Engine Erosion/Corrosion Resistant Coatings Technology Update

Marcio Duffles, MDS

Q1. (Rob Jackson): Marcio, what sand concentrations have you tested at?
A1: From a weight / volume perspective, we don't have that data. From a particle size distribution, the coating has been tested at very fine particle distribution such as Arizona Road Dust (ARD) A4 with a nominal distribution of 50 µm to C-Spec with a nominal distribution of 320 µm + an added concentration of 1000 to 1500 µm and various distributions in-between.

Q2. (Rich, Tony): It appears there are quite a few different versions of the coating that have evolved over the years.... and it appears they are tied to specific applications and/or needs based on tests within a specific design/application. Is it fairly typical to evolve a coating for a specific compressor over a course of an initiative..?
A2: The evolution of the different coating versions address various requirements that have arisen over the years. Each version addresses requirements based on theatre-of-operation, predominant failure mechanism and material type.
The particular coating version is then optimized for different engine configurations and operations. Once the coating is optimized for that particular configuration, the coating process is frozen via an OEM approved process and the coating will not evolve over the course of an initiative. If a modification is required to the coating during the course of an initiative, the process may be required to be recertified and frozen (depending on the modification) by the OEM.

Q3. (Ken Scandell): What substrate materials have been experimented? Ti only... Is this process/chemistry conducive to other substrates?: INCO 625 / CuNi 70/30?
A3: In addition to Ti alloys, the process is conducive to any stainless steel and nickel based alloys

Q4. (Robert Tollett): Have you compared your coatings to other comparable coatings? Have you tested the "Black Gold" against Liburdi's GENIII EB-PVD OR MTU's ER coatings or Lufthansa's coatings on CFM? Any results?.
A4: The coating has been competitively evaluated by OEMs, military and commercial operators for every program that the BlackGold coating has been considered. The competitors and competitive results are not privy to MCT. At the conclusion of T&E efforts, MCT is informed whether the coating has been selected for further qualification and / or implementation. MCT's BlackGold coating has been competitively down-selected for all the military programs that are in various stages of final qualification and implementation.

Q5. (Horsey Michael LtCol USAF: Does MCT have any documentation showing the effectiveness of the coating at the different stages of the compressor? It's obviously very effective in the first few stages, but is it really needed in the later stages?
A5: Yes. All engine sand ingestion tests have documented the effectiveness of the coating on all stages. The coating has demonstrated significant protection against erosion and corrosion for mid and later-stages.

Q6: (Horsey Michael LtCol USAF: Does MCT have any specific documentation on SFC improvement in the T56 engine? I need the specific documentation for AMC's BCA analysis.
A6: Yes, Standard Aero conducted a performance analysis based on comparing the performance between the uncoated and coated sand ingestion test engines. The SFC improvement quoted was at the 95% shp engine off-wing condition.

Q7: (Horsey Michael LtCol USAF: Marcio mentioned an active program with the Air Force in the T56 for C-130. What program is this? I'm unaware of an "active" program other than the initial sand ingestion tests.
A7: The active program is the current effort to complete the Fixed Process Approval (FPA) with USAF and RR.

T55 Turboshaft Engine Update
Tony Rich (TAPO)

Q1. Rob Jackson: Tony, in the UK we've had issues with pop surging which we believe relates to erosion on the 6th/7th stages. Have you come across this and do you know if the coating reduces this issue?
A1. Typically, we do get alt of erosion in stages 6 & 7. I have not been informed about the coating effect on those specific stages.

NAVAIR Overview
Chris Rowe

Q1. Greg Kilchenstein: Chris, Was the Army standard qualification framework published in a joint venue? Can it be posted in the public sector?
A1. The framework was coordinated with the Navy, approved by the Army and released.

Q2. Robert Tollett: Are there any other coatings being evaluated on these programs?
A2. We have historically evaluated other coatings, but in most cases the “Black Gold” tends to win.

AGT1500 Gas Turbine Engine Update

Kevin Kauth, TARDEC

Q1. Bill Queener USAF AFSC/LGMI: Was there any observed effect of the coatings on glass deposits?

A1. Raw uncoated engine at first showed no degradation. When the sand injection rate was increased we did see a reduction in horsepower and a decrease in air flow. We did see glassing at high sand injestion rates. I ca't say it was due to the coating or not. The M-1 accepts a 40% drop in power before turning into depot for maintenance. 70-80% is caused by recuperator loss. The remaining is the compressor.

Q2. Greg Kilchenstein: can you discuss the condition of the coated and uncoated HP01 blades post sand ingestion test

A2. There is a significant improvement in maintaining existing material on the coated blades.

Q4. GREISSINGER, JAMES A Mr. USN USN: For MCT: Implementation and sustainment of airfoil coatings can be costly. What is being done to make coatings more cost effective?

A4. The price is driven by volume.

T56 Turboprop Engine (Series III) Update
Scott Tope, USAF

Q1. Douglas E. Wolfe - guest: Will all of the slides be available to the participants?
A1. Matthew Heddle(privately): All presentation files and written answers to the Q&A will be distributed next week

Q2. When can you expect to get stability data from the A1107 FSE?
A2. Around the end of FY15 (initial data in March 2015).

Q3.Was the HCF reduction within design limits?
A3. That was before my time. They are close to the edge of the margin.

Q4. Henry Wiersma - What is the blade material - is the 5th stage a different material?
A4. 1st-2nd stages: AMS 5643; 3rd - 14th stages: 17-4PH

Q5. Bruce Bodger - CeralUSA, LLC: Is it the Air Force's intention to bring this coating capability into the depot…for application during maintenance intervals?
A5. At this time, no.

Q6. Rob Jackson - Has anyone come across discrete FOD - can we blend?
A6. I would defer to MCT for info on the coating and blending, but FOD is not a major consideration for the T56.