Tester

News and information for Naval Air Station Patuxent River personnel | News archives

Tester >> National News | Local News | Commentary | Features |

November 30, 2000

NAVAIR foreign technology testing wins OSD award

Russian coating expected to save $1.6 million annually for CH-53 engine

by J.C. Milliman
NAWCAD PUBLIC AFFAIRS

With a story line straight out of a Robert Ludlum or Tom Clancy techno thriller, a Soviet-era technology under evaluation by engineers here is promising impressive life span and power improvements for aging aircraft engines.

The program, evaluating a Russian titanium nitride coating for jet engine compressor blades, is proving so successful, its integrated product team members were awarded the Office of the Secretary of Defense Foreign Comparative Test Manager of the Year award in a ceremony Nov. 9 at Ft. Myer, Va.

Accepting the award on behalf of the team, comprised of Naval Air Systems Command engineers as well as American, Canadian and Russian industry representatives, NAVAIR's department head for Propulsion and Power Systems, Dave Pauling, explained the team's success in finding this technology.

"This team really demonstrated how to use technology in the total life cycle of a system to the benefit of our nation and, in this case, our national security," Pauling said. "Many think advanced technology is for new systems only but this team showed us how advanced technology can be applied to legacy systems -- today's fleet -- as well."

The program itself involved evaluating a Russian process that coats turbine engine compressor blades with a thin coating of titanium nitride. These compressor blades, especially those used in the CH-53E *Super Stallion's* T-64 engine, were experiencing dramatically shortened life spans due to erosion.

"(The team) identified a technology need -- engine sensitivity to sand erosion in the Desert Storm environment -- and a technology to fit that need (titanium nitride)," Pauling said. "(Team members) evaluated that technology for the application and showed, through coupon and engine testing, that it was the best available."

"We had a problem with sand erosion taking the compressor in the T-64 engine down to 1/20th of its design life," explained Greg Kilchenstein, a NAVAIR Propulsion and Power Systems engineer and member of the integrated product team evaluating the new coating process. "That trickled down to other problems like compressor stalls."

Ultimately, eroding compressor blades affected performance to the point Leathernecks operating the *Super Stallion* in Southwest Asia during Operation Desert Shield and Desert Storm were having difficulty making heavy lifts.

"They had to call on Army CH-47 *Chinooks* to make heavy lifts," he said.

Obviously, something needed to be done.

Although the CH-53E, like many other platforms, is fitted with a particle separator to filter out larger particles before they are ingested by the engine, the *Super Stallion's* Engine Air Particle Separator is designed to catch particles larger than 10 microns, according to Kilchenstein. That equates to a very fine dust getting "blown" through the engine at very hot temperatures and high speeds, and scouring engine components in its path like a sand blaster.

"In the T-64 engine compressor, the blades in the first 10 stages are titanium," said Kilchenstein. "Titanium is lightweight, strong and a good candidate for building rotating components, but it's not good at handling hard-particle erosion."

Under the Component Improvement Program, Kilchenstein's engine team received funding to fix the T-64's problem.

"The CIP funded us to scour the world to find anything that could help the T-64," he said.

That search led them ultimately to technology used in the Soviet-era Mil Mi-24 Hind attack helicopter.

"The Russians had the same experience in Afghanistan that we did in SWA with engines," Kilchenstein said. "They were scrapping about 80 percent of their rotor blades. This coating technology helped them reduce that rate to about 3 percent."

The coating process had been developed by the Ural Works of Civil Aviation (or PRAD by its Russian initials) in Ekaterinburg, Russia, according to Chris Georgiou, a NAVAIR aerospace engineer responsible for advanced propulsion programs (AIR-4.4T). It has been successfully protecting TV2 and TV3 engines used in the Mi-24 and Mi-48 helicopters, as well as most of the Russian military fleet.

A sales visit by the Montreal-based MDS Aero Support Corporation led to the Canadian engineers asking about the gold-colored turbine blades from the helicopter engines being rebuilt at the PRAD plant. That in turn led to the creation of the joint Russian-Canadian venture, MDS-PRAD Technologies Corporation, to market the process. The NAVAIR team learned of the process through the Canadians.

The team had identified technology to combat the erosion problem in the T-64 engine, but its task was far from over. Because the titanium coating process was foreign, indeed Russian even, they had to pursue it under the Foreign Comparative Test program - an Office of the Secretary of Defense program with congressional oversight.

To meet the terms of the FCT program, it was not enough to buy the product from the Russians (in the form of coated turbine blades); the team had to procure the entire process and relocate it to North America - no small task, according to Georgiou.

"Under the rules of the FCT, it wasn't deemed prudent to have components vital to national security being sent to Russia for work and then getting shipped back," Georgiou explained. "Neither did the

Russian government want to let the process go to the depot at (Marine Corps Air Station) Cherry Point."

The Russians agreed to have a plant, run by MDS-PRAD, in Canada to carry on the process in North America - an accomplishment largely due to the international relations efforts of NADEP Cherry Point's Science and Technology advisor, Gray Simpson.

"There are a lot of international issues to deal with when you deal with the Russians," Georgiou stated. "We had to build trust and Gray Simpson was a big part of that. As part of the FCT program, we had to bring the machines to Canada, bring Russian scientists to teach us how to do the process, and then demonstrate our ability to do it ourselves. That's where we are now."

A large part of the current "Proof of Concept" phase the team is currently in was showing a valid return on investment for the technology. With about 2,000 compressor blades in the T-64 engine, the team needed to show it was worth spending $25 per blade to coat them with the Russian process.

"We had to prove it would work in an erosive environment," said Kilchenstein.

Finding no existing methods to test compressor blades in this manner, the team turned to Dr. Widen Tabakoff, a professor of aerospace engineering and applied mechanics, at the University of Cincinnati and director of the Turbomachinery Deterioration and Erosion Laboratory. Tabakoff, whose materials coatings experience began while working in the World War II German rocket program under Dr. Werner Von Braun, helped them devise their own test.

"We had to invent a sand mix that would replicate the 10 micron and smaller particles that get through the EPS, and the speeds at which the engine ingests those particles," Kilchenstein explained.

Replicating actual conditions was one thing, according to Kilchenstein. Developing a useable criteria to judge the effectiveness of the coating was another. The team turned once again to NADEP Cherry Point.

"We used the standard reject criteria used by NADEP Cherry Point," he said.

Using a "go/no-go" gauge, depot artisans measure a turbine blade's "effective chord" -- the area of the blade that remains and is able to do work. Once a blade is worn to a point indicated by the gauge, it is discarded and its titanium reclaimed, according to Kilchenstein.

"To prove a good ROI on coated blades that cost 1.3 times as much as uncoated blades, we would need them to last at least twice as long," he said. "Using the Tabakoff test, we found the coated blades lasted five times as long as the uncoated blades."

But that still wasn't conclusive enough.

"The real icing on the cake was building an engine with a 'rainbow configuration' - where alternating blades are treated with the Russian coating - and running a sand ingestion test," he explained. "We did that. We sent a rainbow-configured engine to Kirtland Air Force Base and ran it for 17 hours and ingested 30 pounds of sand.

"We proved the Tabakoff test was accurate," Kilchenstein concluded.

Even with that, the team still couldn't declare a victory. The team had to also show no ill effects from using the coating.

"Usually, there's a 'fatigue debit' introduced by a coating," explained Kilchenstein, "but the Russians have another process that takes care of that."

Overall, the results to date are impressive.

"We've proven the technology transfer from Russia," Kilchenstein stated. "And we've proven the technology works. Our next challenge is to get MDS-PRAD to be an approved coating vendor and productionize this process for the T-64 and other engines."

Another success of the coating IPT is the IPT itself, according to Georgiou.

"This has been a model IPT," he said. "It is comprised of NAVAIR elements (PMA-261, AIR-4.4 and NADEP Cherry Point), MSD-Prad, the Naval Research Laboratory, the engine manufacturer (General Electric) and the Naval Inventory Control Point in Philadelphia."

The true success of the IPT's efforts can also be seen in the spinoffs, Georgiou points out.

"We found the coating wasn't just a good erosion coating," he said, "but it's a good corrosion coating, too."

Other benefits of the coating, according to Georgiou, include possible improved heat resistance and lower friction leading to improved fuel efficiency, lower overhaul costs and increased life span.

Engine engineers around NAVAIR, NAVSEA and the Army have taken note, too, said Georgiou.

"Here at AIR-4.4 we've started talking to other engineers," Georgiou said. All gas turbine engines could derive direct benefits from the Russian technology. The Russians have even found other uses for it.

"They use it on their surgical instruments," he said.