

MachineryWatch.Com, Inc. Case History

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| Machine: | 80 Kilowatt Standby Generator |
| Industry & Location: | Manufacturing, Michigan |
| Equipment: | V6 Engine Driven, Natural Gas Fuel, 4.2 Liter Displacement, Engine Speed = 3600 RPM |
| Instrumentation: | MAARS Model 5000, accelerometers |
| Condition: | Resonance @ 1.5X RPM (5400 CPM/90 Hz) and |
| Indication: | Excessive 1X and 1.5X RPM vibration amplitude, Confirmed using spectrum analysis and phase analysis and torsional analysis |
| Corrective Action: | Changed design of rotor to be supported at both ends of generator with a bearing rather than only at the outboard end of the generator, dynamic balancing of rotors |
| Result: | Natural frequency of the rotor was shifted away from the 1.5X RPM area sufficiently to eliminate resonance and reduce 1.5X RPM vibration amplitudes and 1X RPM vibration was reduced due to dynamic balancing |

The emergency generator manufacturer was developing a new line of mid-range (50 – 200 kW) emergency generators, powered by automotive derivative engines running on natural gas rather than diesel and operating at 3600 RPM rather than 1800 RPM. The advantages are greatly reduced size and weight of the generator set.

Reliability problems were encountered with the prototype units. Bearing failures were occurring too early and rotors were rubbing on the stators causing catastrophic failures. The manufacturer requested assistance in data acquisition and analysis. The generator manufacturer had already acquired data indicating a rotor critical speed near 1.5X RPM. The entire unit was mounted on rubber isolators.

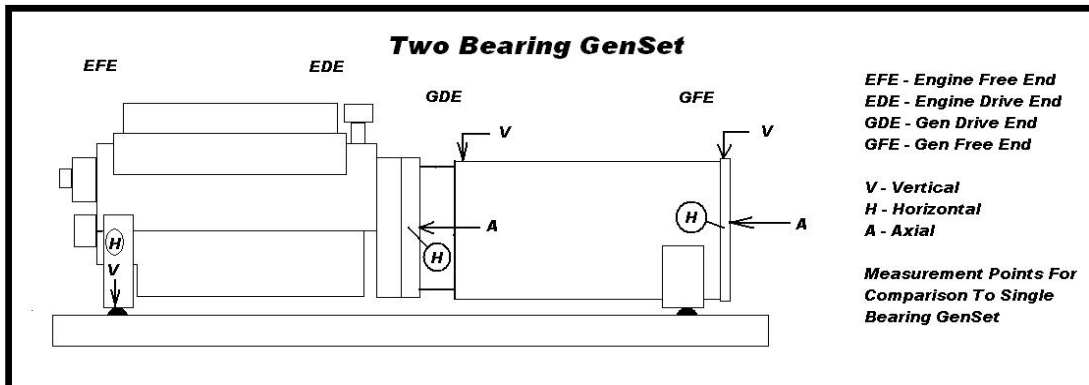
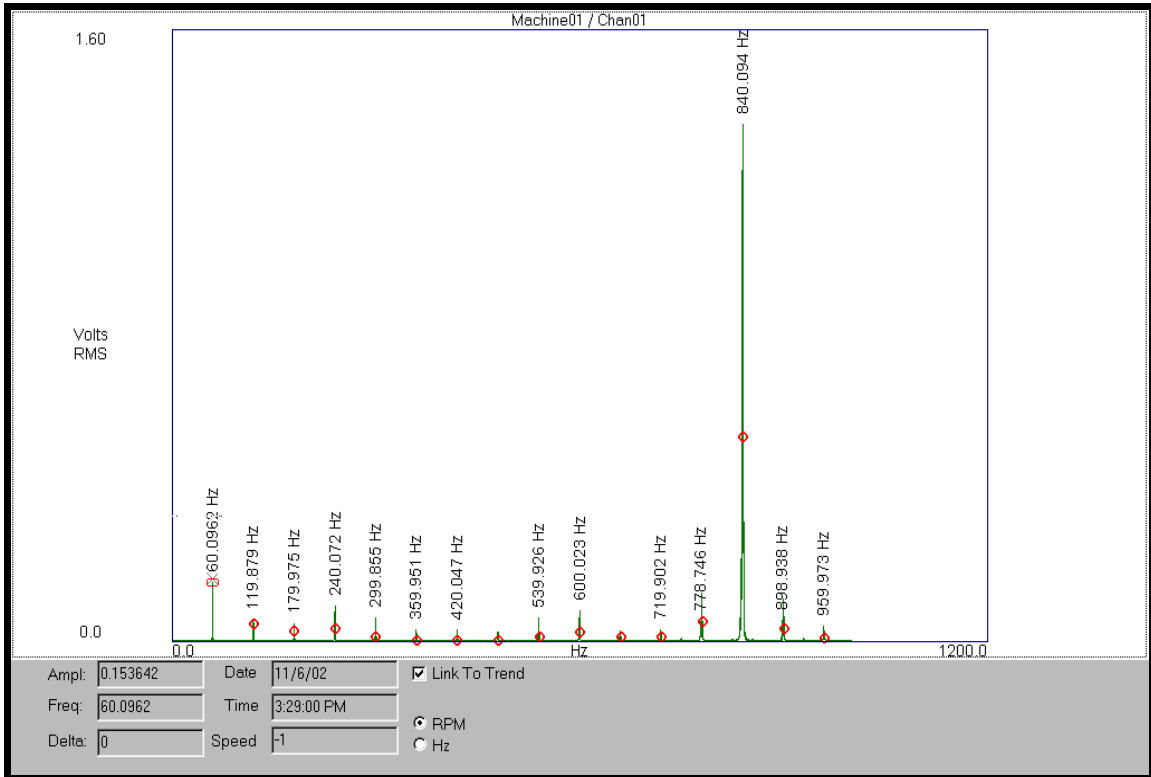
The initial readings were taken on the generator set with a full range of load conditions. The outboard end of the generator generated the highest vibration amplitudes in the vertical direction due to 1X RPM sources and was not load dependent. The horizontal direction vibration was dominated at low loads by 1X RPM vibration but was dominated by 1.5X RPM vibration at high loads.

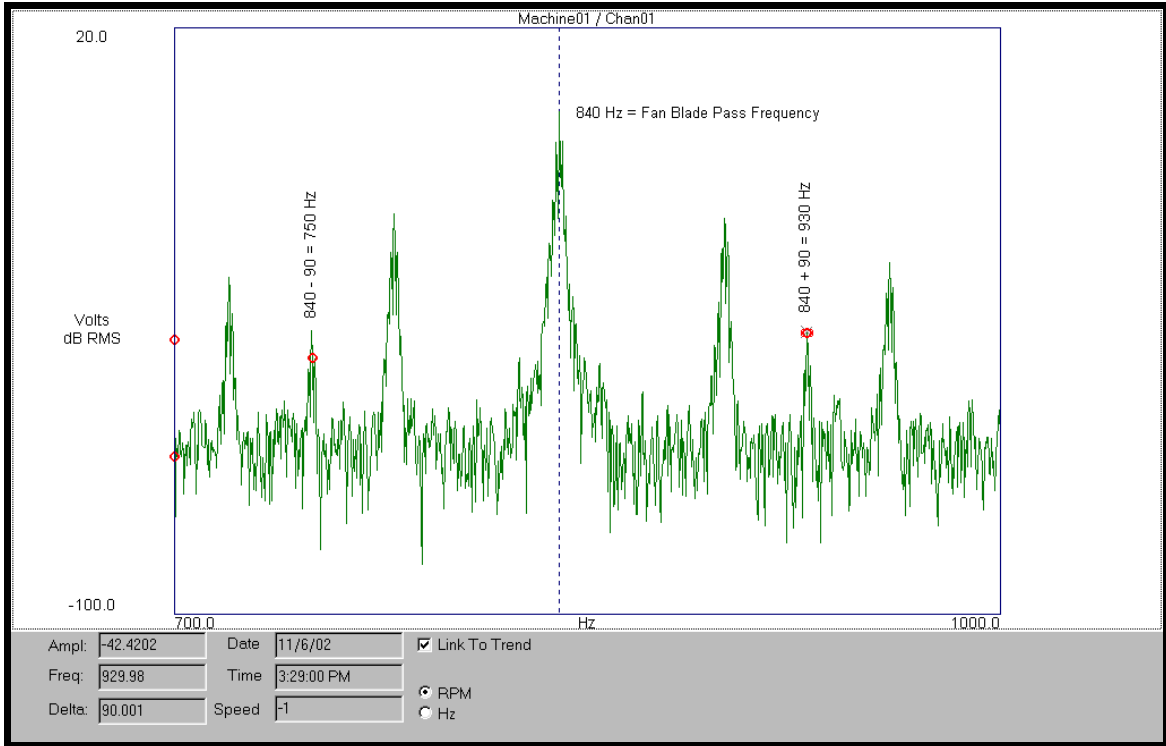
1/2X RPM harmonics are characteristic of V6 reciprocating engines. The intensity of these pulses increases significantly with load. This coincides with the findings that the 1.5X RPM amplitude increases significantly with load. The rotor/stator contact was likely a result of excessive rotor deformation when the rotor critical at 1.5X RPM was excited by high load 1/2X RPM harmonics from the engine. Also

these pulses often excite torsional natural frequencies of attached machinery.

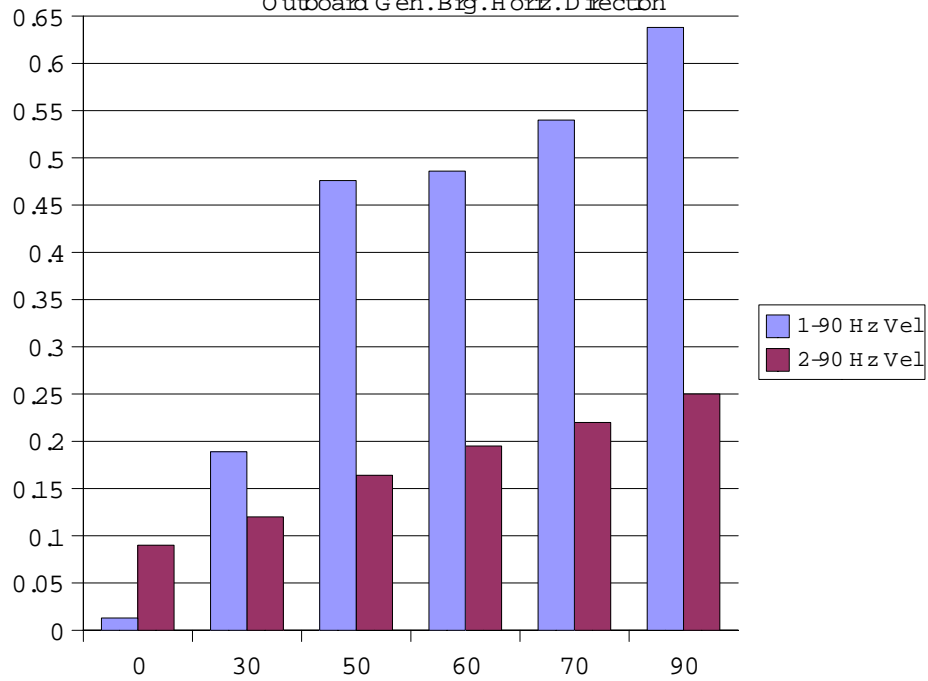
To determine if torsional natural frequencies were excited, a spectrum/sideband analysis was performed on the signal generated from the 14 generator fan blades as they passed a photocell. The high-resolution spectrum is included along with the “zoom” view of the data that clearly shows sidebands spaced at 1.5X RPM (90 Hz). The sidebands are caused by torsional vibration of the rotor.

The new rotor configuration was tested in February. Results showed that the 1X RPM vibration on the generator was significantly reduced in the vertical direction as a result of the balancing. The natural frequency of the rotor assembly was also shifted away from the 1.5X RPM frequency sufficiently to reduce the 1.5X RPM vibration amplitude significantly. The rotor/stator contact problem was eliminated.





1.5X RPM Vibration (Vel.) Amplitudes
Versus Load, Before and After
Outboard Gen. Big Horiz. Direction



1X RPM Vibration (Vel.) Amplitudes
Versus Load, Before and After
Outboard Gen. Brg. Vertical Direction

