Spin Rig Facility

The spin rig facility at the NRC Institute for Aerospace Research (NRC Aerospace) is used to test gas turbines components, as well as other rotating components and assemblies. It tests performance, strength, durability and damage tolerance under cyclic, steady-state or combined centrifugal loads, at ambient as well as elevated temperatures.

The versatile system can simulate the effect of fatigue and creep loads in a programmable sequence across a wide range of test types. Light-weight to very heavy components and component assemblies can be tested at high rotational speeds and high temperatures, while loading and unloading rates are controlled with high accuracy using air drive and breaking turbines. The spin rig is also equipped with a programmable logic control (PLC) system that ensures safe and fool-proof operation.

Testing capability

The NRC Aerospace spin rig can be used for:

- performance tests under cyclic and/or steady-state loads to demonstrate a design or qualify a rotating part or rotating assembly
- cyclic or steady-state tests to experimentally determine the fracture-critical locations in rotating components
- cyclic or steady-state durability tests to experimentally determine fatigue or creep crack initiation life
- damage tolerance tests to demonstrate crack propagation resistance of rotating parts and to verify safe inspection intervals
- increasing centrifugal load tests to determine the burst strength and over-speed margin of rotating components.

Lowering a turbine disk into the spin rig

Specifications

- Chamber: 1.2 m (48”) diameter x 1.2 m (48”) deep
- Air turbine 15 cm (6”) in diameter:
  - can spin a component up to 114 kg (350 lbs) and 1.9 m (47 3/4”) in diameter (cold testing, smaller for hot testing) at speeds up to 40,000 RPM
- Air turbine 5 cm (2”) in diameter:
  - can spin a component up to 11.5 kg (25 lbs) at speeds up to 100,000 RPM
- Air turbine 10 cm (4”) in diameter that can spin up to 60,000 rpm available on request
- Dedicated 350 HP air compressor used to power the air turbines
- Component test can be maintained at a temperature of up to 800°C
- Testing is performed in a vacuum – approximately 50-100 millitorr

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- Fully PLC-controlled with safety interlocks and vibration monitoring
- Up to 11 variable-length dwell steps can be pre-programmed to produce various mission profiles.

Safety and performance features

Safety interlocks
The safety interlock system will shut down a test when any of the 12 monitored temperatures – such as coolant water, lubrication oil, or air temperature – exceed their preset limits. Excessive vibration will also cause system shutdown. In addition, If the oil or water supply to the turbine is below set-up pressure, the testing will stop. Rig operation is also halted if the vacuum in the chamber goes above a preset level. The chamber is flooded with inert gas to prevent fire or explosion in the case of vacuum failure or a catastrophic failure during a heated test. In the event of a component burst, the lid dogs retain the cover, while the chamber lining composed of two feet of lead bricks absorbs the fragments.

Available operational modes
In **the performance mode**, the speed is controlled manually by an air valve. This mode is used to check the balance of a test piece and the integrity of the system. **The cycle mode** is used to rotate a test article between a set minimum and a set maximum speed. A desired number of cycles is uploaded into the PLC system and upon reaching the preset number of cycles the system shuts down automatically. In **the dwell mode**, as many as 11 steps can be programmed into the PLC system at any desired rotational speed. In addition, the time spent at each step can also be set according to a desired mission profile.

Test monitoring
An early warning of imminent failure may be detected by monitoring the vibration level and phase angle. The vibration monitoring system can be set to shut down testing at any desired maximum acceptable level of vibration. The tachometer signal, vibration level, temperatures, etc. are monitored and recorded during testing for further analysis.

Supporting technologies
Non-destructive inspection techniques, including liquid penetrant, eddy current, ultrasonic, X-ray, microfocus X-ray and magnetic particle are available on-site. Life prediction services, including finite-element-based stress, as well as fracture mechanics analysis tools and expertise, are available. Also available onsite are other complementary testing services ranging from coupon level to components and full-scale engine testing.

CONTACT:
Dr. Wieslaw Beres
Structures & Materials Performance Laboratory
NRC Institute for Aerospace Research
Ottawa, Ontario, Canada K1A 0R6
Tel: (613) 993-0033 Fax: (613) 990-7444
E-mail: wieslaw.beres@nrc.gc.ca

Mr. Jeff Mackwood
Marketing and Contracts Office
NRC Institute for Aerospace Research
Ottawa, Ontario, Canada K1A 0R6
Tel: (613) 990-0765 Fax: (613) 952-7214
E mail: jeff.mackwood@nrc.gc.ca

Or visit our Web site at: www.nrcaerospace.com

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