Erosion / Corrosion Resistant Coating Evaluation for MH-47’s T55 Compressor Airfoils

29 July 2014
U.S. Army Coating Evaluation Program Summary

- 7 coating vendors + uncoated blades evaluated in 2007-08 U.S. Army CIP program
- Engine sand ingestion test in “rainbow” configuration completed in Dec 2008
  - MCT’s Erosion Resistant coating demonstrated “significant improvement in erosion resistance over uncoated blades” and rated best against erosion
- Program cancelled in August 2008 due to corrosion concerns
- MCT continued efforts to develop robust erosion / corrosion resistant coating
  - Results presented to Boeing / Honeywell and U.S. Army in August 2010
- Honeywell issued test report that concluded enhanced corrosion resistant coating acceptable for both erosion and corrosion
T55 Engine Sand Ingestion Test

C-Spec Media
MCT Erosion Resistant Coating vs. Uncoated Blades

- Total sand ingested = 25.4 lbm of C-spec sand
- Total test time ~ 6 hour test
- Ingestion rate = 4.3 lbm / hour
Boeing / SOAR Program Plan

- U.S. Army’s Special Operations Aviation Regiment (SOAR), identified operational need to increase engine time-on-wing due to compressor airfoil erosion
- Boeing contributed funds via Industrial Regional Benefits programs to continue evaluating MCT’s BlackGold® erosion / corrosion resistant coating.

- Original work scope
  - Conduct corrosion tests on uncoated and MCT coated blades
  - Conduct component level erosion tests
  - Conduct fatigue tests
  - Conduct sand ingestion test on uncoated and coated engine at HWL
  - Install coating on SOAR lead-the-fleet Chinooks
Corrosion Test

- AED approved corrosion test plan conducted July 2013 by University of Alabama at Huntsville
  - Conduct corrosion test on six (6) uncoated and six (6) coated 1\textsuperscript{st} stage compressor blades
  - Conduct test per ASTM B117 test standard over 17 days
- BlackGold\textsuperscript{®} coated blades met test objective and provided greater corrosion protection than uncoated blades
Erosion Test

- AED requirement that coating exposed to abrasive media could not result in Leading Edge Preferential Erosion (LEPER)
  - Typical of traditional hard coatings
  - Serrated LE or birdmouth features

LE Preferential Erosion ❌

Graceful erosion ✔

serration

smooth
Erosion Test

- MCT conducted lab tests on parameters that impact LE erosion:
  - Impingement Angle
  - Particle Size
  - Particle Velocity
  - LE Radius
  - Temperature
  - Media Concentration
- Tests completed with MCT’s Internal Erosion Rig Tests
- Confirmed **BlackGold®** coating’s design capability to resist LEPER
Fatigue Test

- Honeywell conducted fatigue tests in 1Q CY14
  - 1st torsion test on uncoated and coated blades
  - Approved for limited field trial via Airworthiness Impact Statement
  - Final report to be issued

- Innovative Test Solutions conducting HCF tests in Aug 2014
  - 1st bend test on 12 uncoated and 12 coated 1st stage blades
Field Trial

- Leverage a scheduled Degraded Visual Environment (DVE) field trial for MH-47 Special Ops in April 2014
  - Uncoated and coated engine
  - Coated engine has two (2) uncoated blades per stage
- DVE field trial in Yuma, AZ
  - 35 hours completed in DVE
  - MH-47 test aircraft continuing to fly in desert environments
- Engine inspection scheduled at Ft. Campbell, KY for Nov ’14
  - Estimate 200+ operational hours with coated engine

Pending teardown inspection, engine performance and ROI analysis conduct further FSE, implement coating or conclude program