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Test Devices Inc.

Spin Rig Testing net results

By: Kami Buchholz / Aerospace Engineering & Manufacturing Magazine

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The 18-lb steel blade of an F-class industrial gas turbine survived a series of resonant spin tests, and that bodes well for the component's manufacturer, a global energy services company looking to improve engine durability by redesigning the blade.

"To our knowledge, this is the largest blade of this type that has ever been successfully tested under specific conditions in a spin rig. The dynamic spin process is a component-level spin test that imparts dynamic (vibrational) and static (centrifugal) stresses in gas turbine engine blades in order to validate the predicted life of a blade," said Robert Murner, President of Test Devices Inc. (TDI), a Hudson, MA-based dynamic materials testing company.

Figure 1
Test Devices Inc.'s strain gauge and non-intrusive stress measurement instrumentation stations are part of the aero-pulse high cycle fatigue spin test system at its facility in Hudson, MA.

The dynamic spin process was developed in the late 1990s under a U.S. Navy research contract. To make the process more relevant for specific testing applications, the technique was updated and in 2004 TDI received a patent addressing both the testing apparatus and method for dynamic resonance testing in a spin rig. TDI's patent encompasses a number of items, including a specific nozzle design for the delivery of jet oil as a means of instigating resonant vibratory amplitudes.

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“We also have produced computer algorithms that assist in holding resonance on a specific mode for extended periods of time, usually five or more hours. It is essential that the test method be capable of holding resonance for long periods in order to quickly accumulate 10 million cycles. For this reason, it was necessary to enhance our speed control as well. We also developed an aero-pulse method for dynamic blade/damper response testing at high temperature. This method does not use oil to force stress amplitudes,” said Murner.

Dynamic blade response testing can be done using an actual engine, but oftentimes the blade is not overly stressed to avoid damaging or destroying the entire test engine. “Simply stated, the patented TDI Dynamic Spin method is the only technique, other than a full-engine test, that can adequately test the interaction between static and dynamic stresses in a blade. Other methods do not test blades in steady-state resonance, but TDI’s patented oil jet method makes this possible,” said Murner, adding that early prototype testing enables designs to be optimized before a test engine is built.

The aerospace and energy industries are the primary candidates for high-speed rotational blade testing. “But any blade application that requires empirical data to support analytically predicted life would benefit from this technique. This includes new blade designs, redesigns, or analysis related to foreign object damage,” Murner said, adding, “We normally test the actual bladed engine rotors. But we have also designed custom rotors that hold fewer blades if the test requires, or the bladed component itself is too big for our spin rig. The dynamic spin process also is well-suited for testing blade damping mechanisms.”

TDI’s patented oil jet excitation system can prompt resonant vibratory amplitudes to pinpoint blade flaws. “The dynamic spin test method is well-suited for blade crack growth studies. We have already performed such tests in the aerospace and energy markets with great results. Understanding how a crack progresses—specifically the time it takes to reach a critical length—in a specific type of blade will influence the inspection intervals, which in turn drives the cost to maintain a particular turbine engine,” said Murner.

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