Diagnostic Indicators for Shipboard Systems using Non-Intrusive Load Monitoring

LT Thomas W. DeNucci, USCG

Prof. Steven B. Leeb	Prof. Timothy J. McCoy	Prof. David L. Trumper
Thesis Supervisor	Thesis Supervisor	Thesis Reader

Field studies have demonstrated that the Non-Intrusive Load monitor (NILM) can provide near real-time indication of the condition of many critical electromechanical systems on board naval vessels. Results from data collected from engineering systems on board *USCGC SENECA (WMEC-906)*, a 270-foot U.S. Coast Guard cutter, indicate that the NILM can effectively identify faults, failures and deviations from normal operating conditions on numerous shipboard engineering systems.

Data collected from the sewage system identified metrics that can be applied, for example, to cycling systems (high pressure air, hydraulic systems, etc.) to differentiate between periods of heavy usage and fault conditions. Sewage system variability and randomness was minimized by employing a MATLAB simulation designed to permit a thorough exploration of system behavior that might not have been exposed during the underway observations. Simulation data suggests that the presence, location and magnitude of a spike in the bi-modal distribution indicated the presence of a leak. Data from the actual shipboard system, when subjected to a quantifiable leak, displayed the same behavior.

Data collected from the Auxiliary Seawater (ASW) System indicated that the NILM is able to predict the failure of a flexible coupling linking the pump and motor components. The ASW motor-pump system was modeled using a 5^{th} order induction motor simulation to explore the electromechanical relationships between the motor, coupling and pump. Changes to the mechanical parameters of the coupling were captured in the electrical signature of the motor in both the simulation and shipboard data.

Frequency domain analysis of the ASW System data also suggested that the clogging of a heat exchanger on a critical shipboard system can be identified with the NILM. Further development of hardware and software, along with continued research into the behavior of shipboard systems, will allow the NILM to augment existing monitoring systems and potentially serve as a stand-alone indicator of critical system performance.