CASE STUDY: Nuclear Emergency Diesel Generator - Poor Component Assembly

Summary
Following a periodic engine analysis activity, it was immediately noted by the analyst that Cylinder #2 had a peak firing pressure approximately 134 PSI lower than the engine average, the peak firing pressure was early ~3 degrees and exhaust temperatures were approximately 180 degrees F lower than engine average. The fuel pump and injector were replaced, the subsequent engine analysis data confirmed the problem had been corrected. After a root cause analysis and complete disassembly and inspection of the fuel pump revealed that two internal components were not installed during the last pump rebuild.

Background
Emergency Diesel Generators at nuclear power plants worldwide provide a critical safety function to provide emergency power to critical equipment and systems in the event of a loss of site power. As such these engines are operated in test conditions periodically to ensure operation as well as tested after any maintenance activity is performed. In this instance the #2 EDG which is an 8 Cylinder Enterprise DSR-48 diesel engine rated at approximately 4890 Brake Horsepower was being operated as part of a periodic engine surveillance test and in which engine analysis was performed. The Windrock analyst noted the decreased firing pressure, early peak pressure and on a more detailed review noted that the fuel pump ultrasonic data had a double mechanical after the injector “popped”. Less then 24 hours later the pump had been replaced, the engine returned to operational status.

Technology
The client contacted Windrock who used a 6320/DA portable analyzer to assess the condition and performance of the diesel engine. The 6320/DA analyzer measures dynamic data relative to crank position and then applies the principles of thermodynamics and science to precisely assess machinery condition and performance. The portable analyzer utilizes multiple sensor technologies to collect data degree-by-degree with respect to crank-angle. Measurement points include in-cylinder pressure, vibration and ultrasonic data on the cylinders. The system also measures vibration in the spectrum realm on the turbocharges and frame as well as angular velocity of the crankshaft. Using this information and built-in diagnostics, Windrock analyzers and software are able to assess the mechanical condition, performance and economic return of diesel engines.

Findings
A third-party company was tasked with a detailed inspection and disassembly of the pump to identify the root cause of the failure. This detailed inspection revealed that the Fuel Delivery Valve Stop and Fuel Delivery Fuel Valve Spring were not installed. Due to the design of this Fuel Delivery Valve, there was enough fuel being delivered for the cylinder to fire but at a reduced pressure. It was also noted that there was a through wall crack in the Delivery Valve Assembly. It is believed that this crack was caused by high pressure being built up in the pump due to the restricted flow area to the fuel injector.

(Figure 1) Initial dataset showing low pressure on cylinder 2. (Figure 2) Ultrasonic signature on fuel pump indicating the double hit on closure.
Analysis Details
This nuclear power station had just begun conducting engine analysis on their 3 EDG’s and with this finding, which allowed for the immediate knowledge to identify the cause of the low pressure and temperature on this cylinder, is now performing engine analysis on their EDG’s regularly. This plant today is utilizing the latest technology in the form of multi-channel phased data collection of cylinder pressures, vibration and ultrasonic data.

About Windrock
Windrock offers industry-leading expertise in condition-based and performance-based monitoring solutions for compressors and engines across multiple applications. We design and manufacture portable analyzers and online systems at our headquarters in Knoxville, TN. In addition to our products, Windrock Technical Services analysts travel the world to help companies with their reliability and maintenance programs. We are proud to be a part of Dover Energy Automation (a Dover Corporation company).