At Vibration Specialty . . .

Vibrational Analysis Detects Elusive Problems

By W. Keeley, W. McGuckin and E. J. Schramm*

VIBRATION analysis along with precision static and dynamic balancing by trained personnel having current instrumentation and equipment can solve many major and minor vibration problems by pinpointing the source of the problem within engines and other rotating equipment. Performed routinely, significant advantages accrue with vibration analysis, such as permitting machine operators to predict when a failure will occur, thus enabling preparation for manpower, spare parts and best fit into the production schedule. Vibration analysis also tells the operator when no problem exists, thereby eliminating unnecessary downtime for unnecessary work.

A recent example of the problem-solving benefits of vibration analysis involved four 2700 kW generators powered by 16-cylinder diesel engines. The gen-sets, which are located in the Dominican Republic, are typical 60-cycle overhung type having a single outboard bearing. However, they were designed to yield maximum power output at 1200 instead of 900 rpm. All the engines' thrust bearings failed during a short trial period prior to start of warranty, despite double-checking clearances, coupling alignment, generator balance, and the like.

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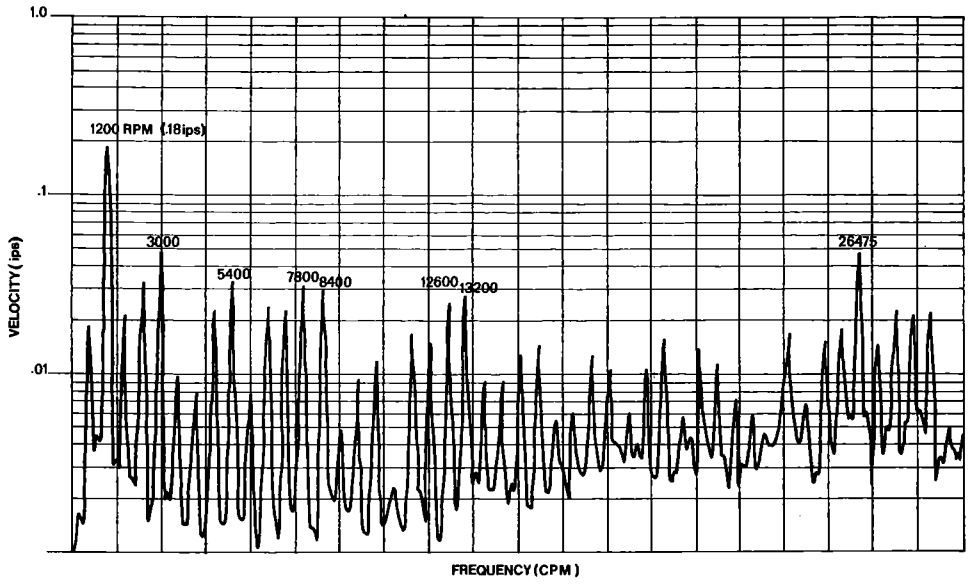
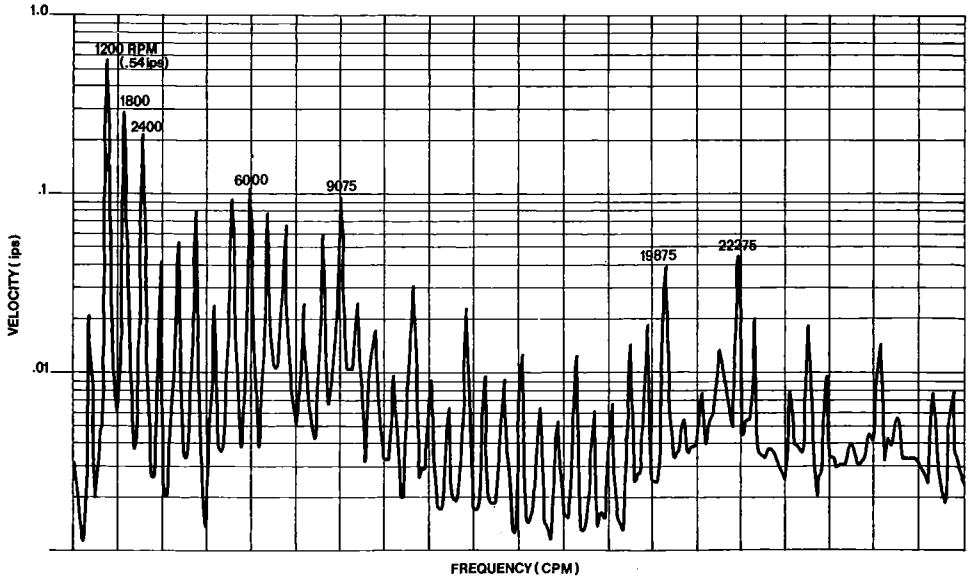


Mechanical vibration measurements taken on engine thrust bearings of diesel gen-set in Dominican Republic indicated no change in vibration levels with time, temperature or loading. "Signature" above resulted from one engine thrust bearing measurement at 1000 kW loaded test conditions.



Vibration measurements recorded on Dominican Republic gen-set generator thrust bearing increased dramatically with temperature. Above "signature" resulted from one generator thrust bearing measurement of 1000 kW loaded test conditions. Vibration problem was solved by a new generator bearing design.

Vibration Specialty Corp. was asked to perform an on-site vibration signature analysis, which involved measuring the mechanical vibration the bearings were experiencing and resolving the vibration energy into its frequency components by means of an accelerometer and real-time spectrum analyzer. The resulting "signatures" were compared and coordinated with the machines' system components and operating conditions to analyze and diagnose the source of the problem.

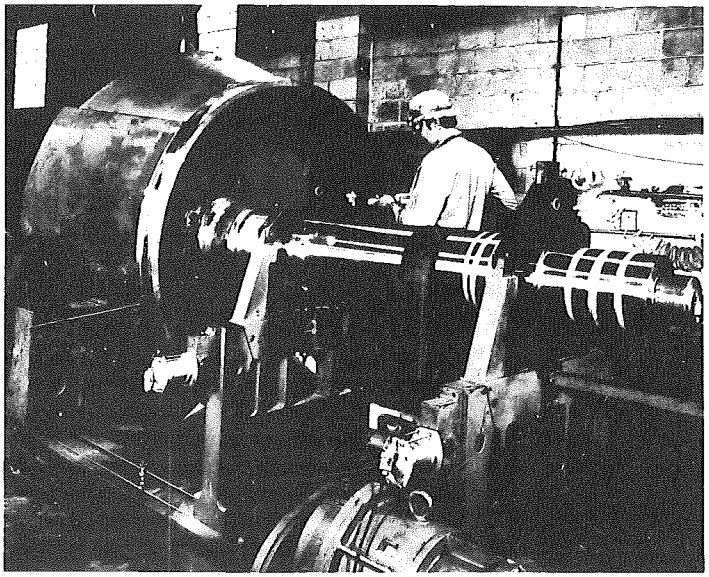
Measurements taken on the thrust bearings indicated no change in vibration levels with time, temperature or loading. Those recorded in the generator bearings, however, increased dramatically with temperature. This pattern was repeatable and directly related to the effect of thermal growth of each unit.

Thermal growth for the generators had been theoretically calculated for the increased rpm. In operation, however, thermal growth turned out to be considerably greater. After the generator bearings' clearance for axial growth was gone, the shaft continued in the opposite direction. The forces would then wear out the thrust collars and bearings in the engines. The problem was solved by a new generator bearing design.

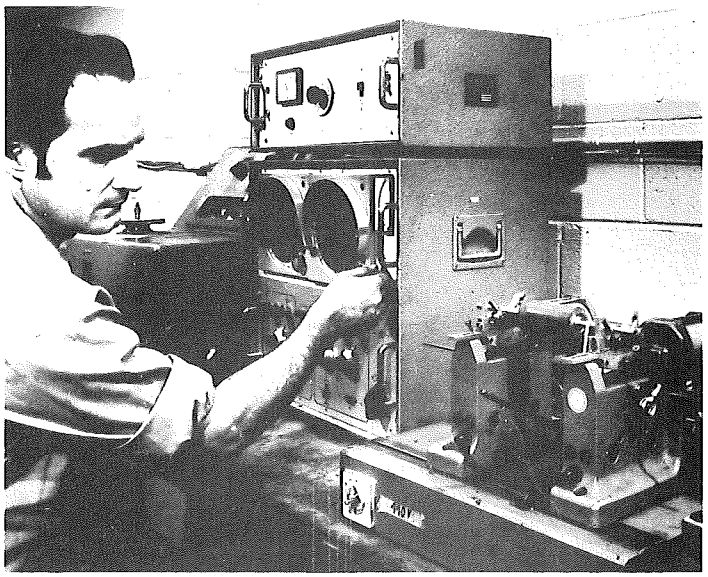
Another example involved both Vibration Specialty's Service Center and Field Analysis Group, which complement one another. Initially we were asked to balance a turbine rotor on an emergency basis; the turbine drives a gas compressor.

In our Philadelphia Service Center the rotor was checked for run-out, which was found to be less than one mil (0.0254 mm). The turbine had a precision balance tolerance of 0.5 oz. in. (36 g-cm). The initial unbalance was found to be 0.81 oz. in. (58.3 g-cm), slightly out of tolerance. The condition was corrected and the rotor shipped with a realized balance of 0.4 oz. in. (28.8 g-cm). Subsequent discussion with the customer indicated a vibration problem far more severe than would have been produced by the rotor unbalance.

On startup of the turbine/compressor unit, the severe vibration persisted, and Vibration Specialty was asked to perform an on-site analysis. With data from the turbine operating alone and in combination with the compressor, it was determined the problem was in the compressor. The compressor was disassembled and a large buildup of material was found on the blades and diaphragms; the balance problem was caused by a large mass of material breaking off the rotor. After thorough cleaning and shop balancing, the compressor was returned to service and operated smoothly.



Large pump impeller being balanced in Vibration Specialty's Service Center. Balancing is an important step in the manufacture and repair of high speed rotating equipment.



A small roller is balanced for high speed operation. Balancing services, in the Service Center or on-site, can be performed on rotating elements weighing from one-quarter oz. to 25 tons.

One final example involved a combination centrifugal and axial compressor having a 17,000 hp (12,700 kW) prime mover directly coupled to the centrifugal compressor, which in turn was coupled to a speed increaser. The speed increaser drove the axial compressor. A serious vibration was emanating from the driven units.

After extensive data taking and analysis, the problem, which was a combination of mesh, alignment and torque, was located in the speed increaser. On replacing the existing gears with new, precision balanced gears and making sure all alignments were correct, the entire train of equipment operated smoothly.

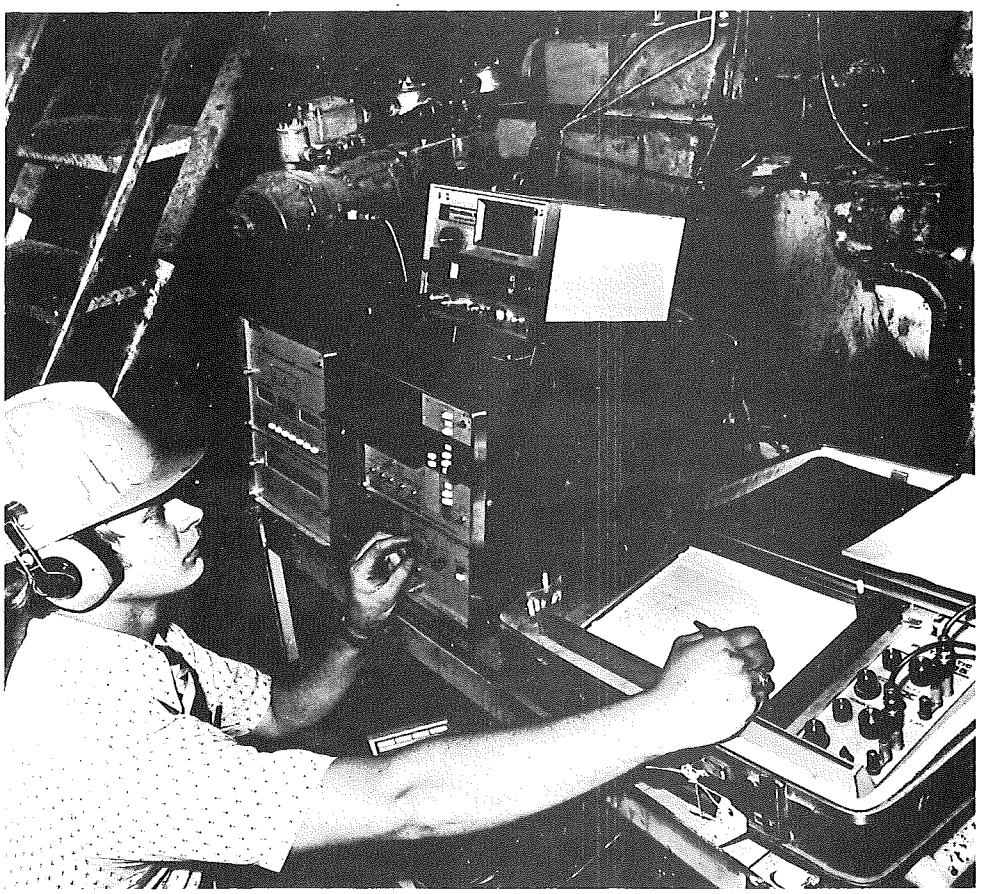
Although these examples show the value of vibration analysis in troubleshooting, they also demonstrate that considerable time and money was wasted by not calling on this technology sooner. The best and most economical time would have been during initial design and test stages before installation.

In Vibration Specialty's modern comprehensive Service Center, we can balance rotating elements weighing from 1/4 oz. (7 g) to 25 tons (22,700 kg). We have equipment such as Schenck cradle balancing machines, dies for fabricating lead correction weights, lathe and drill presses, grinders, taps, drills and special fixturing.

In the field, our vibration experts can come equipped with necessary instrumentation, tooling and weights for multi-plane and single-plane balancing, plus acoustic analysis. We can use computer programs to achieve on-site precision balancing on multi-plane problems. We perform on-site machinery diagnostics to pinpoint maintenance problems. Equipment includes portable Nicolet-Scientific real-time spectrum analyzers and recording equipment, portable balance/vibration analyzers, noise analyzer, X-Y plotters, and dial indicating equipment.

Vibration Specialty's staff is familiar with all facets of vibration, sound and maintenance problems in many industries, including paper, steel, petroleum, textiles, mining, utilities and cosmetics. Our experience in developing dynamic balancing machines, vibration meters, plus our service center and on-site service organization can be very useful in providing consultation on particular problems. We can provide consulting service to both OEM manufacturers and users of rotating equipment.

Today's machinery generally is and will continue to be subjected to greater demands than ever before. It will be made to operate faster and frequently under full load for longer periods. And with operations and maintenance costs escalating, downtime or nonproductive periods are expensive. Vibration analysis and precision balancing will continue to grow as a proven means of reducing unnecessary stress that could lead to machinery breakdown.



Vibration signature analysis can diagnose a machine's health by using an accelerometer and real-time spectrum analyzers that resolve vibration signal into its frequency components; resulting "signatures" are compared and coordinated with machine's system components and operating conditions to analyze and diagnose source of problem.

REPRINTED FROM DECEMBER 1978 NORTH AMERICAN EDITION DIESEL & GAS TURBINE PROGRESS Printed in U.S.A.