

# **Diagnostic Indicators for Shipboard Mechanical Systems Using Non-Intrusive Load Monitoring**

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This thesis examines the use of Non-intrusive Load Monitoring (NILM) in auxiliary shipboard systems, such as a low pressure air system, to determine the state of equipment in larger connected systems, such as the main propulsion engines.

Using data collected on previously installed NILM's at the Naval Surface Warfare Center, Philadelphia DDG-51 Land Based Engineering Site (LBES), major event changes were analyzed and diagnosed using power data collected from the in-service low pressure air compressor (LPAC) and the in-service fuel oil pump. Events investigated include main propulsion engine starts and loadings, gas turbine generator starts, major electrical load shifts, and leak insertions into the low pressure air system.

An additional NILM was installed on the General Electric LM2500 Universal Engine Controller (UEC) in order to assist in the diagnosis of various state changes. The UEC provides the appropriate interfaces to monitor and control each LM2500 GTM. The UEC controls the application of starter air, ignition power, and fuel to the engine while also receiving feedback of engine parameters from sensors on the engine.

Using the combined data received by the LPAC, fuel oil pump, and UEC, a diagnosis system is derived that can detect major events in the engineering plant described above.