

Utilization of Vibration Assessment during Rotor Spin-down to determine the Mechanical Health of Rotating Machines

LT Ryan Zachar, USN

Prof. Steven Leeb	Patrick Hale
Thesis Supervisor	Thesis Reader

Vibration analysis is a common method to assess the mechanical health of a machine and its associated hardware. Rotating machines such as engines and generators need to be properly balanced in order to function correctly, and excessive vibration can be an indicator of an abnormality. In certain applications the machines may also have special vibration arresting mounts to reduce noise levels. The US Navy's fleet of Mine Countermeasures Ships (MCMs) employ special mounts for their Ship Service Diesel Generators (SSDGs) in order to minimize the radiated noise from the SSDG to the hull and water. Vibration readings are currently taken above and below the mount periodically to try and determine the condition of the mount, however since the measurements are infrequent the condition is often not known until failure. This project seeks to develop a method for continuous monitoring by recording the generator's vibration only during spin-down. Rotor speed, which is derived by measuring the back EMF off of the generator phase lines, is combined with vibration to create a Frequency Response Function (FRF) for each spin-down which visualizes vibration levels at individual frequencies. These FRFs can be compared to a baseline to determine the relative health of the machine and its mounts. Each FRF features a resonant peak which changes in frequency and amplitude as the mount condition degrades or an imbalance develops. A test rig consisting of two motors coupled together to simulate a generator set was constructed in the Laboratory for Electromagnetic and Electronic Systems (LEES) in order to test the underlying theory that the vibrations in the FRF corresponded to levels obtained at actual frequencies during controlled tests. Tests were also conducted on in-service SSDGs aboard the USS CHAMPION during in-port and underway periods, with FRFs constructed for each spin-down. Results from these tests as well as experiments on other larger and smaller machines are presented.

Naval Engineer

Master of Science in Engineering and Management