OS9-6 Wavelet Analysis of an Instability Event in a Nuclear Power Plant

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Abstract

Power signals from an instability transient event in a nuclear power plant are analyzed by the wavelet technique. Besides determining the dominant oscillation frequency of the event, other frequencies were also found in the power signals and were analyzed for their importance to the event. The instability event will be described and results from traditional Fourier and wavelet analysis will be presented and discussed. The wavelet technique is shown to be a powerful additional tool to the traditional Fourier analysis in the signal analysis from transient events in nuclear power reactors.

Keywords: Nuclear Reactor, Power Instability, Wavelet, Fourier Analysis

1. INTRODUCTION

Wavelet analysis to diverse kind of signals has attracted lots of attention in the last decade, or so. One important limitation to the Auto Regressive Moving Average (ARMA) and Fast Fourier Transform (FFT) techniques is that they may not be applicable for transient phenomena, although the multivariate auto regressive technique has been shown to give useful information on the interdependence of signals coming from different components during a transient [1]. Wavelet analysis provides temporal information, so it can be a powerful complementary tool to the traditional Fourier analysis.

Wavelet analysis has been proposed as a way for denoising and signal reconstruction [2]. The technique was tested using numerical results of the point kinetics equations without feedback. Analysis of actual transient power signals from nuclear power reactors has also been accomplished by the wavelet methodology [3].

In this paper, it is presented a short analysis of power signals from a transient event that occurred at the Laguna Verde Nuclear Power Plant, in Mexico. Both the traditional fast Fourier analysis and wavelet technique are used to provide with a better insight into the phenomena occurring during the transient. The power signals were coming from the Average Power Range Monitors (APRMs) in a Boiling Water Reactor (BWR).

2. EVENT DESCRIPTION

Unit 1 of the Laguna Verde Nuclear Power Plant presented power oscillations during the startup. The operation conditions of the plant at the time of event were 37% power and 37.8% flow in the core. Also, the recirculation pumps were working at low speed and the control flow valves of the loops were partially opened. Then, the control flow valves were set to their minimum closing position, with the intention of making the transference from low to high speed, on the recirculation pumps. Operation conditions of 31.8% power and 32% flow in the core were reached through these maneuvers. At this time, the reactor operator observed oscillations of power on the APRMs. The amplitude of the oscillation was of approximately 10%, shown on APRM A, and its frequency 0.54 Hertz. Figure 1 shows the power signal from one of the APRMs during the transient event.

![Figure 1: Power signal from one of the APRMs during the transient event](image)

3. RESULTS

The power Spectral Density (PSD) obtained by applying the FFT of the signal shown in Fig. 1 is presented in Fig. 2. Two main frequencies can be detected in Fig. 2: the 0.16 Hz and the 0.54 Hz, which was the main oscillation frequency, as already stated in the
previous section. In Fig. 3 the wavelet analysis shows the magnitude of the wavelet coefficients, both in function of time and frequency. The wavelet technique allows to observe how the power oscillation grows during the transient event.

![Fig. 3: Wavelet coefficients magnitude of signal on Fig. 1, as function of both time and frequency](image)

**4. CONCLUSIONS**

In this work, it is shown how the traditional frequency domain analysis can be well complemented by information obtained from the wavelet analysis. A deeper analysis showing advantages and disadvantages of both techniques will be presented and discussed during the paper presentation.

**REFERENCES**

