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Develop Methods and Tools using NSUF Data to Support Risk-informed Predictive Analytics

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Changing the World's Energy Future

Idaho National Laboratory

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Method and Tool Development Using NSUF Data to Support Risk-Informed Predictive Analytics

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Project Description: The scope of this research encompasses enhancing the reliability of test/advanced reactor operation by understanding their current and future states. The specific objectives are to 1) develop operational signatures by using data from the Advanced Test Reactor (ATR), and 2) develop classification models using machine learning (ML) to accurately classify any deviation from normal operation. This knowledge will enable the integration of predictive-model development with reactor risk assessments, leading to predictive maintenance strategies that enhance the reliability and availability of these reactors.

Impact and Value to Nuclear Applications: This project will foster technologies that enable complete state awareness of the reactor. Such awareness would lead to the development of advanced autonomous operation and risk-informed decision making.

Recent Results and Highlights: Data from acoustically telemetered sensors installed in the ATR were collected for different operating cycles. The real-time acoustic data from the ATR's primary coolant pumps (PCPs) were analyzed using recursive short-time fast Fourier transformation (STFFT), which allows for tracking the beat frequency when two or three PCPs are operated under different operating conditions. The beat frequency captures the baseline acoustic signatures, along with other events. Binary ML classifiers, support vector machine (SVM), and linear discriminant analysis (LDA) were developed to automate the classification of acoustic data (from the M7 and M8 PCP combination) into "normal" and "event" categories (see Figure 1 and Table 1). A similar approach can be applied to other acoustic spectrograms from other PCP combinations. For data collected through different PCP combinations, a data fusion approach can potentially be applied to build in robustness.

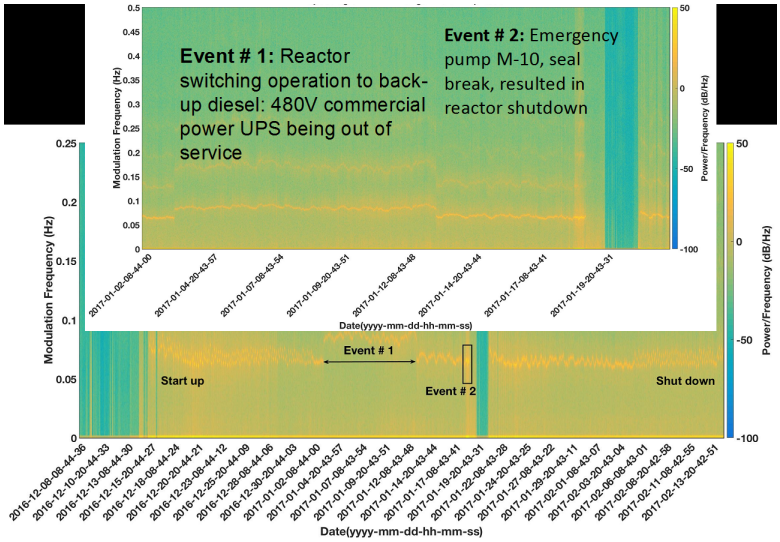

Figure 1. ATR acoustic baseline signature for the M7 and M8 PCP combination with two operational events.

Table 1. Classification results from using LDA and SVM models.

Models	LDA model			SVM Model		
Test samples 3,240	Predicted Class 1 (Normal)	Predicted Class 2 (Events)	Accuracy	Predicted Class 1 (Normal)	Predicted Class 2 (Events)	Accuracy
Actual Class 1	1,575	45	0.9720	1,600	20	0.9815
Actual Class 2	50	1,570	0.9691	35	1,585	0.9782