A Quality Control Success Story With The Michigan Army National Guard's Diesel Engine Rebuilding Program

Figure 1. SenX Technology for the Dyno Test Lab at the Michigan National Guard CSMS in Lansing.

"Knowing that we are only shipping to the field, diesel engines in known top condition is a great comfort for all of us at the CSMS Dyno Shop. This development has been a big step forward for us, and use of these tools has become an important part of our standard operating procedure." - Michigan Army National Guard

The Michigan Army National Guard operates and maintains a very large fleet of heavy diesel equipment. It is imperative that this fleet be kept at a high level of readiness and reliability at all times. The vehicles are stationed at armories distributed around the state and are maintained at a number of strategically located Field Maintenance Site (FMS) centers that support these local armories. When a particular vehicle exhibits mechanical problems requiring extensive engine repair, the problem engine is removed at an FMS and sent to the Centralized Service and Maintenance Site (CSMS) facility where extensive engine rebuilds can be made. A rebuilt or new engine is then sent from a quality controlled inventory at the CSMS for reinstallation at the FMS center.

It is really important that these rebuilt engines be carefully inspected and analyzed to assure that the resulting engine is truly as "good as new" before sending it out to an FMS for replacement in an active service vehicle. To accomplish this, the final step in the CSMS rebuilt engine quality assurance protocol is to place the engine on the CSMS dynamometer and verify that all of the cylinders, valves, head gaskets, injectors, fuel pumps and all the required mechanical adjustments are "just right" for shipment to the field. The CSMS technical staff, SenX Technology, and Pico Technology have assembled a mechanical testing solution that provides the Michigan Army National Guard a quantum leap in the speed and accuracy of this final testing procedure. A four channel PICO automotive lab scope is used to display the data from two SenX Technology FirstLooktm ADS ES 100 pulse sensors and one trigger signal simultaneously on a laptop computer screen. One FirstLook sensor is placed in the exhaust pipe to observe valve condition and for comparing compression across the cylinders. The second FirstLook sensor is placed in the oil dipstick tube to monitor the crankcase pressure variations due to blow-by. Optionally a third sensor could be placed in the intake manifold for additional information. The trigger signal is taken from either an electrical signal to the #1 injector or from a piezoelectric sensor placed on the fuel line to the #1 cylinder. This allows the identification of any problem seen in the FirstLook data to be associated with a particular cylinder by consideration of the firing order.

Figure #2a. Picture shows Firstlook sensor secured in exhaust using a copper tube.

Figure #2b. Picture shows Firstlook sensor with vent hood in place.

Figure 3. Operational detail showing FirstLook sensor probe over dipstick tube.

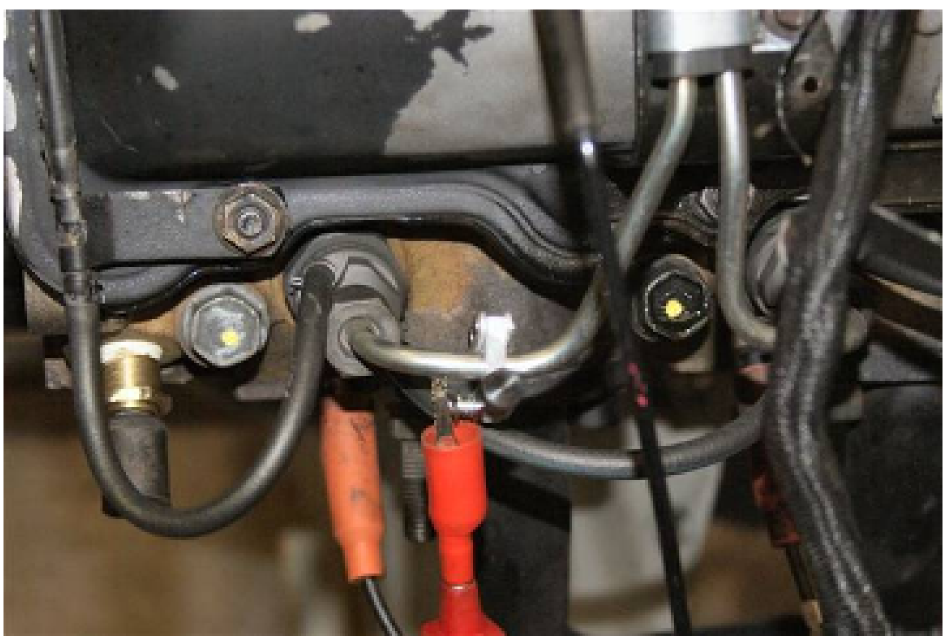

Figure 4. Operational detail showing piezo trigger placement on #1 injector fuel line.

The engine tests are run under three conditions – cold cranking with no fuel at about 300RPM, warm idle at about 750 RPM, and with a braking load at about 1500 RPM. Under all of these conditions, the pulse data from each cylinder should compare virtually identically with all of the others in a well set up and properly assembled engine. A major deviation between cylinders indicates a problem to be diagnostically examined more closely. Typically such an engine must be returned to the shop for repair. On the other hand, if all the data between cylinders is closely comparable, the mechanical condition of the engine is good and it may be confidently placed in the inventory for future installation in the field.

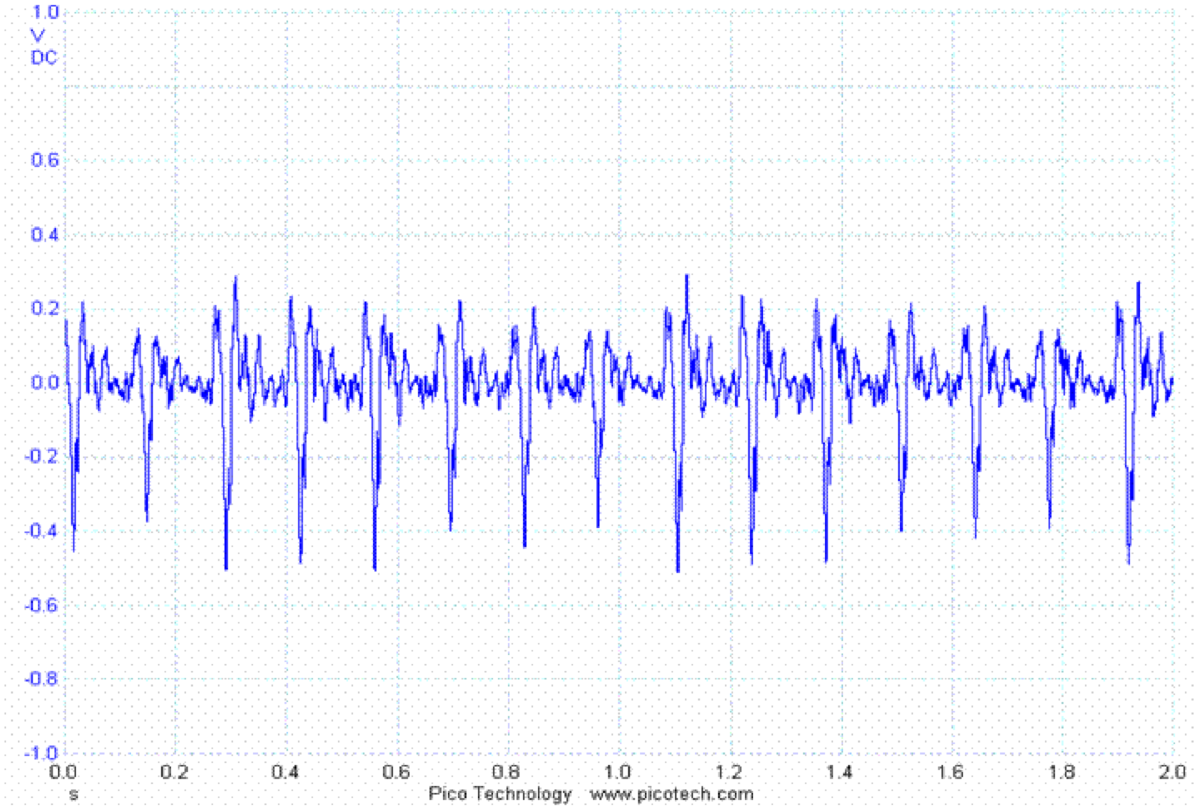

Figure 6. Cold crank on 6 cylinder Cummings diesel engine. Exhaust Waveform is basically uniform showing clearly individual cylinders.

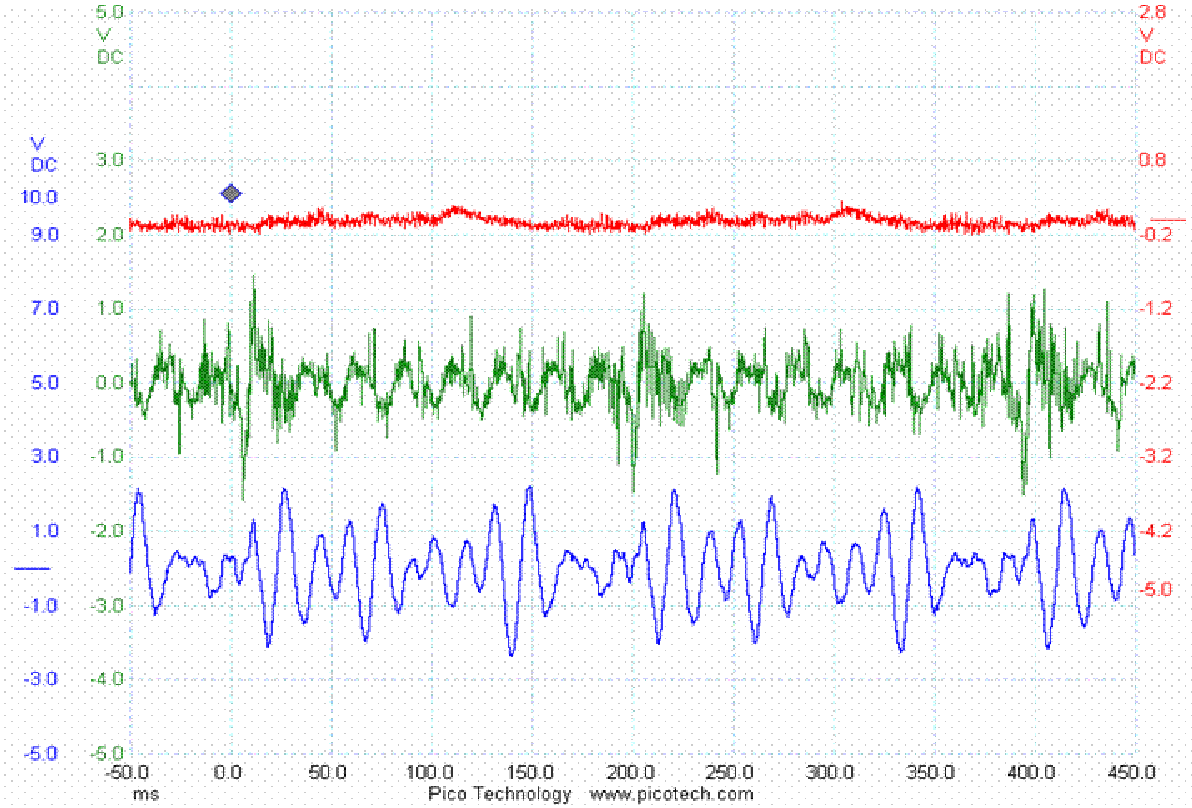

Figure 7. Idle data from exhaust (bottom), crankcase (top) and trigger from a bad engine.

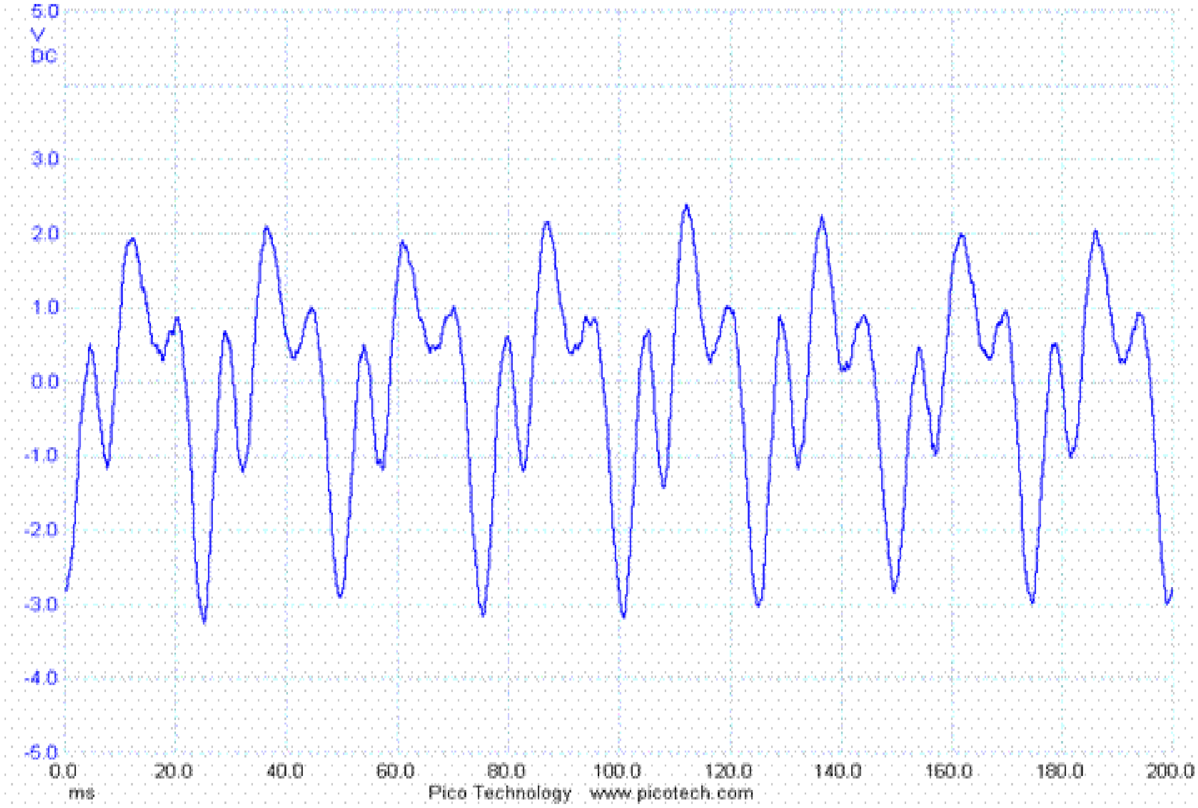

Figure 8. Idle exhaust data from a Cummings diesel engine in good condition. Note the clean repeating waveform.

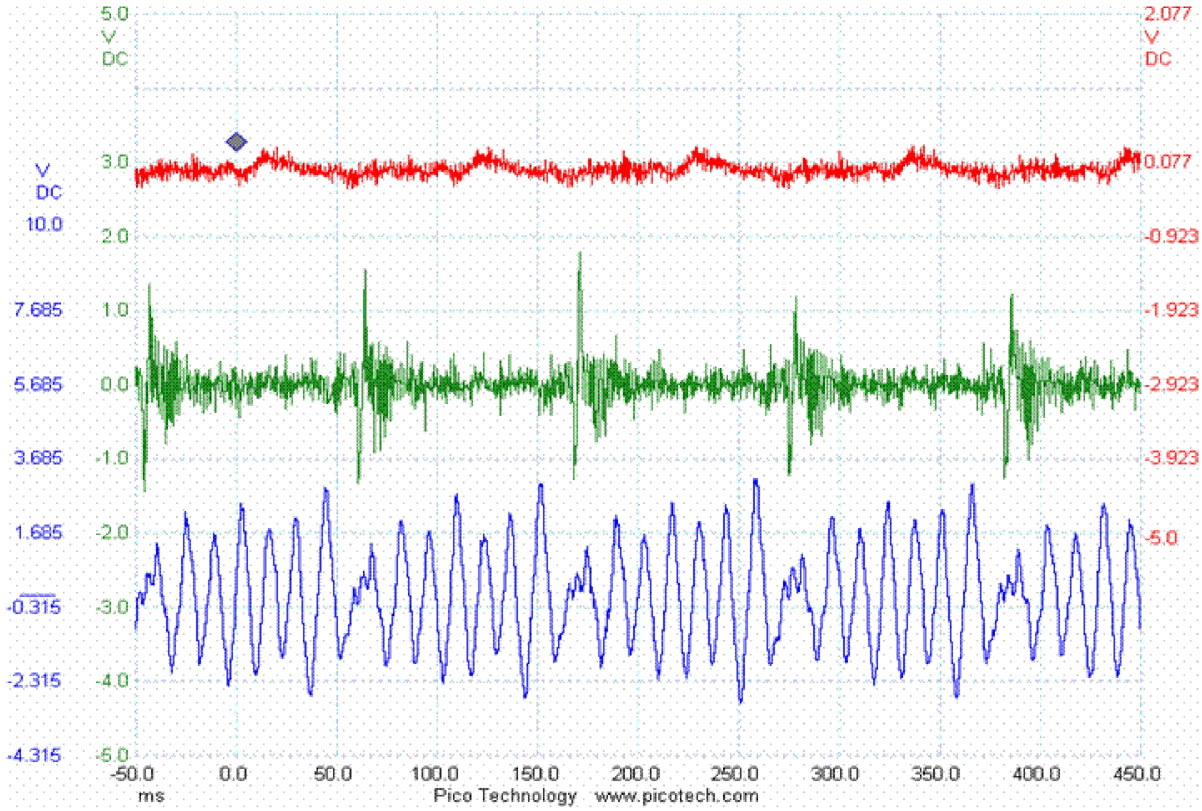

Figure #9. Note the top line which is the crank case pressure fluctuations. This indicates leakage into the crank case of a cylinder when under load.

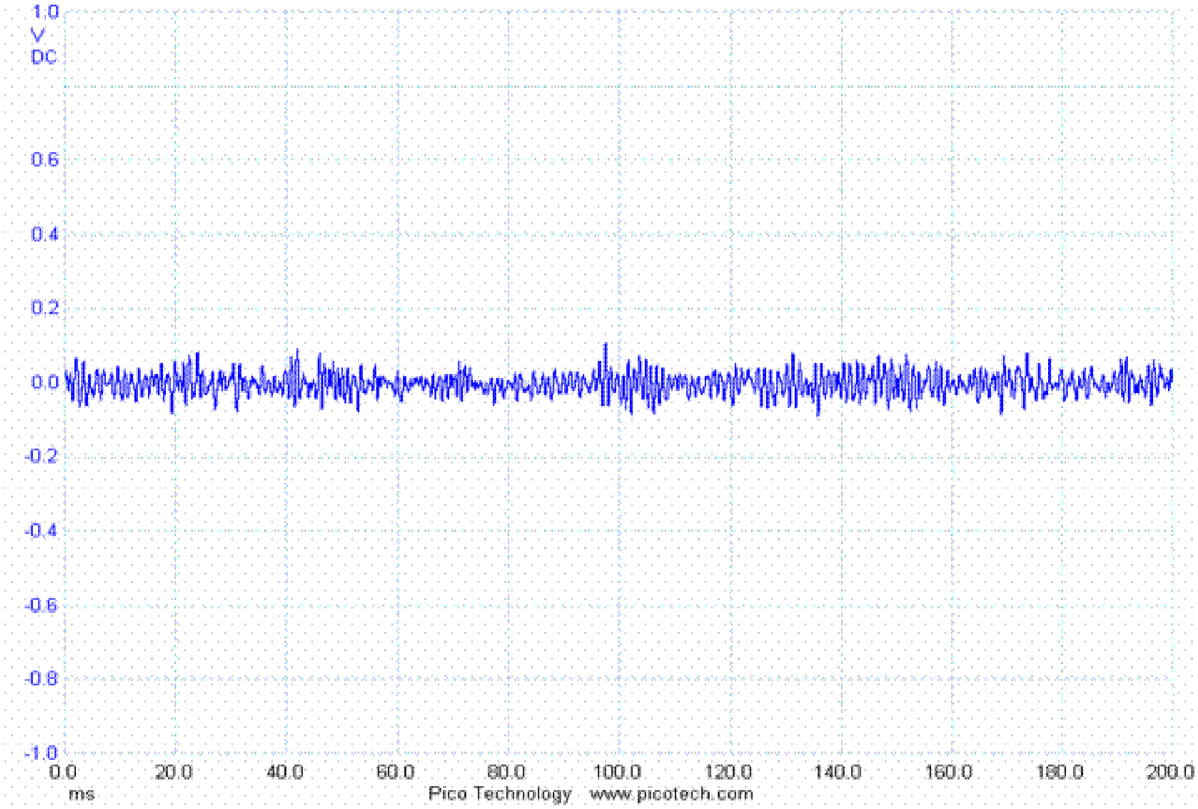

Figure #10. This shows normal crank case fluctuations in a Cummings Engine. Diesel engines will always show a percentage of blow by. As the engine gets old this will increase and can be used to gauge engine condition.

This solution is very economical to implement, and the benefits are so large that payback has been almost immediate. The cost for implementing this solution, assuming a portable or desk mounted PC is available, is less than $4000 for the lab scope and sensors. In the very first weeks of this solution's operation, several engines, which to outward appearance and from normal testing were suitable for shipment to the FMS for replacements, were found to be faulty and require further work. Stopping even one problem engine from leaving the CSMS would have saved the cost of the testing equipment, and already several engines have been identified and proper corrective actions taken before final QC approval was given.

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For more information on FirstLook Automotive and Diesel Diagnostic Sensors see www.SenXTech.Com

For more information on PICO Technology Automotive and Diesel Diagnostic Oscilloscopes please see www.PICOTech.Com