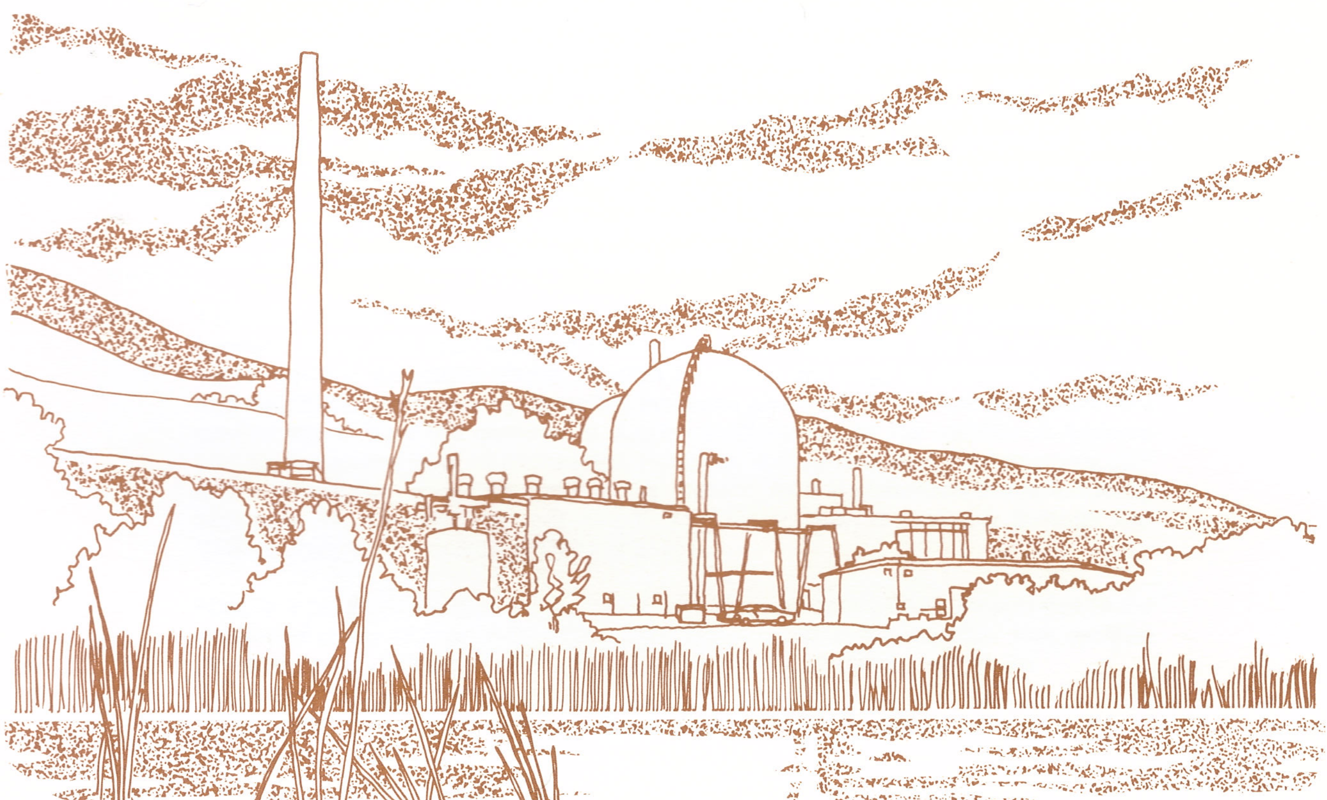
APPLICATION NOTE 140-7

Nuclear Power Plant Diagnostics Using Fourier Analysis Techniques

Summary of this Note

This note describes application of Fourier Analysis techniques to nuclear power plant diagnostics. Reactor core measurements discussed include: a) detection of core component vibration, b) detection of core motion, c) detection of departure from nucleate boiling. Other reactor plant measurements discussed include: a) measurement of vibrations of rotating machinery, b) seismic measurements, c) modal analysis of vibrating pipes.



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NUCLEAR POWER PLANT DIAGNOSTICS USING FOURIER ANALYSIS TECHNIQUES

by

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INTRODUCTION

This note describes application of Fourier Analysis techniques to nuclear power plant diagnostics. Both reactor and balance of plant applications are discussed. Reactor applications are identified separately from balance of plant and receive greater emphasis because two recent technological advances have greatly increased the utility of neutron noise analysis for power reactor diagnostics. The first is the development of miniature neutron detectors that fit between the fuel channels of large power reactor cores thus making available detailed information about spacially dependent parameters. The second is the development of portable, high-speed Fourier Analyzers such as the HP 5451 with miniature computers for fast manipulation of the large amounts of data encountered in neutron noise analysis.

DESCRIPTION OF NUCLEAR POWER REACTORS

The United States has relied almost exclusively on Light Water Reactors (LWR's) for nuclear production of electric power. There are two kinds of light water reactors presently in use: the most common is the Pressurized Water Reactor (PWR), in which high pressure water circulates through the reactor to a steam generator. In the steam generator, heat is transferred to water at a lower pressure to produce steam which drives the turbine-generator. The other type of reactor produces steam directly in the core and is called a Boiling Water Reactor (BWR). Figures 1 and 2[1] show some of the complexities of both reactor types.

Typically, power reactors are heavily instrumented with neutron detectors, having between thirty and four hundred in-vessel neutron detectors and ten or more ex-vessel neutron detectors. These neutron detectors are used to determine the level and distribution of power by detecting neutrons given off in the fission process. The current signal from the detector is directly proportional to the number of fissions, and so, the power level of the reactor. However, the current level contains only part of the information about the state of the reactor. As is summarized in the following argument [2,3], we shall see that much more information is available through frequency analysis of neutron detector signals.

Neutrons enter the detector randomly due to their random movement and due to the noise-equivalent source with which they are created in the reactor. The neutron power spectral density (NPSD) observed in a reactor at power is given by

$$(1)\quad \phi_n(\omega) = \frac{2\,W_n\,Q^2\,P}{\Lambda} + \frac{W_n^2\,Q^2}{\Lambda^2}\,|G_o(\omega)|^2 \cdot [\phi_s(\omega) + P^2\,\phi_\rho(\omega)]$$

where

$\phi_n(\omega)$ = Neutron spectral power density

W_n = The detector efficiency, equal to number of neutrons captured by the detector divided by the number of neutrons produced in the reactor

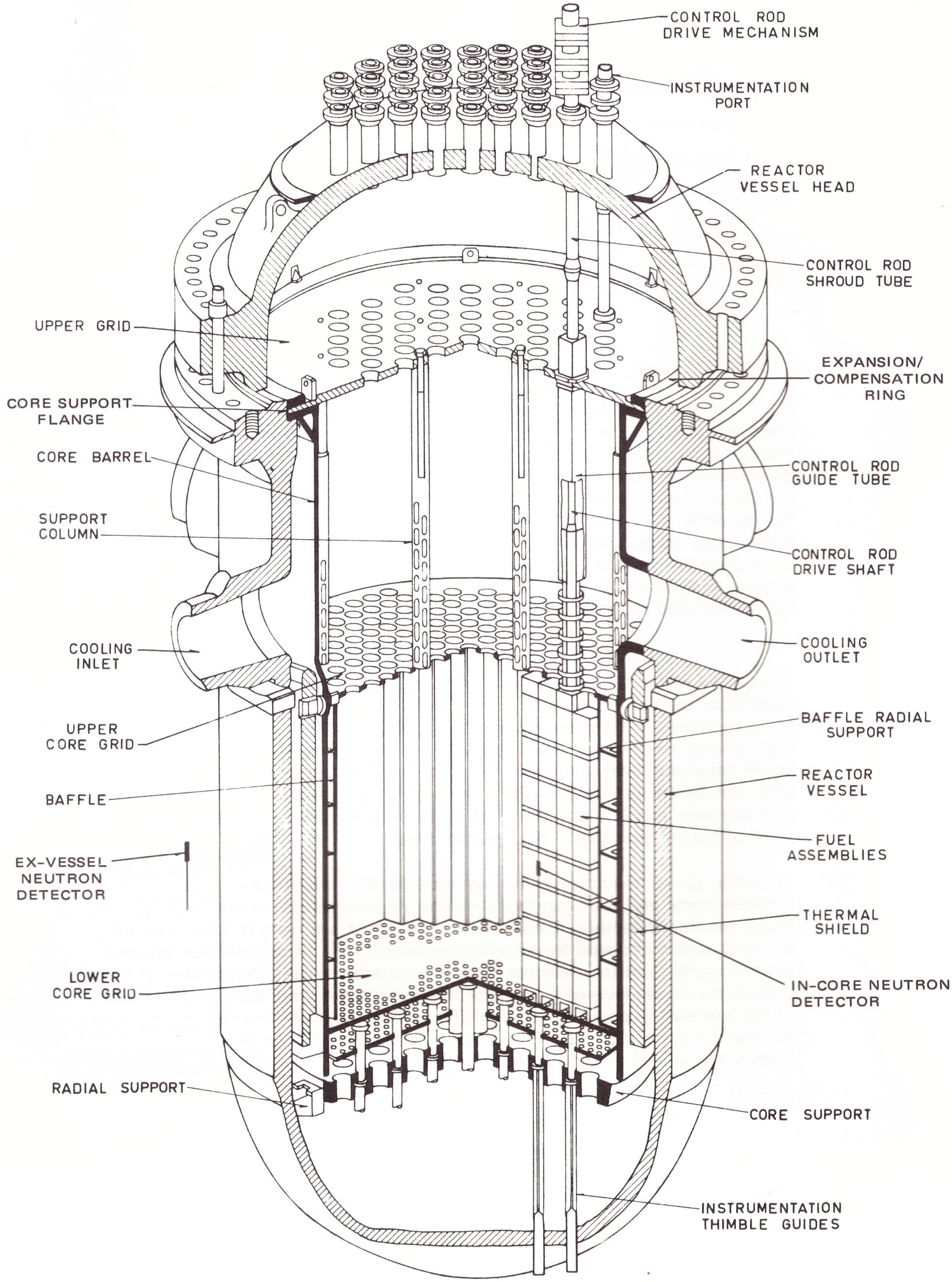

FIGURE 1. A Pressurized Water Reactor. Photo Courtesy of Westinghouse Electric Co. (Ref. 1)

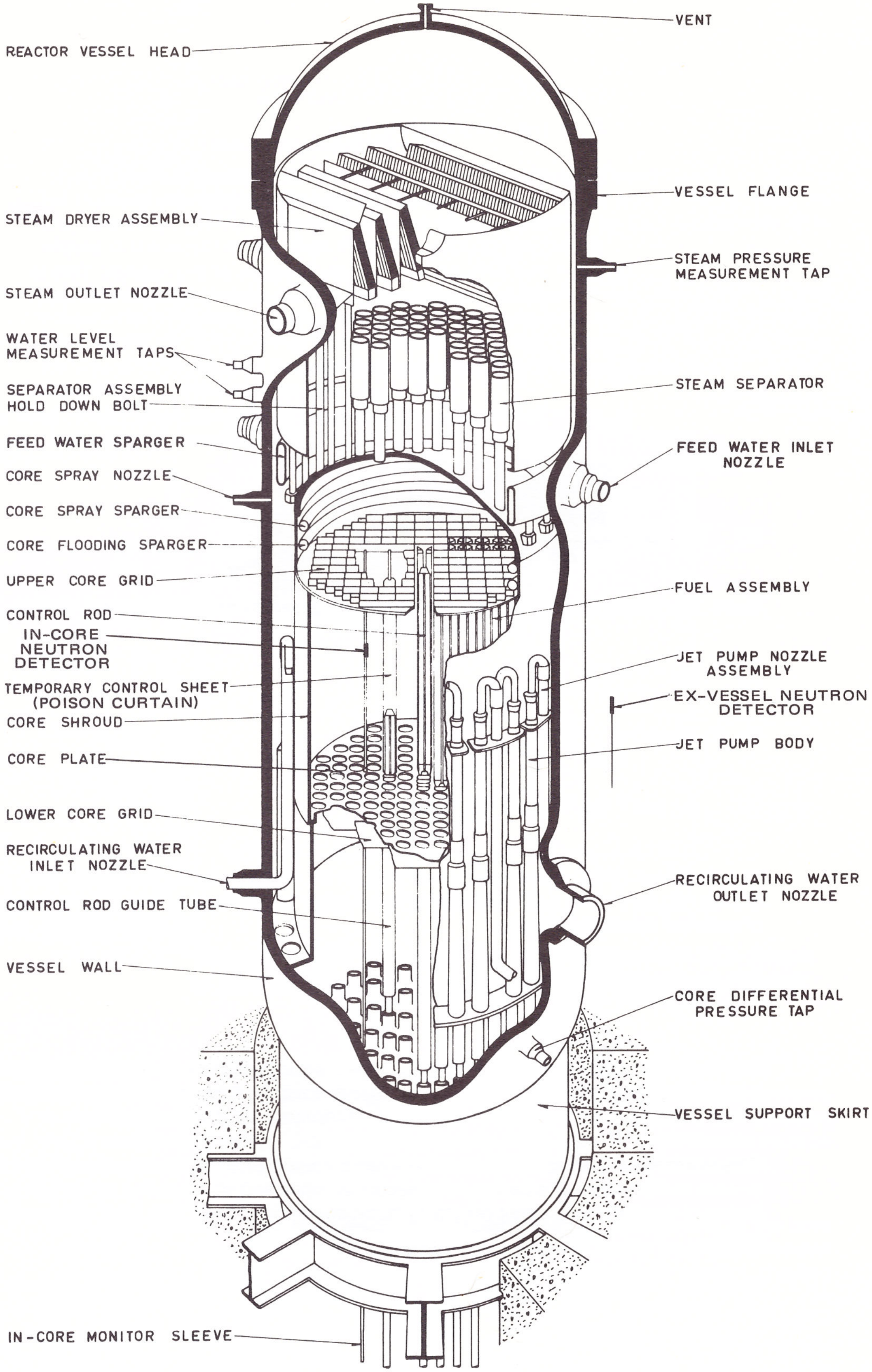

FIGURE 2. A Boiling Water Reactor. Photo Courtesy of General Electric (Ref. 1)

Q = Charge transferred per neutron captured in the detector

P = The reactor power level

Λ = The neutron generation time. Typically on the order of 10^{-5} seconds, and usually available through the reactor physics information

$G_o(\omega)$ = The zero power transfer function of the reactor. This is usually calculated, but can be measured experimentally. It is always a smoothly varying function

$\phi_s(\omega)$ = The noise-equivalent neutron source

$\phi_\rho(\omega)$ = The neutron noise caused by external perturbation such as core component vibrations and reactivity feedback effects

At high power operation this can be approximated

$$(2) \quad \phi_n(\omega) = \frac{P^2 W_n^2 Q^2}{\Lambda^2} |G_o(\omega)|^2 [\phi_\rho(\omega)]$$

Since the average detector current I_{dc}, an experimentally observed variable, is

$$(3) \quad I_{dc} = \frac{P W_n Q}{\Lambda}$$

Eq. (2) becomes

$$(4) \quad \phi_n(\omega) \cong I_{dc}^2 |G_o(\omega)|^2 \; [\phi_\rho(\omega)]$$

The observed NPSD can then be normalized by dividing by I^2_{dc}. Theoretically predicting $|G_o(\omega)|^2$ one can then obtain the actual magnitude of the driving function of external reactivity effects:

$$(5) \quad \phi_\rho(\omega) \cong \frac{\phi_n(\omega)}{I_{dc}^2 |G_o(\omega)|^2}$$

The frequency spectrum of the NPSD measured in this manner does not resemble the zero-power measurements because $\phi_\rho(\omega)$ does not have a white spectral density shape like the noise equivalent source which dominates at zero power.

This information makes neutron noise analysis useful for monitoring the integrity of in-core components. If a component becomes loose and vibrates due to the hydraulic forces of coolant flow, small reactivity fluctuations will result with attendant neutron noise.

Reactivity disturbances measured in this manner are extremely sensitive because of the amplifying effect of the term $|G_o(\omega)|^2$ in the frequency range where many mechanical vibrations occur. Reactivity disturbances are subject to change with coolant flow rates, control rod positions, or fuel loading. Hence, to be certain of diagnoses from NPSD measurements, one must acquire a library of normal neutron noise patterns for normal operation. This effort is necessarily ongoing, and as malfunctions are detected, their "signatures" can be added to a collection of noise patterns from previously discovered problems.

2.0 REACTOR CORE DIAGNOSTICS

2.1 Detection of Core Component Vibration

While there are several examples [4,5,6] of loose or vibrating components in nuclear reactors, Fourier analysis has been available to characterize only a few of these. An example of the ability to make diagnoses of this condition by Fourier analysis techniques is the work[2] at the High Flux Isotope Reactor (HFIR).

Fig. 3 shows three sets of NPSD data taken at different times. The spectra before failure and after repair of an upper control guide bearing are similar. The spectrum taken while the bearing was broken shows a change in noise level, particularly at a frequency of 5 hz. The frequency is significant in that it is possibly the vibration characteristic of the control rod.

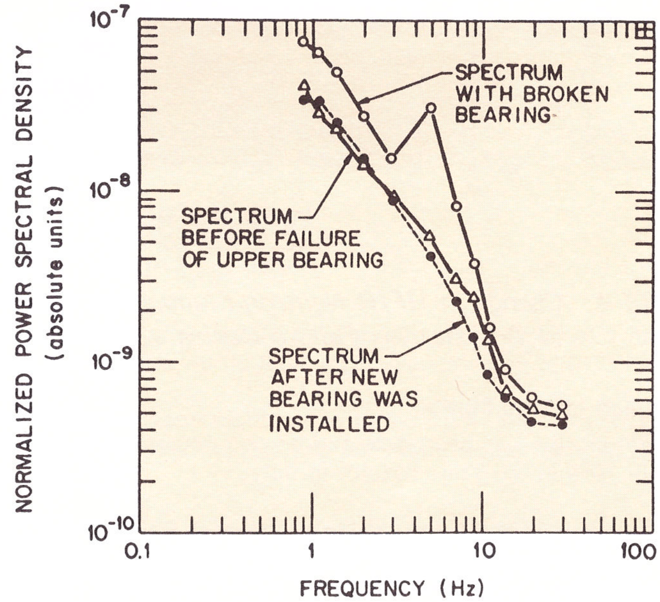

FIGURE 3. Change in HFIR Neutron-Fluctuation Spectrum as a Result of Rod Bearing Failure During an Early Fuel Cycle (Ref.2)

Several fuel cycles later, a different guide bearing failed with the result shown in Fig. 4. Note that the NPSD's are different for Figs. 3 and 4, and also that the increase in noise level was most pronounced at 5 hz. These results indicate the conclusion that it may be possible to detect bearing failures more quickly at HFIR with neutron noise monitoring than with any other instrumentation installed at that reactor.

The consequences of failure to detect and repair vibrating components in the core become more apparent with reactor operating experience. At the Muhleberg reactor in Switzerland, a poison curtain installed in the reactor for reactivity control, cracked loose and vibrated in the coolant flow. The vibration remained undiscovered until the pressure vessel was opened for refueling. The poison curtain had by that time damaged the surrounding fuel channels. The additional work of replacing the damaged fuel channels quite possibly increased the length of that reactor outage. Similar problems, now resolved by design changes, have been observed at the Vermont Yankee and the Pilgrim One reactors in this country[7].

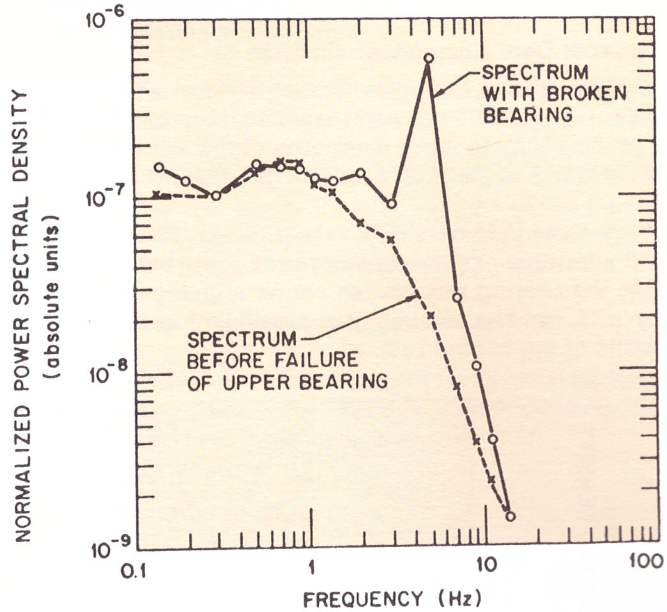

FIGURE 4. Change in HFIR Neutron-Fluctuation Spectrum as a Result of Rod Bearing Failure During a Later Fuel Cycle (Ref. 2)

2.2 Detection of Core Motion

Core barrel motion has been detected on two occasions in modern PWR's. The first occured in 1969 at the Trino reactor in Italy.

This section describes the application of a Hewlett Packard (HP) Model 5451A Fourier Analyzer to diagnose core barrel motion in the second occurrence at the Palisades reactor in 1973.

The first indication of core barrel motion at Palisades came when operating personnel noticed low frequency oscillations in the power level indication of the ex-vessel detectors. Similar variations were not present in the in-vessel detector signals. Engineers were called in to perform measurements to determine if core motion was in fact present[8]. Their equipment included the Hewlett Packard Model 5451A Fourier Analyzer.

Fig. 5 shows the equipment used to perform the measurements. A more detailed description is available in Reference 8. The rolloff frequencies of the anti-aliasing filters were set at 0.4 times the Analog to Digital sampling rate.

Digitized Signals were Hanning-windowed using the Fast Fourier Analyzer. Data collection times were up to 2 hours to yield a standard deviation of not more than 2% on NPSD's. Cross-power spectral densities (CPSD's) were also computed between signals of different detectors.

The phase relationship between signals was computed from the measured data using

$$\theta(f) = \tan^{-1} \frac{\text{IMCPSD}}{\text{RECPSD}} \quad (6)$$

Where IMCPSD = Imaginary part of the CPSD
RECPSD = Real part of the CPSD

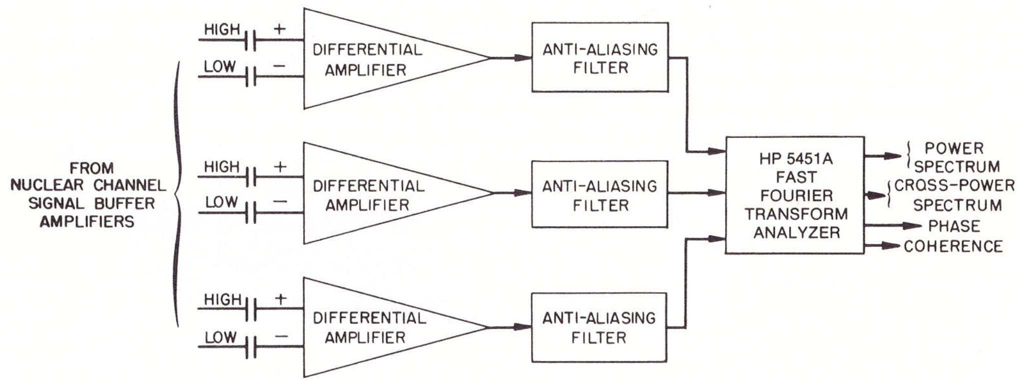

FIGURE 5. Signal Conditioning and Analysis for Detection of Core Motion of Palisades (Ref. 8)

The other variable used as a diagnostic aid was coherence, which is a measure of the commonality of two signals (A and B). In this application it is computed as

$$(7) \qquad COH(f) = \gamma^2 = \frac{|CPSDAB\ (f)|^2}{PSDA\ (f) \cdot PSDB\ (f)}$$

Two perfectly correlated signals would have a coherence value of 1 and two completely unrelated noise signals would have a coherence value of 0.

The signals used in the measurements were taken from detectors whose locations are shown in Figure 6. Both in vessel and ex-vessel detectors were necessary to this analysis.

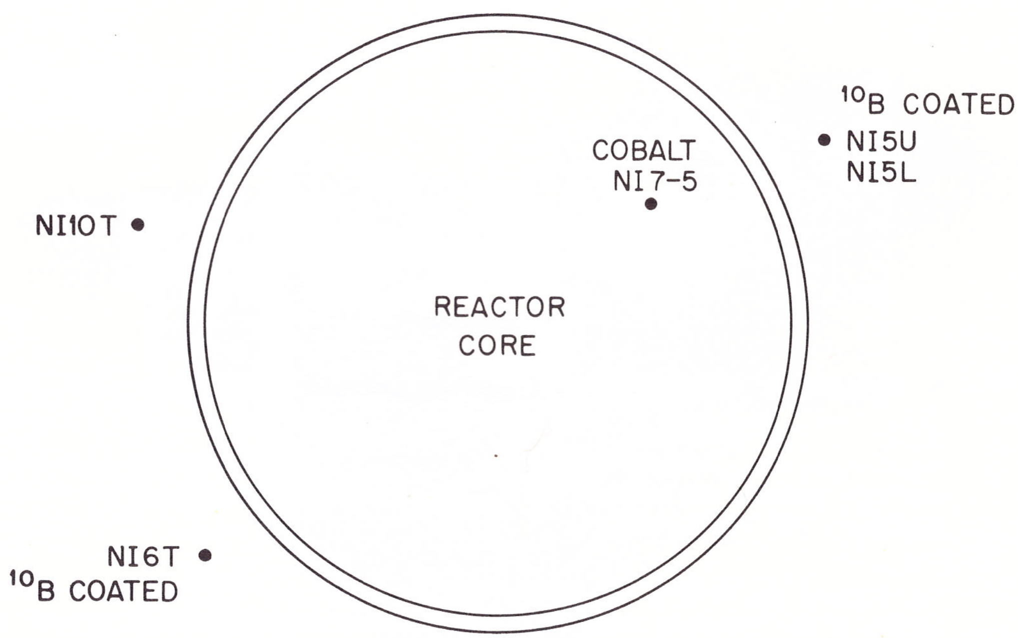

FIGURE 6. Neutron Detector Locations (Ref. 8)

Many tests were performed to assure signal quality. Fig. 7 shows the effect of an electrically noisy data logger on the signal. This source of extraneous noise would have contaminated all data had it not been detected and turned off during measurements. Hence, one of the real advantages of immediate data processing becomes apparent. It would have been very difficult to determine the cause of other peaks in the contaminated spectrum if frequency analysis had been performed offsite.

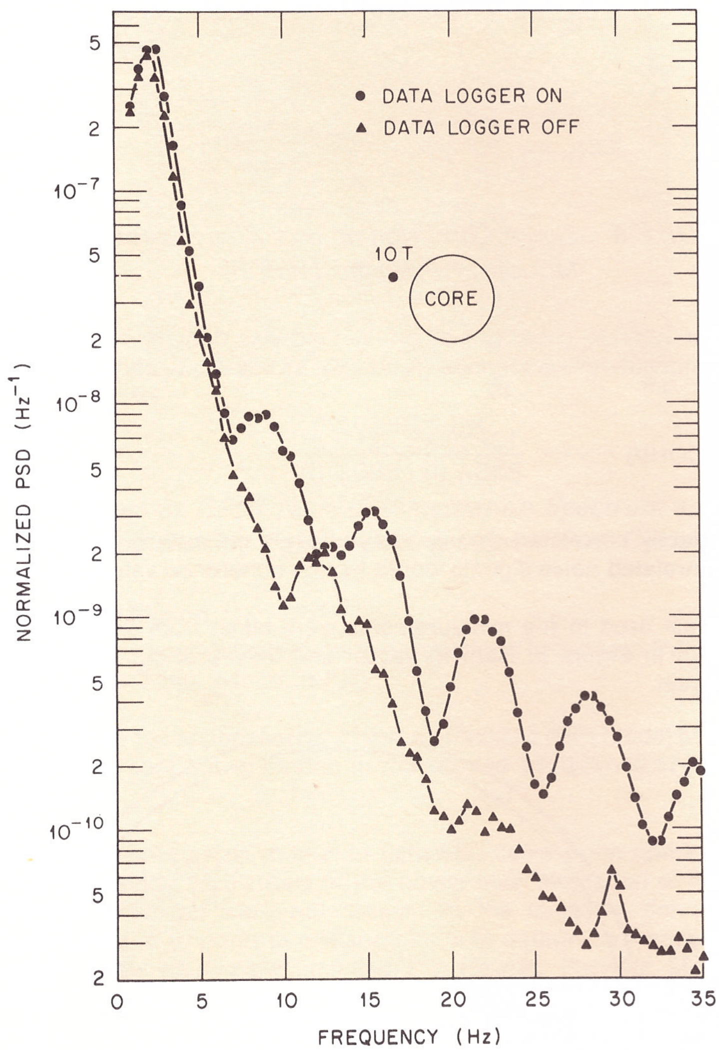

FIGURE 7. Effect of Data Logger on Detector Noise Signal (Ref. 8)

Fig. 8 shows the coherence and phase of the two ex-vessel detectors located diametrically opposite one another. Note the high coherence and the fact that the two signals are 180° out of phase.

Fig. 9 shows two NPSD's. The NPSD of the ex-vessel detector has a much higher content of low frequency noise that is not coherent with the in-vessel detector as shown in Fig. 10.

Upon opening the pressure vessel for inspection, significant wear was found on some restraining components, indicating that motion had indeed taken place.

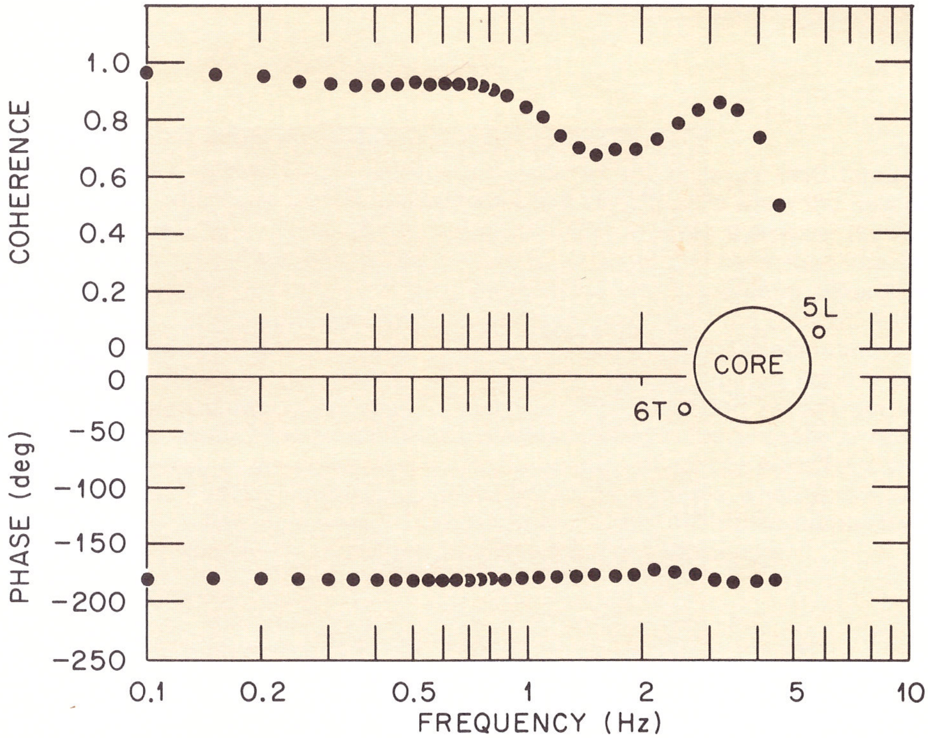

FIGURE 8. Coherence and Phase Between Ex-core Detectors on Opposite Sides of the Vessel (Ref. 8)

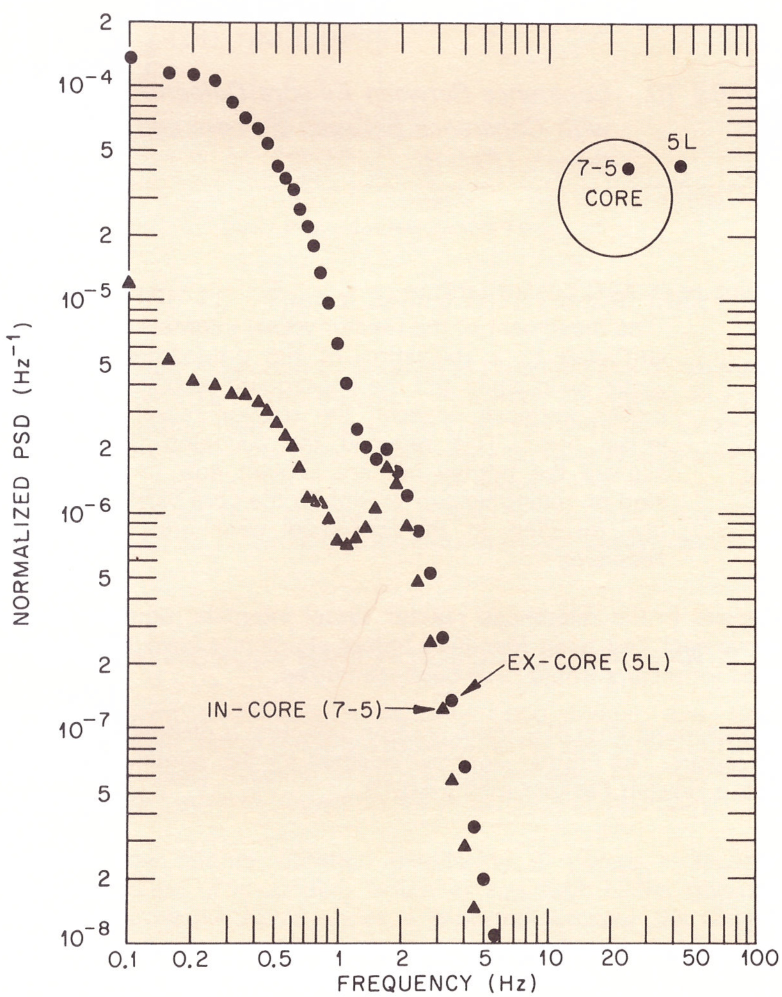

FIGURE 9. Power Spectral Density of Ex-vessel and In-Core Detector Signals (Ref. 8)

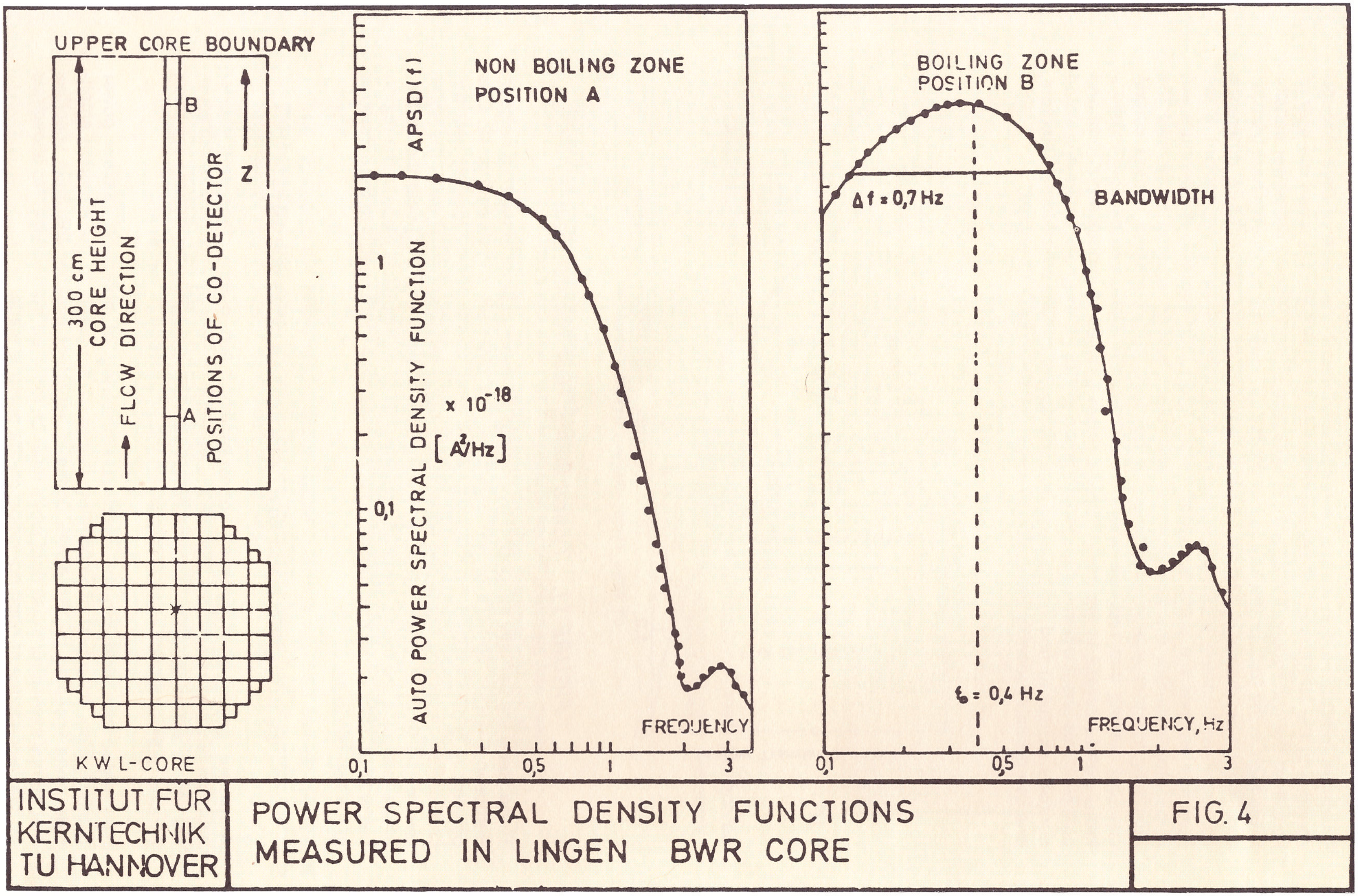

FIGURE 12. Power Spectral Density Functions Measured in Lingen BWR Core (Ref. 11)

This code accepts use of portable survey instruments which measure only the displacement of vibration as valid. Unfortunately, much information about the possible deterioration of internal components is contained in changes that can be small with respect to the total amplitude but that are relatively large with respect to the vibration amplitude at a particular frequency. Hence, a frequency analysis of the vibration is a much more sensitive means of detecting incipient failure. Also, frequency analysis is useful as a diagnostic tool in the event that excessive vibration is found.

Trade literature indicates that detection of impending failure in rotating equipment is important because rotating equipment failures accounted for 65% of all forced outage in the first quarter of 1974[13]. The second greatest cause of forced outage (24%) was repairs to reactor components damaged by excessive vibration.

The HP Model 5451B Fast Fourier Analyzer with a rotating equipment package should find widespread usage in reducing the impact of these problems. The wide dynamic range (80dB) and high frequency response (up to 100 khz) make it possible to perform measurements with greater sensitivity and over a greater frequency range than with previously available instrumentation. The portability of HP analyzers makes application of turbine diagnostic procedures such as those developed in Europe[14] both practical and convenient.

The 5451B Fourier Analyzer extends the ability of machine problem analysts to gather complete vibration data during the normal startup of plant equipment with minimal interference in plant operation. Data such as that shown in Fig. 13 can be useful in diagnosing transient problems in the startup of a pump or turbine. The advantage that the Hewlett-Packard system offers over previous methods is the ability to collect and organize data at each motor speed during a single continuous pass from zero to full operating speed without stopping to establish constant speed, a requirement for traditional swept-frequency-type measurements.

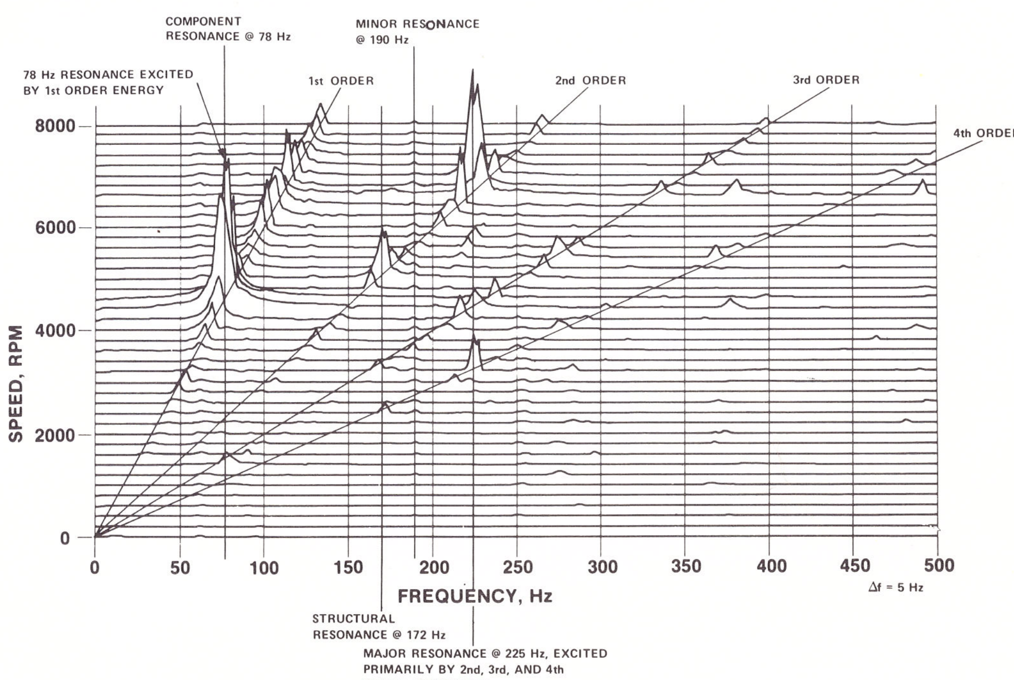

FIGURE 13. RPM Spectral Map.

4.0 SEISMIC ANALYSIS OF NUCLEAR POWER PLANTS

Nuclear power plants are built to demanding seismic requirements[15] and are instrumented to confirm that the operating basis of the design is not exceeded in the event of an earthquake. Presently, the design and placement of instrumentation is primarily based on expensive calculated response spectra.

An alternative to the calculated placement of earthquake instrumentation is now available through measured response spectra based on impact tests and modal analysis available with the Model 5451B Fourier Analyzer. While this technique has been applied only to small-scale machinery[16] at this point, the potential of the application to nuclear power plants is clear.

An HP Fourier Analyzer is being employed for structural vibration measurements by the John A. Blume Earthquake Engineering Center at Stanford University, but to date these techniques have not been directly applied to nuclear power plant construction. Determination of structural integrity by remote, rather than visual inspection, is especially valuable because access to some areas of a nuclear power plant are limited after initial operation due to buildup of radioactivity.

5.0 PIPING ANALYSIS OF NUCLEAR POWER PLANTS

Another potential application is the modal analysis of vibrating pipes. Ideally, a piping designer would prefer to place pipe hangers and hydraulic snubbers (there are typically 8,000 - 10,000 in a nuclear power plant) at points of maximum vibration to reduce the possibility of fatigue failure or excessive wear of piping. The modal analysis package of the Model 5451B is well suited to this application. While it is unlikely that the piping designer could wait for measurements of this sort, the technique is useful for analysis of any problems that emerge from "as built" configurations, or in selecting hanger and snubber locations for piping which is modified after initial operation of the plant.

6.0 CONCLUSIONS

With proper application, the Hewlett Packard Model 5451B Fourier Analyzer offers the possible early detection of incipient failure. Early detection of problems can aid the reactor owner by increasing his plant reliability through knowledge of additional options in scheduling preventive maintenance, by finding alternate modes of operation, or in cessation of operation before more serious damage results.

Thus, the Fourier Analyzer contributes to the reliability of a nuclear power plant not only by measuring the operability of a given piece of hardware, but also by giving quantitative information about its status so that intelligent choices can be made with regard to the operation of the power plant system as a whole.

REFERENCES

1. *Directory of Nuclear Reactors*, Vol. VII: Power Reactors, IAEA, Vienna, 1968. STI/PUB/174. Pages 55 and 191.
2. D. N. Fry, "Experience in Reactor Malfunction Diagnosis Using On-Line Noise Analysis," *Nuclear Technology*, Vol. 10, March 1971.
3. J. C. Robinson, "Analysis of Neutron Fluctuation Spectra in the Oak Ridge Research Reactor and the High Flux Isotope Reactor," ORNL—4149, Oak Ridge National Laboratory (1967).
4. GEAP—13979, F. H. Berg, et al. "State of the Art Report on Acoustical Monitoring of Nuclear Reactors," July 1973. Page 2-2.
5. "Flow Induced Vibrations," *USAEC Power Reactor Technology* Vol. 8, pp. 273-275, Fall 1965.
6. J. E. Reisland and E. A. Gustafson, "Work Performed on Fuel Channels and the Core Cupport Plate at Big Rock Point Nuclear Plant," *ANS Transactions*, Vol. 8 Supplement, 1965.
7. Nucleonics Week, November 22, 1973, p.6.
8. D. N. Fry, R. C. Kryter, and J. C. Robinson, "On-Site Noise Diagnostics at Palisades Nuclear Power Station." A paper presented to the Symposium on Power Plant Dynamics, Control and Testing held Oct. 8-10, 1973 at Knoxville, Tennessee, and sponsored by the Power Plant Dynamics, Control and Testing Division of the University of Tennessee Engineering Experiment Station, The American Nuclear Society and the Instrument Sciety of America.
9. ROE 74-3 Reactor Safety-Operating Experiences, USAEC, "Mechanical Vibrations of Reactor Internals" Feb. 8, 1974.
10. W. M. Rohsenhow and H.Y. Choi, "Heat Mass and Momentum Transfer," Prentice Hall, Inc., Englewood Cliffs, N.J. 1961, p.212.
11. D. Stegemann, P. Gebureck, A. T. Mikulski and W. Seifritz, "Operating Characteristics of a Boiling Water Reactor Deduced from In-Core Measurements." A paper presented at the same symposium as Reference 8.
12. ASME Boiler and Pressure Vessel Code, Section XI, Subsection IWP, "Inservice Testing of Pumps in Nuclear Power Plants." Summer 1973, Addenda.
13. "Factors Responsible for Delay in Getting Nuclear Power On Line," *Nuclear Industry Magazine*, April 1974, pages 22 and 23.
14. "On-Load Surveillance of Nuclear Power Plant Components by Noise and Vibration Analysis," Status Report on work performed for the Commission of the European Communities under Euratom Study Contract No. 043-71-10 ECIC (F), April, 1972.
15. U.S.A.E.C. Regulatory Guide 1.12, "Instrumentation for Earthquakes."
16. I. E. Morse, W. R. Shapton, D. L. Brown and G. Kuljanic, "Application of Pulse Testing for Determining Dynamic Characteristics of Machine Tools." HP Application Note 140-3.

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