

Turbine Generator Balance Testing

using the ZonicBook

Power Industry

Application Note #99

Application Summary

Leading universities, hospitals, and certain chemical manufacturers are increasingly installing their own boiler houses and power plants to generate steam for internal processes, to heat their facilities, and for turbines to generate electricity. The turbines typically develop from 5 to 50 MW and are used for back up as well as primary power sources. Such action breeds several benefits, not the least of which comes from selling electricity to the utility company's power grid. Other benefits include cleaner environments, more efficient use of energy, and local control, which in turn means less downtime from nationwide power-grid failures.

But there are some drawbacks as well, although on average, not particularly serious. For instance, continuously running machines suffer wear and require periodic maintenance by mechanical specialists. Also, turbines frequently suffer from imbalance and misalignment vibration through normal bearing wear. Unfortunately, serious, premature problems frequently

crop up when service personnel cannot get turbines aligned properly. Poor alignment accelerates bearing wear and can cause components to rub.

Potential Solution

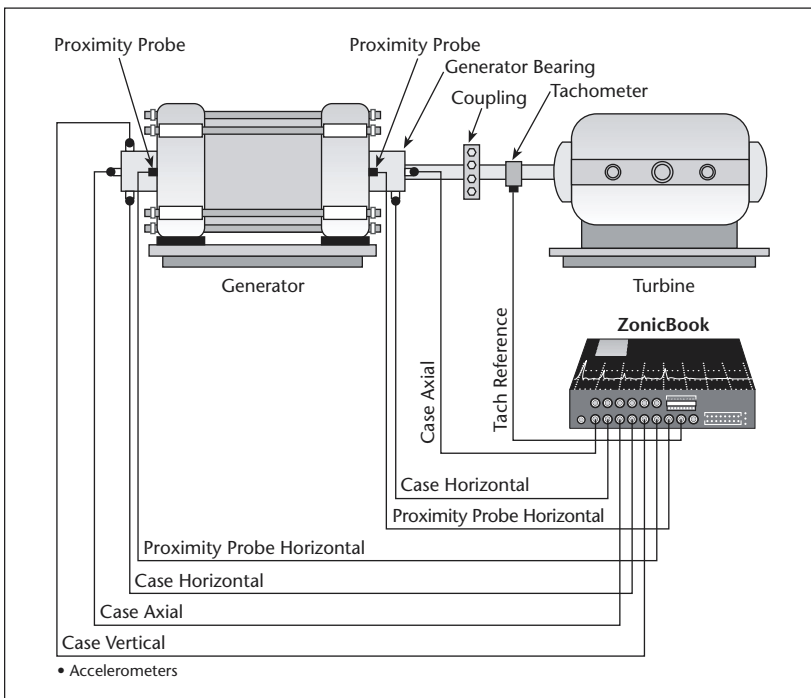
Diagnosis combines skills in acquiring critical data and analyzing them. But analysis is only 10% of the job. Acquiring the right data consumes the remaining 90%. The instrumentation required for robust data acquisition and storage must meet certain basic guidelines, including high acquisition speed and accuracy, portability, and durability. Its memory must be large enough to store hours of continuous data gathered from sensors of different types, and it should support numerous channels. Many data acquisition manufacturers supply computer plug-in boards and dedicated equipment with appropriate software to measure, store, display, and analyze vibrations. But not every one has the ability to meet all these requirements simultaneously.

IOtech's Solution

A vibration consultant with many years of measurement and analysis experience servicing rotating machines uses an IOtech **ZonicBook™**. He likes the ability to have his entire measurement system in one small enclosure and be able to connect up to 8 channels simultaneously. In contrast, auxiliary equipment that he previously employed included digital tape recorders, integrating power supplies, racks, and a stash of auxiliary hardware – all too cumbersome and heavy to conveniently carry around among the different installations.

Moreover, the **ZonicBook** provides the accuracy, resolution, and frequency range needed for analysis. The IOtech system lets analysts identify critical frequencies and measure shaft eccentricity in terms of velocity to as little as one inch per second. Allowable displacements are less than 30% of the bearing clearance, which amounts to about 0.003 inches for a 0.010-inch bearing specification. Displacements exceeding 50% of the bearing clearance, however, can lead to turbine bearing failures.

Vibration analysts typically connect the **ZonicBook** to seismic sensors and proximity probes that are permanently mounted to clients' machines. Because they are of various brands and operating specifications, the **ZonicBook** input can be adapted and calibrated to each sensor in the field under software control. Some older turbines do not have permanently installed proximity probes or seismic sensors, but have what's called "shaft riders,"



Vibration analysts often use an IOtech **ZonicBook**, a portable data acquisition system, connected to a combination of displacement sensors and accelerometers to diagnose vibration problems in large compressors, fans, turbines, and similar machinery. Sensors located in both horizontal and vertical planes around the bearings and case measure the maximum displacement of the rotor as well as vibrations that provide data for frequency and spectrum analyses, Fourier transforms, and determining balancing weights.

spring-loaded devices that ride on the shaft. Under these conditions, the analyst installs his own accelerometers on the shaft riders and runs those signals into his **ZonicBook**.

The **eZ-Analyst™** software that works with the **ZonicBook** has the capability of digital recording and playback, which lets the analyst manipulate the data resolution, frequency ranges, and other parameters to suit his specific needs after acquiring the data. Moreover, the equipment can be set up in the field to record data for two days at a time using **eZ-TOMAS™** before the analyst attempts to balance a rotor. In 48 hours of collecting data, he may find that one particular file is the best. For example, file number 293 may represent the data that he wants to use for the balance calculations.

In another example, an analyst recorded two vibration readings, one vibration measured on the bearing housing and the other, a seismic vibration, measured on the casing. The two vibrations were summed together, and the result is the absolute vibration, with a displacement close to 10 mils (pk-pk). Consider that the rotating element weighs 2500 pounds and runs at 1800 rpm. The force equals the mass of the rotating element multiplied by the eccentricity, or half the unbalance, and the square of the angular velocity. These parameters determine the force. Using the radius and the 5 mils (pk), (half the absolute vibration mentioned above), the force is calculated to be 10,000 lb. From this, the weight that had to be added was calculated, and it worked on the first try.

Many vibration specialists teach vibration courses and use IOtech equipment for training and demonstrations. One in particular found the equipment so user friendly that he didn't need to pore over the instruction book. In addition, he uses the **eZ-Analyst** software for recording features and transfer functions. The **eZ-Analyst** software is also easy to learn and understand, although he does refer to the handbook occasionally for certain items. He also uses **eZ-TOMAS** software when working on large fans and monitoring coast-downs. He finds all the software very well thought out.

Conclusion

Numerous vibration specialists successfully use IOtech **ZonicBooks** to measure, record, and analyze vibrations in turbines, large fans, and other massive rotating equipment. The **ZonicBook's** accuracy, resolution, frequency range, and flexibility make it easier, faster, and less costly for analysts to set up to make

measurements. Also, its small size and ability to work with a laptop computer lets analysts transport it easily among all the sites they service. Moreover, the **eZ-Analyst** and **eZ-TOMAS** software packages let analysts pinpoint the problem and rapidly calculate accurate balancing weights.

ZonicBook/618E

Vibration analysis and monitoring has never been easier than with the new ZonicBook/618E™ and eZ-Series™ analysis and monitoring software. The ZonicBook leverages 25+ years of experience providing vibration measurement solutions. This new Ethernet-based solution adds another dimension — the *lowest cost* full-featured 8 to 56 channel analyzer available. The ZonicBook hardware is the signal conditioning and acquisition engine, while the eZ-Series software in the PC defines the specific analysis and monitoring features of the system.

Features

- 8 dynamic input channels, expandable up to 56 channels
- 4 tachometer channels for rotational measurements
- High-speed Ethernet connection to the PC for continuous recording
- Four eZ-Series software packages address a wide variety of vibration monitoring and analysis applications
- TEDS support



Software Overview

Four software packages are available for the ZonicBook, each tailored to a particular vibration measurement and analysis application. Choose the package that suits your application now, and upgrade to additional packages as your requirements evolve.

- **eZ-Analyst™** provides real-time multi-channel vibration analysis, including overlay of previously acquired data while acquiring new data, strip charts of the throughput data files, cross channel analysis, and direct export to the most popular MODAL analysis packages, ME Scope and Star Modal.
- **eZ-TOMAS™** provides on-line vibration recordings, limit checking, storage, and analysis of rotating machinery. Order track, Waterfall, Orbit, Polar, Bode, Spectrum, and Trend displays show machine startup or shutdown events, as well as diagnose long term changes in machine health.
- **eZ-Balance™** is used to balance rotating machinery with up to seven planes. A balance toolkit, including Split Weight calculations, supports the balance process. The balance vectors are displayed on a polar plot so the user has a visual indication of the improvement. Time and spectrum plots show detailed vibration measurement during the balance process.
- **eZ-NDT™** package is exclusively used in production applications to determine the quality of composite-metal products at production rates of 1 part per second.

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