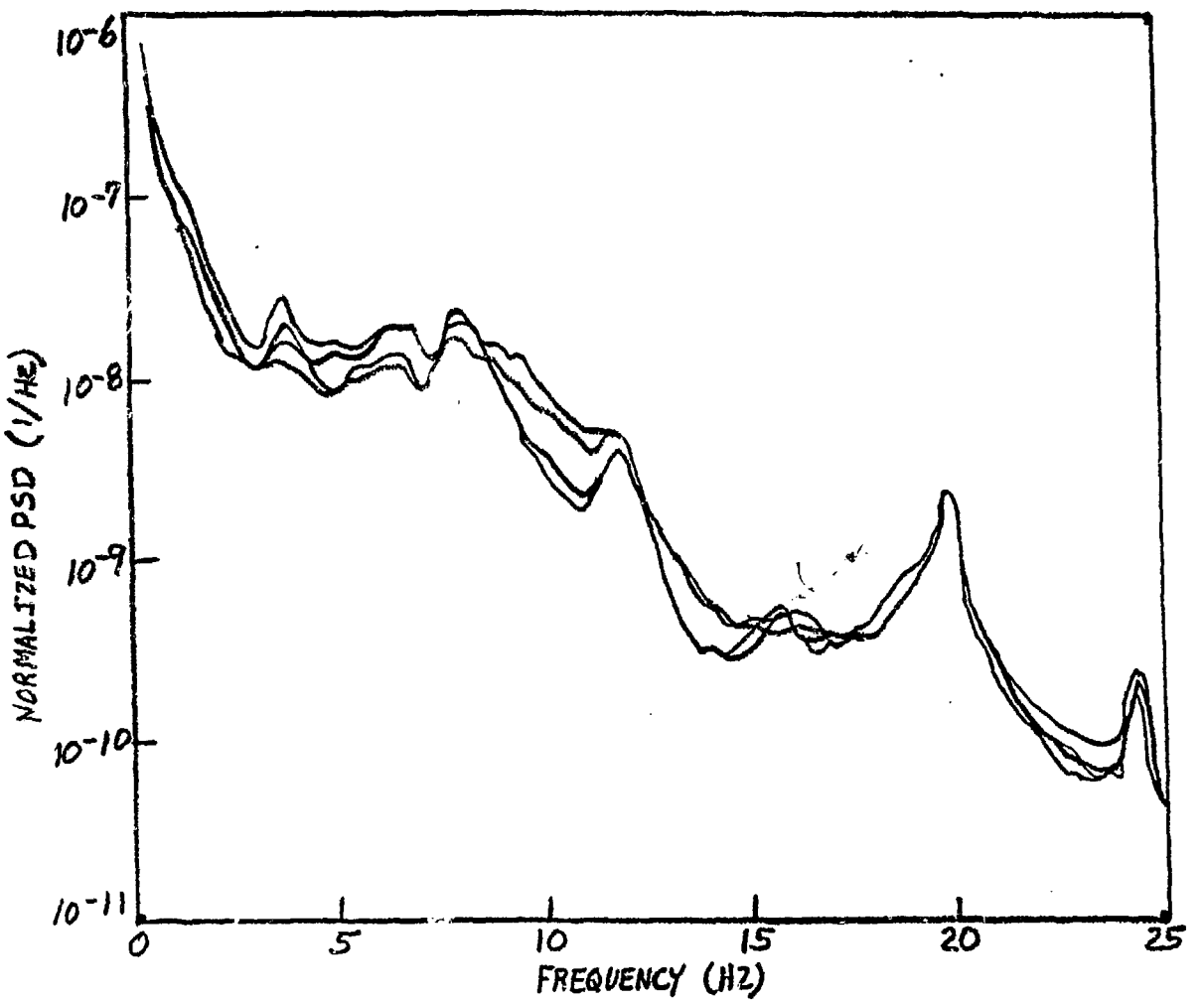
CALVERT CLIFFS-2 NEUTRON NOISE SIGNATURES



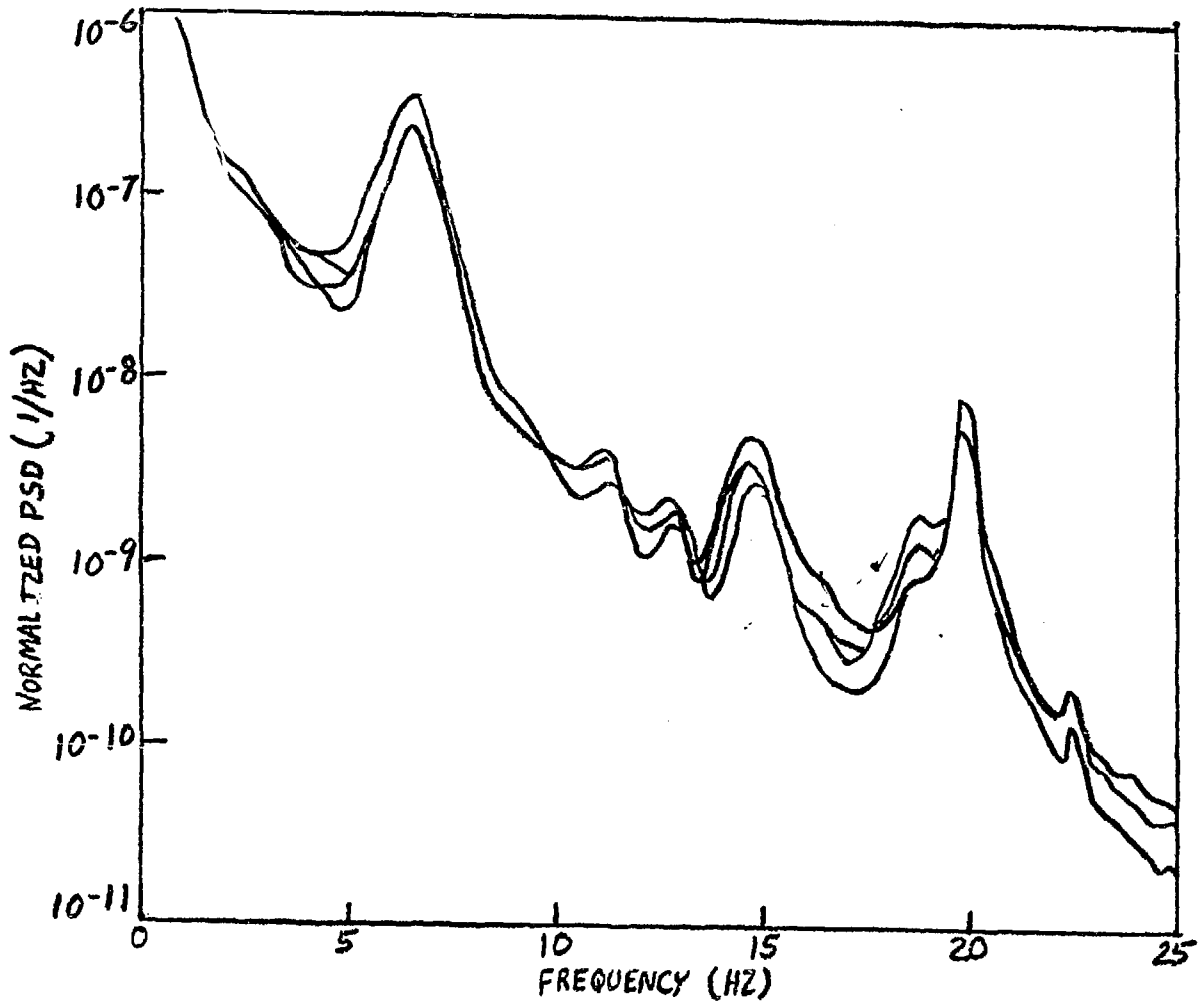
ANO-1 NEUTRON NOISE SIGNATURE



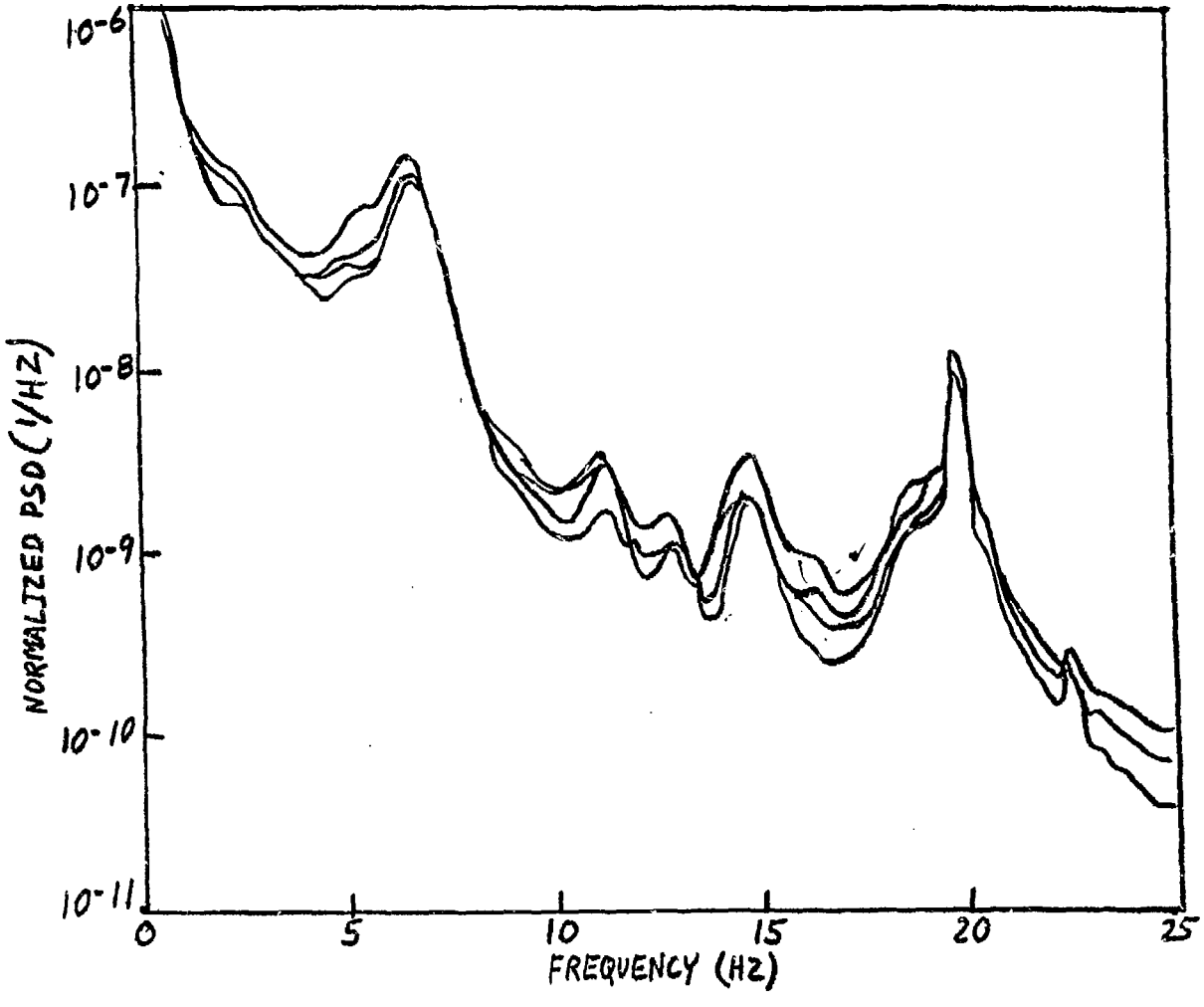
SEQUOYAH-1 NEUTRON NOISE SIGNATURES



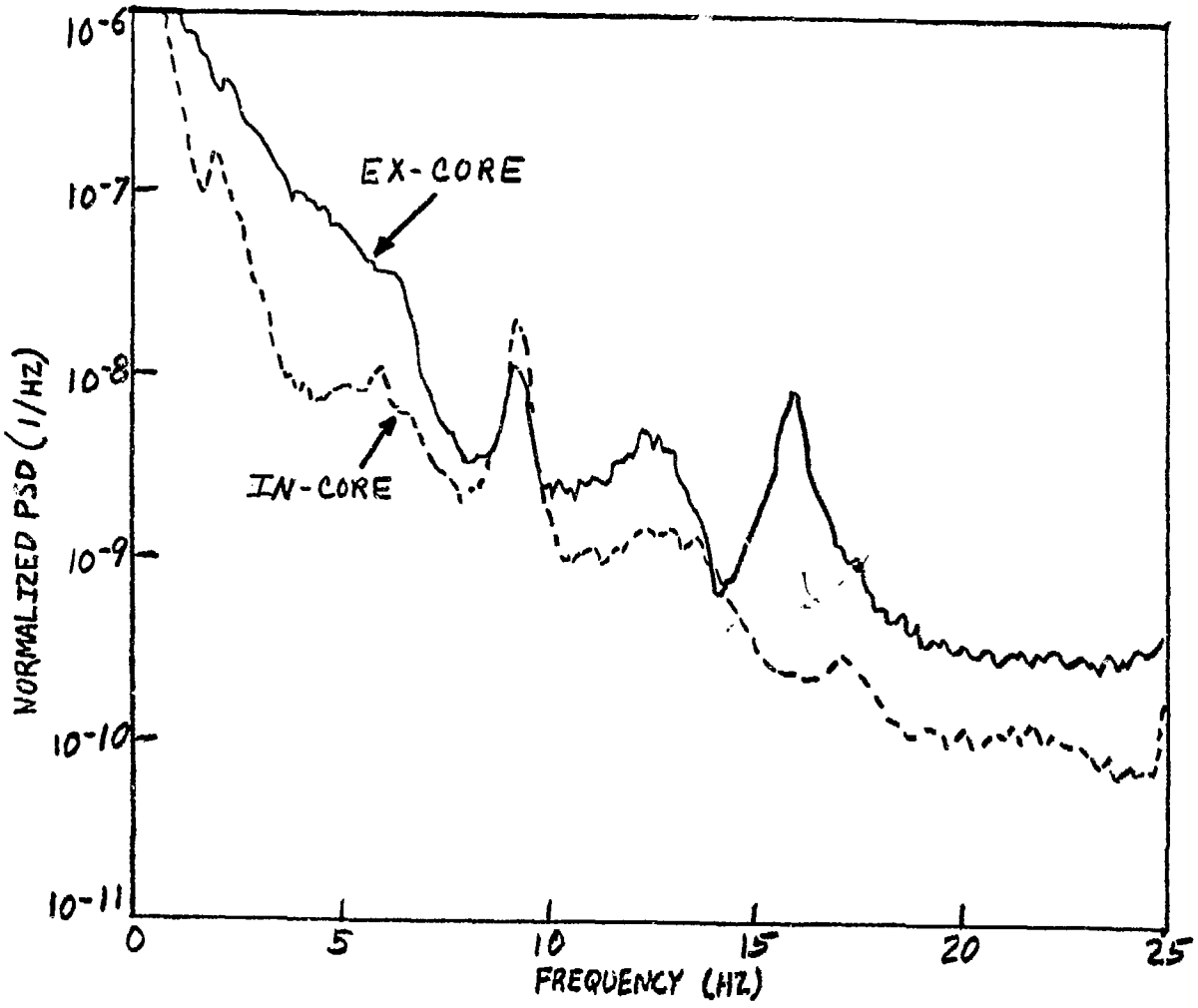
H. B. ROBINSON LOWER NEUTRON NOISE SIGNATURES



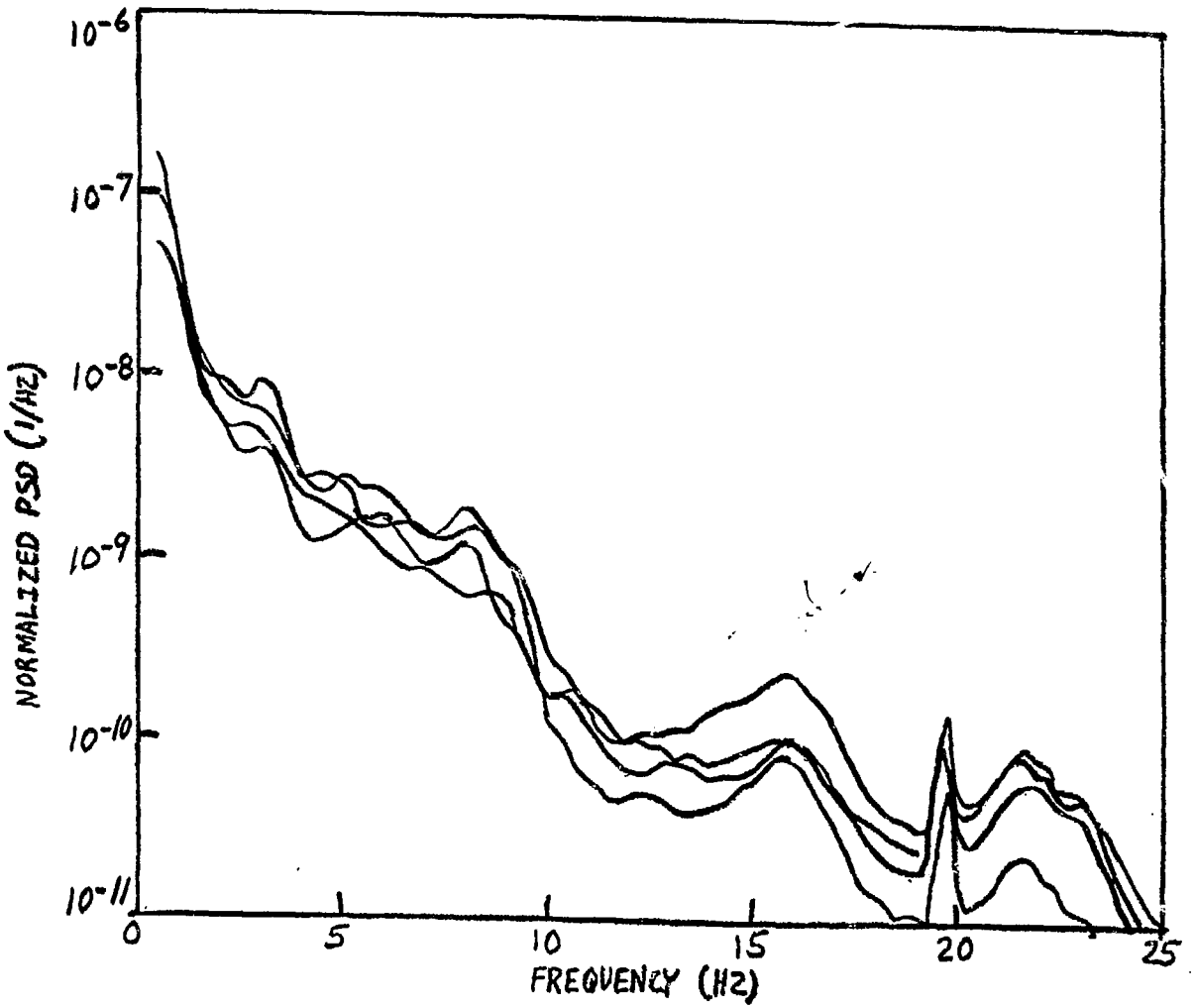
H. B. ROBINSON UPPER NEUTRON NOISE SIGNATURES



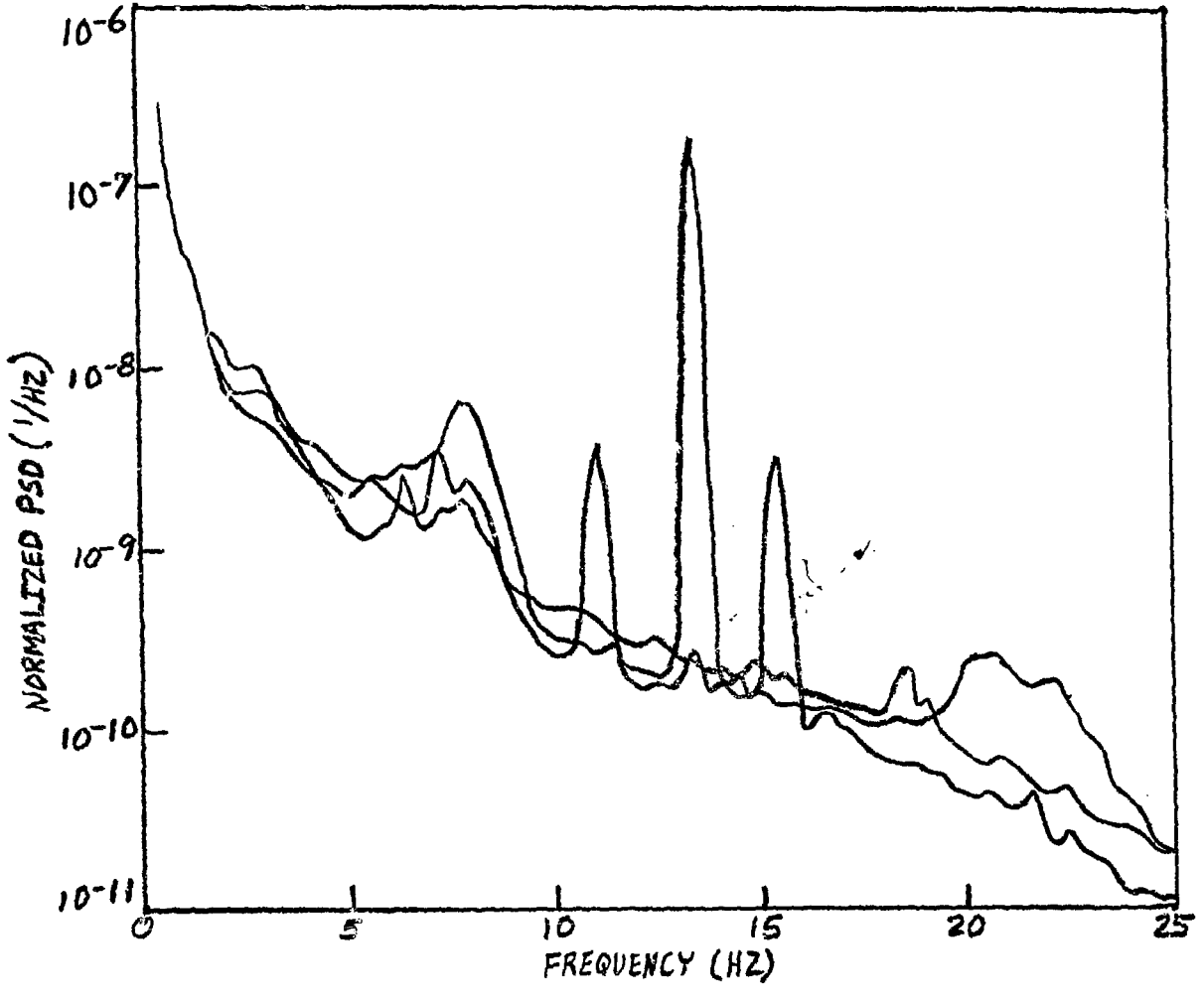
BORSSELE NEUTRON NOISE SIGNATURES



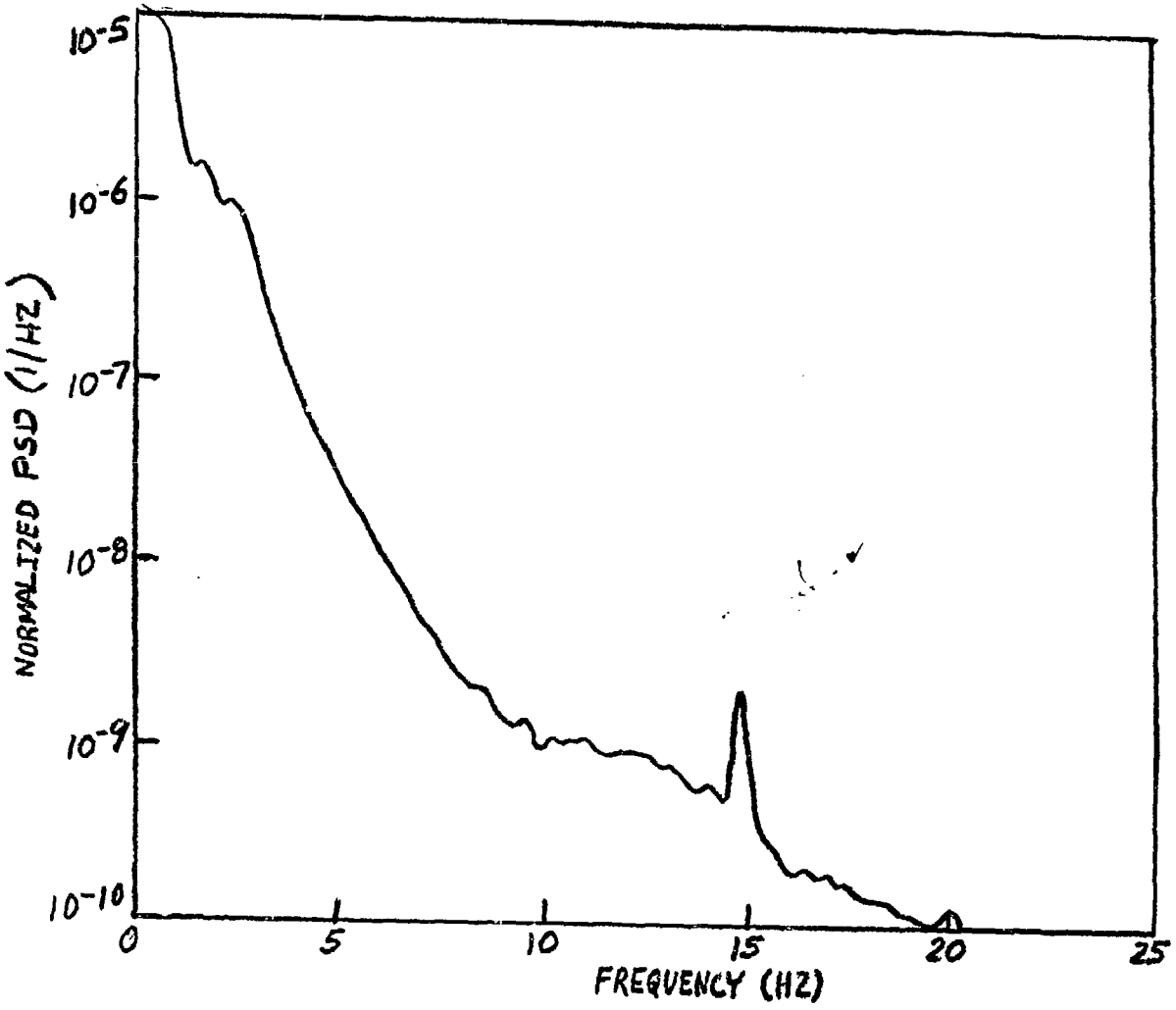
TROJAN NEUTRON NOISE SIGNATURES



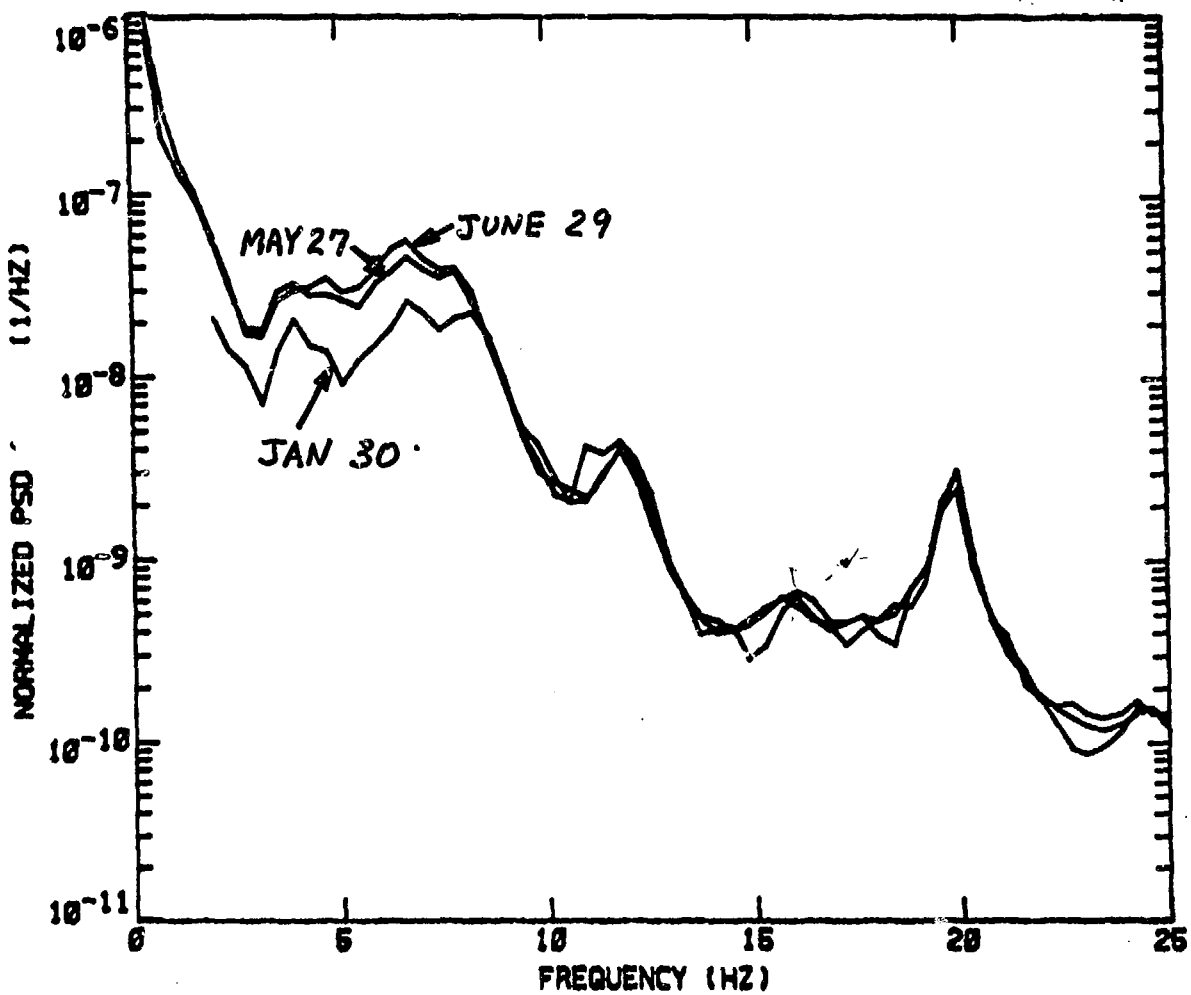
ANO-2 NEUTRON NOISE SIGNATURES



EX-CORE NEUTRON NOISE WITH A LOOSE CORE BARREL



SEQUOYAH UNIT-1 EX-CORE NEUTRON NOISE



IN SUMMARY, WE CONCLUDE THAT:

- EX-CORE NEUTRON NOISE CONTAINS INFORMATION ABOUT THE VIBRATION OF COMPONENTS IN THE PRESSURE VESSEL

- BASELINE SIGNATURE ACQUISITION CAN AID OUR UNDERSTANDING OF PLANT SPECIFIC VIBRATION FREQUENCIES AND PROVIDE A BASIS FOR DIAGNOSIS OF FUTURE PROBLEMS IF THEY OCCUR

AND

- AN ABNORMAL CORE SUPPORT BARREL VIBRATION COULD HAVE BEEN DETECTED OVER AND ABOVE THE NEUTRON NOISE SIGNATURE VARIATION AMONG EIGHT PLANTS