CASE STUDY: Nuclear Emergency Diesel Generator (EDG) Maintenance Induced Maintenance

Summary

Following a routine maintenance activity and the subsequent surveillance runs, which included the performance of engine analysis on the EDG, it was noted that Cylinder 12 had a peak firing pressure approximately 500PSI lower than the engine average. However, the exhaust temperature for cylinder 12 was above average on the final test. In the previous test conducted only 17 hours earlier, cylinder 12 had normal peak pressures and temperatures. An additional engine analysis run on only cylinder 12 was conducted to obtain phased vibration and ultrasonic data and to determine the source of the low pressure. This last data set confirmed a mechanical fault. As this activity was occurring at the end of a 7-day allowed maintenance outage time, a shutdown of the reactor was commenced.

Background

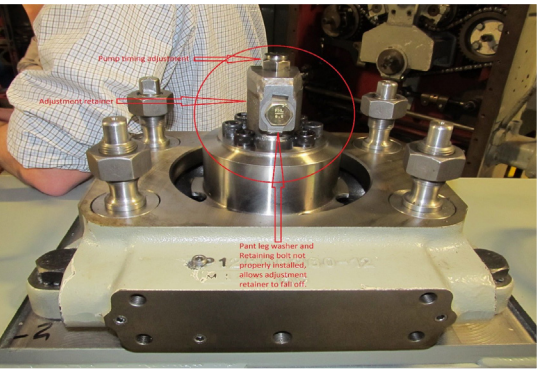
Emergency Diesel Generators at nuclear power plants worldwide provide critical emergency power to equipment and systems in the event of a loss of off-site power As such these engines are tested periodically and after any maintenance activity to ensure correct operation. In this instance the A-Train Fairbanks Morse Pielstick 2.5, 14-cylinder diesel engine rated at approximately 8800 brake Horsepower, was coming out of a 7-day preventative maintenance activity and the subsequent operational testing. Once an inspection of the fuel pump on Cylinder 12 was conducted, it was easily identified that the "pant leg washer" and retaining bolt were not properly installed.

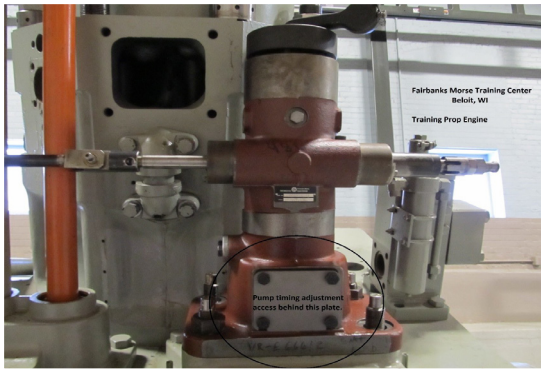
Technology

The client utilized a Windrock four channel portable analyzer to assess the condition and performance of the diesel engine. The analyzer measures dynamic data relative to crankshaft position and then applies combustion principles 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

This nuclear power station has been performing engine analysis on their 2 EDG's since 1994. The above event occurred in 2010 allowing for plant personnel to immediately identify a fault, the reason for the fault and correct it in short order. This prevented the plant from operating in a potentially unsafe condition following engine maintenance.





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Machine Protection

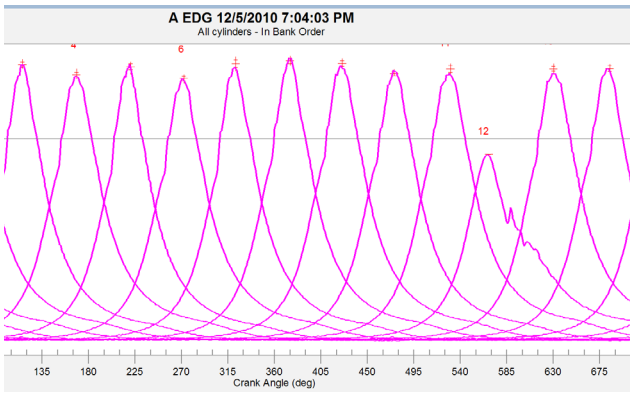
Condition Monitoring

Performance Analysis

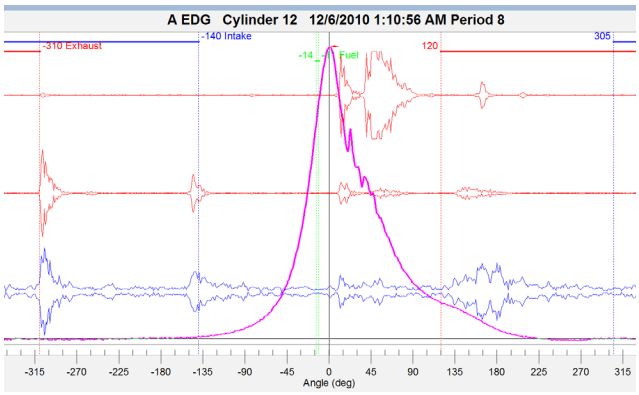
Economic Evaluation

Analysis Details

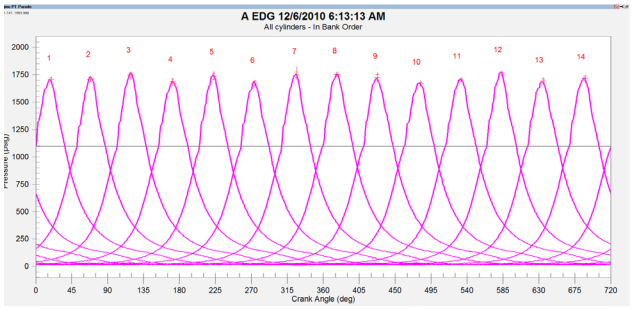
The customer identified that cylinder 12 was not firing and easily ascertained that the pant leg washer and retaining bolt were not properly installed (Figure 1). This allowed the pump timing adjustment retainer to fall off which led to the pump timing change, resulting in the fuel pump timing becoming retarded. Thus, the retarded timing caused the cylinder combustion to start very late and not reach even compression pressure, however it created a normal to slightly elevated exhaust temperature. To confirm the issue, additional data was taken were it was noticed that there was a slightly elevated exhaust temperature (Figure 2). Approximately 24 hours later the pump had been repaired, the engine returned to operational status, and the reactor restarted approximately 36 hours later (Figure 3).



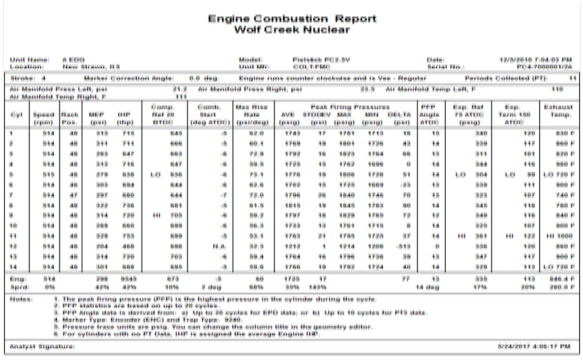
(Figure 1) Cylinder 12 identified as not firing at 1904 on 12/5



(Figure 2) 12-6 at 0110 additional data taken to confirm cause



(Figure 3) Post repair test on 12/6 at 0613


Engine Combustion Report
Wolf Creek Nuclear

(Figure 4) Engine Combustion Report

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).

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