

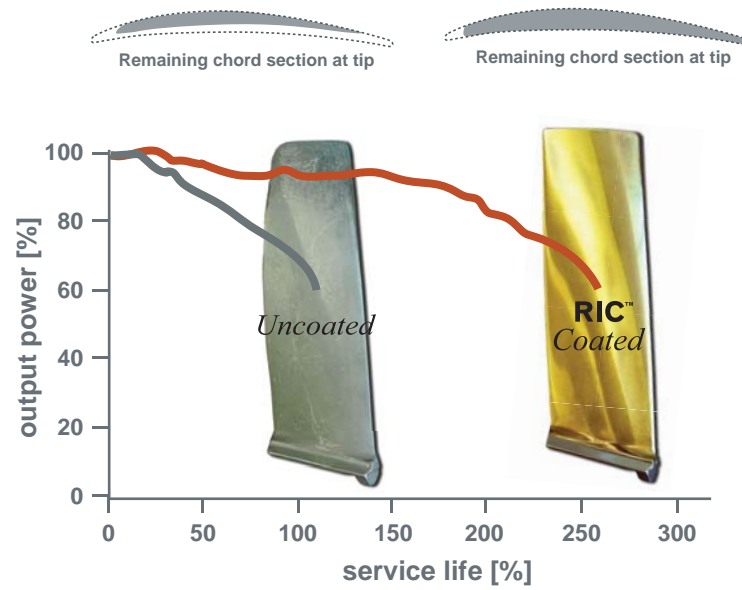
RIC™
Reactive Ion Coating

Industrial

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**Test Engine Comparison:
GE T-64 Turboshaft Compressor**



Liburdi Turbine Services Qualifications

- Over 20 years of service
- Fully Qualified for RR/Allison T-56/501D
- Cleared for Flight Test for GE T-58
- Successfully Flight Tested for GE T-64 Turboprop and Turboshaft
- Successfully Flight Tested for P&W JT8D
- Save up to 3 times the cost on replacement blades

RIC™ Results

- Minimized chord loss
- Lowered SFC (Specific Fuel Consumption)
- Preserved "New Compressor" power levels and stall margins
- Reduced erosion change in resonant induced frequencies and fatigue strength



Electron Beam Physical Vapor Deposition



Extending Component Life

INTERNATIONAL | tel: 1-905-689-0734 | sales@liburditurbine.com
www.liburdi.com



Extending Component Life

Titanium Nitride Erosion Resistant Coatings

Our renown RIC™ coating applied to aircraft gas turbines is now used for industrial frame compressor blades and compressor guide vanes.

The application of a titanium nitride coating is a proven process which protects the blades from erosion attack from dust/debris and water droplets in the inlet air.



Flight Approved by Aircraft Engine OEMs

Since the late 1990s Liburdi's RIC™ protective coatings have been approved for use on aircraft turboprop engines which operating in some of the harshest environments - military aircraft such as the C130 Hercules and transport helicopters in active desert operations.

Subjected to rigorous qualification testing by the aircraft engine OEMs leading to flight approval by Rolls-Royce in 1994.

Since that time over 100,000 Stage 1 and Stage 2 compressor blades have been coated by Liburdi for use by the USAF and NATO air forces around the world.

The strict aero qualification testing involved Custom 450, IN718, and Ti-6AL-4V alloys, erosion testing, and fatigue testing. Testing was performed by the US Navy labs, the National Research Council of Canada, as well as Liburdi's own labs

RIC™ Coating Process, Evolution and Development

Titanium Nitride is an extremely hard surface coating (Vickers 2200 or Rockwell 85C equivalent) and was used to coat cutting tools and carbides for improved wear resistance and endurance. The RIC™ system employs electron beam evaporation and a plasma charge which allows processing below thermodynamic equilibrium temperatures and therefore compatible with most compressor blade and vane alloys and also compatible with shot peened components.

The RIC™ Electron Beam evaporation process was chosen for airfoil application since it produces coatings which are dense and free of the macro-particle defects commonly found in the tool coater Arc and Sputter processes. The RIC™ process deposits a hard ceramic / metallic alloy in a thin layer (less than one thousands of an inch) which does not affect aerodynamic performance or fatigue properties, but does protect the airfoils against sand and water erosion damage.

The RIC™ coating was developed over the past 10 years, through three evolutions, to the point where is able to achieve three times the compressor blades service life extension for aircraft compressor blades. RIC™ allows engines to maintain power for extended time periods critical to military operations as well as a significant cost savings to the operators.



Benefits of RIC™ Coatings for Industrial GT Blades

Liburdi super-polish process to pre-clean and polish airfoils before coating.

Super-polish improves surface finish for Frame 7FA Blades

- Standard new part surface 120 – 150 micro-inches finish
- Liburdi super-polish RIC™ coated is 40-60 micro-inches finish

Smooth surface finish produces positive benefits

- Fatigue resistance, fouling resistance, erosion resistance
- Engine performance – efficiency and power gain

Chemical stripping of service-run blades is possible in specially controlled mineral spirit solutions. An effective stripping process makes re-coating of service run parts a viable option extended service life of the blades.

Maintenance Program – for Coated Row 0 Blades

- Full service interval, 24,000 hours
- Inspections at regular intervals during planned maintenance and combustor inspections to verify coating protection
- At end of full service interval – clean, inspect, chemically strip RIC™ coating, polish, re-coat with RIC™ coating
- Install blades for next service interval



RIC™ Coatings for GE Frame 7FA Row 0 Compressor Blades

Liburdi began coating Frame 7FA compressor blades in 2007. These first blades were put into service in early 2007 as a means of providing protection against water and dust erosion attack of the airfoil, which has become a concern, possibly contributing to fatigue damage initiation for these parts.

Liburdi's RIC™ coating systems are much larger than a conventional tool coater and able to process large batches of aircraft blades or several "F" class row 0 blades in a single batch.

