Evaluation of Non-Intrusive Monitoring for Condition Based Maintenance Applications on US Navy Propulsion Plants

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This thesis explores the use the Non-intrusive Load Monitor (NILM) in Condition Based Maintenance (CBM) applications on U.S. Navy ships as part of the Office of Naval Research Electric Ship Integration (ESI) Initiative. The NILM is a device that measures an electrical component's performance by applying a single voltage and current transducer to a ship's existing power distribution system. The NILM was originally developed to monitor electrical power usage in buildings where it was noticed that it could disaggregate and report the operation of individual loads when many loads were running. The first chapters of the thesis explore the limits of this capability by first employing a signal processing script in MATLAB using component data gathered on the *USCGC Seneca (WMEC-906)*. Then raw data collected from individual components at the Naval Surface Warfare Center Philadelphia DDG-51 Land Based Test Site (LBES) is re-scaled and run through the NILM processing software to determine if it can still provide useful information when multiple loads are monitored with a single NILM. Finally, a single NILM is installed on a LBES load center upstream of several components. The resulting data is compared to pervious simulations to evaluate their ability to predict successful monitoring. The next chapter evaluates the use of the NILM as an enabling technology for Navy CBM. The Integrated Condition Assessment System (ICAS) is the U.S. Navy's "Program of Record" for CBM and is currently installed on over 97 ships fleet wide. NILM data from individual components at the LBES was monitored simultaneously with ICAS and the results are compared. The next chapter evaluates the use of the NILM as a diagnostic device for shipboard systems. Data collected from the sewage system of the *USCGC Seneca (WMEC-906)* 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 such as a system leak. The NILM was installed on a Low Pressure Air system at the LBES to validate these metrics. The final chapter discusses the plausibility of using a few NILMs to provide machinery monitoring information for an entire engineering space, and the resulting opportunity to reduce sensor growth on future Navy ships.