SIKORSKY'S S-76D™ BREAKS NEW GROUND
CONTRARY TO WHAT MIGHT BE EXPECTED, THE LATEST VARIANT OF SIKORSKY’S POPULAR S-76 LINE IS FAR MORE THAN JUST A COSMETIC UPGRADE TO ITS PREDECESSORS; UNDER THE FAMILIAR SKIN THE S-76D™ IS AN ALMOST ENTIRELY NEW MACHINE.

STORY BY LEIGH NEIL / PHOTOS BY NED DAWSON
THE NEW D-MODEL IS REALLY A 76 IN NAME ONLY. PEOPLE LOVE THE 76; THEY LOVE THE WAY IT FLIES AND HOW IT HANDLES BUT WE WANTED TO MAKE IMPROVEMENTS TO THE AIRCRAFT WHEREVER WE COULD GAIN ADVANTAGES FROM THE LATEST TECHNOLOGICAL ADVANCES, AS WELL AS IMPROVING OR FIXING SOME THINGS THAT WE KNEW COULD BE BETTER — BUT WITHOUT BREAKING ANY OF THE THINGS THAT WERE ALREADY SO GOOD ON THE AIRCRAFT.

OUT WITH THE OLD – WELL SORT OF

There is little more than most of the fuselage structure carried over from earlier 76 models to the new S-76D™. Sikorsky technical specialist Dave Walsh described the new model’s development targets at Leadville, Colorado, where HeliOps caught up with the new model’s testing program. “The new D-model is really a 76 in name only. People love the 76; they love the way it flies and how it handles but we wanted to make improvements to the aircraft wherever we could gain advantages from the latest technological advances, as well as improving or fixing some things that we knew could be better – but without breaking any of the things that were already so good on the aircraft.” The D has all new rotor systems, with the tail rotor being an airfoil section of higher efficiency utilizing swept tips that now run at lower speeds for less tip vortex effect with dramatically less noise than the legacy tail rotor.

Yet it loses no control authority.

All rotors are equipped with Sikorsky’s RIPS (rotor ice protection system) with the goal of getting the 76D certified for flight in known icing conditions. The new-design 1,050shp PW-210S (‘S’ for Sikorsky) engines are from Pratt & Whitney Canada, rather than the Turbomeca Ariel power plants of previous models. These were designed specifically around the requirements of the 76D, although 210 series engines are now already slated for fitment to other aircraft. The D comes with a new cockpit, one fitted with Thales TopDeck avionics including a 4-axis fully coupled digital autopilot system.

TECHNOLOGY AND MORE TECHNOLOGY

While obviously being an extremely complex aircraft, the 76D was designed to be simple to fly. Project Test Pilot Greg Barnes explained the philosophy, “If it’s not simple to fly, then I haven’t done my job properly. Part of the design brief to Thales when finalizing the avionics suite was that I had to be able to access any page or carry out any system function within two button-presses. There are a few things that cannot
be done within two presses, but for every one of those things, Thales had to come to me and explain why that was the case and why it couldn’t be improved. I got them to incorporate a ‘back’ button because the system did not originally offer that function; a small change which has simplified many of the selection processes.”

The aircraft boasts a new active vibration control system that utilizes accelerometers and force generators throughout the aircraft to constantly mitigate vibration in the cabin. This high-tech system is even tunable to the extent that the optimum smoothness can be centered on a particular seat if desired, obviously a real advantage in an aircraft that will see a high percentage of service in the VIP transport role. The electrical system is also new and a true 28V DC, with a small onboard AC generator required to power just the windshield heat and the force-generators. Other changes include small modifications to the fuel bladders to gain some range and make room for crashworthy seating, a brand new pitot-static system, a comprehensive HUMS system and the adoption of crash-attenuating seats.

While the avionics/autopilot fit-out is cutting-edge for a helicopter, Barnes quickly points out that fixed-wing pilots have been flying with such advanced systems for years in high-end corporate aircraft. “There’s no reason that we don’t have this technology and more in helicopters. In fact, you could argue that helicopters need it more than the fixed-wings. After all, when was the last time anyone flew a Gulfstream single-pilot at 500ft?” The 76D is not yet certified for single-pilot IFR but Barnes expects approval by the end of the year. The single-pilot seat in the D will be on the right, as that is the side that retains power in the event of a total generator failure and reliance on battery power only; a scenario that is able to be supported for more than 30 minutes flying time. Barnes has spent a great deal of effort in maximizing the use of available space in the
THE NEW-DESIGN 1,050SHP PW-210S (‘S’ FOR SIKORSKY) ENGINES ARE FROM PRATT & WHITNEY CANADA, RATHER THAN THE TURBOMECA ARIEL POWER PLANTS OF PREVIOUS MODELS. THESE WERE DESIGNED SPECIFICALLY AROUND THE REQUIREMENTS OF THE 76D, ALTHOUGH 210 SERIES ENGINES ARE NOW ALREADY SLATED FOR FITMENT TO OTHER AIRCRAFT.

D-model’s cockpit. In particular, he has eliminated hardware control panels wherever possible, replacing them with ‘virtual’ control panels within the glass cockpit avionics. The exact same functions are carried out, but on a glass panel instead of a dedicated hardware device. A nice detail that illustrates the commitment to making the electronic interface both practical and user friendly is the new PLI (power limit indicator). While many aircraft have a similar type of device, Sikorsky’s PLI automatically detects and identifies the lowest power limiting factor, be it torque, ITT or Ng and normalizes the available power redline to 100% of that limit. The pilot therefore knows that when that PLI reads 50% – for example – the aircraft is at an actual 50% of the available power in that particular circumstance.

The glass cockpit offers an opportunity to make changes to the

Heliops
THE GLASS COCKPIT OFFERS AN OPPORTUNITY TO MAKE CHANGES TO THE WAY PILOTS VIEW AND MANAGE MANY OF THE INFORMATION STREAMS AVAILABLE TO THEM.
way pilots view and manage many of the information streams available to them. Barnes explained that he didn’t see any reason why a pilot should be monitoring engine gauges on the MFD when the aircraft’s computers are able to monitor them and advise of any problem before a pilot could probably even recognize the issue. “I believe it’s much better for them to be looking at operational and navigation information like the map screens,” he said. “The interfaces are so good that I can log or change a flight-plan directly from the map screen, by touch. If, for example, I want to proceed direct to a particular location while in flight I just need to click on the helicopter, click on where I want to go and click ‘execute’. If I’m coupled up the aircraft will then automatically turn and track to the new destination/waypoint.” Within a year or two Barnes intends to have the interface improved to also permit programming the comm’s channels direct from the MFD.

Despite the dramatic advances evident in the 76D, Barnes is still enthusiastic about staying abreast of any new technologies that may permit further advances in Sikorsky’s products. Presently available head-up displays (HUDs), for example, present difficulties when considered for helicopter applications. The limited field of view coverage in a fold-down or fold-up HUD preclude their effective use in most helicopter operations and helmet-mounted displays, while overcoming the field of view problem, are not an option in a VIP machine where the pilot is simply not going to wear a helmet. In the not-too-distant future however, HUD information is likely to be available in a format as simple as putting on a pair of glasses – technology already being looked at by Thales. Barnes sees that this step will make HUD technology truly feasible and readily adaptable to machines like the 76D, with its existing avionics technology.
POWER

Aside from all the technology, it is the power and performance that really differentiate the ‘D’ from its predecessor models. When initially certified, the S-76D™ had a maximum takeoff altitude of just 3,000ft; mainly due to the density altitude in Florida where the initial testing was carried out. Dave Walsh outlined what Sikorsky was doing with the 76D at Leadville. “Our primary goal here was to expand the category-B takeoff and landing envelope, up to the maximum performance capability of the engine and rotor package. That’s turned out to be very close to 11,000ft Density Altitude at close to our maximum weight of 11,875lb.” The reason for choosing Leadville as the testing location was its relatively long runway and usual density altitude of 11-12,000ft, making it the highest public airport in the continental US. With the Sikorsky team certain that the 76D had the capability for maximum performance takeoffs at
around 11,000ft, Leadville offered the ideal location. Other 76 models have also been tested at Leadville but the D model is the first to offer maximum gross weight performance at these altitudes.

There are three elements to the altitude performance testing carried out over about a month at Leadville. Part one included IGE and OGE hover performance at WAT (weight, altitude and temperature) limiting conditions. Part two consisted of verification of the height/velocity diagram, which was originally established at sea level. Sikorsky’s philosophy is to calculate the height/velocity diagram at maximum gross weight and keep it conservative, so that it remains simple and valid from sea-level to normal operational altitudes, at any normal operating weight. The third portion of the altitude performance testing was determination of the category-B takeoffs and landings. Cat-B uses very similar profiles to Cat-A takeoffs and landings, but without
the guarantee of nil exposure given a failure anywhere in the profile. In Cat-B there are areas in the profile that permit a small amount of risk exposure in the event of a failure, but this allows operation at much greater weights than those attainable under Cat-A limits. As 90% of Sikorsky’s S-76D™ customers are VIP or offshore oil clients, there is no real need to carry out altitude Cat-A testing for their requirements. “We have done sea level Cat-A testing at our airfield though, which covers the requirements of our offshore operators,” assured Walsh.

HANDLING

The next ‘piece of the puzzle’ that Sikorsky needed to resolve was handling qualities testing. “We have to show that we can hover in a crosswind of up to 35kts from any direction. The way in which we establish that is by an airborne crosswind simulation in which we have our test pilots fly the aircraft 10ft above the ground; sideways, backwards and in every orientation, up and down the runway at 35kts. So a part of what we’re establishing is how heavy we can be and still have sufficient pedal authority to keep the nose straight.” The testing proved the machine’s capability to hover with the wind within 30 degrees of the nose if over 15kts, or from any direction if at 15kts or below at WAT limiting conditions. The WAT conditions at which the aircraft had 35 knot crosswind capability in all directions was also defined. During testing the S-76 was also comfortably hovered at 14,500ft and +11°C (density altitude of around 16,000ft) without exceeding the specified testing limitations, and exceeding the planned operational maximum of 15,000ft, expected to be published in the aircraft’s manual.
Innovative Maintenance Tracking

Competitive Pricing | Fixed Wing and Rotor Wing | OEM Deviation Report

Solutions at your fingertips.

- Web-based
- Analyst Support or User Managed
- Flight Operations
- Fleet Reports
- Maintenance Tracking
- AD Notifications
- Inventory with Preloaded OEM Parts
- Warranty Tracking
- Document Vault

© 2013 SkyBOOKS Inc. All rights reserved.
All registered trademarks are the property of their respective owners.

904.741.8700 | 866.929.8700 | www.SkyBOOKS.com
“When testing is completed the maximum takeoff and landing height will be at approx. 13,000ft Density Altitude but that will not be at max gross weight. We will be near max Gross Weight at 11,000ft and then a lower weight at 13,000ft. The weight is reduced on a constant weight over density ratio basis” Walsh explained.

Walsh said that the performance envelope testing commenced at about 1/2 inch forward of the permitted CoG and around 3-400lbs over the maximum gross weight. “He always want’s to make my job more interesting,” quipped test pilot Greg Barnes in response. Steel plates bolted to the aircraft floor are used as ballast for the testing, enabling the aircraft to be configured at whatever weight and CoG (center of gravity) are required for any given test. “Testing is very much a team effort, for which you carry out a great deal of preparation. As a test pilot, what I like to see is a boring flight. If it’s boring it means we’ve done our homework. We may be operating at the edge of the envelope but there shouldn’t be any surprises,” remarked Barnes. Walsh elaborated further, “Don’t get us wrong, boring doesn’t mean it’s trivial. This is high-risk stuff but the tech team works hard to make sure the pilot knows exactly what he’s getting into. Our extrapolation tools give us very accurate predictions of exactly what the pilot is going to encounter at the limits we’re testing.” Each night the aircraft is checked over and prepared in the required configuration for the next day’s testing program. As Barnes says, “The whole purpose of collecting this data is so we’re not going to be surprised and our customer’s not going to be surprised at anything that occurs out there in this aircraft. It should all be predictable. Anything a customer ends up doing we should have done before – and then some!”
Presenting the leading-edge Heliops iPad App
Get Plugged In - And OUT of the Stone Age!

Click on the Icon to access a whole new experience - right at your fingertips
POWER TO GO

The final aspect of performance testing carried out at Leadville related to the new PW-210S powerplant. Engine cooling, operating characteristics such as power recoveries from descents and engine performance at altitude were thoroughly evaluated and defined in this phase. Apart from the now-expected-these-days dual channel FADEC, the new ‘smart’ engines include such clever touches as permanent magnet alternators (PMAs) – providing continuous electrical power to the engine control systems even in the event of total failure of all other aircraft electrical supply systems including the battery. Generator load monitoring permits variable engine acceleration limits. There are absolutely no mechanical linkages between the cockpit and the engines, everything is totally digital. The electronic engine controls will even automatically and momentarily shed non-essential generator loads to permit more rapid turbine acceleration if a high power demand is detected. Walsh and Barnes both commented on how pleased they
THE 76D HAS A VNE OF 155KTS AND ACCORDING TO WALSH IT WILL CRUISE AT THAT SPEED ALL DAY, AT A RELATIVELY LOW POWER LEVEL.

were with the apparent durability of the new engines. “We used more than ten times the production specified OEI 30-sec and 2-min time limits (up to 600 seconds of 30-sec power) with the engine showing no degradation and still comfortably producing spec’ power afterwards”.

For the Leadville exercise, the Sikorsky team brought a complete array of testing equipment in two large trucks. Barnes joked that they brought West Palm Beach to Leadville; everything in fact except a tug, which they hire from the FBO.

During a test, telemetry transmits real-time data directly to the tech crew in the mobile van, in which only the tech director communicates with the pilot. Several other technicians and engineers separately monitor various factors, such as aircraft performance parameters, handling qualities and engines. The 76D has a Vne of 155kts and according to Walsh it will cruise at that speed all day, at a relatively low power level. An FAA requirement for establishing Vne is testing to 1.1 times that value, so the D had to be tested to 172kts. Barnes reported that the machine easily met and exceeded that goal and did it in level flight, requiring no nose-over whatsoever in order to reach it. While the initial certification Vne is unchanged from the legacy
76 models, the testing has allowed Sikorsky to look at expanding the speed envelope at altitude, increasing the altitude at which 155kts can be maintained. Data was gained which – in the next year or so – should see 155kts permitted up to 5000’ instead of the current 3000’, and then a reduction of just 5 1/2 kts/1000’ thereafter. This is seen as a valuable improvement for many of their customers.

Unlike test programs of yesteryear, the equipment and technology used in modern testing regimes permits aircraft development without pushing the machine to the point of structural or aerodynamic failure. “You should never get to the point where you’re actually breaking things on the aircraft. The days of guys like Chuck Yeager going up and having to jump out of something they’re test-flying have gone.” observed Barnes.

When asked how successful he considered the Leadville program of performance envelope testing had been, Barnes was upbeat, telling HeliOps “It went well. The aircraft performed at least as well as expected and there were no surprises. That means I’m about as happy as a test-pilot can be.” He went on, “The reason we’re about ten days ahead of schedule is due to all the homework that’s been done beforehand; not just for up here, but also all the work done at sea-level.”

ADVANTAGES

So with testing complete and final certification imminent, what does this virtually all-new machine offer to a potential client?

According to Walsh, “This aircraft offers the latest cockpit technology, increased power and great performance, but while retaining great fuel-specifics all the way from 120kts to Vne.”

And what about hiccups? “We’ve had a few,” admitted Barnes. “Program delays of about a year were directly attributable to issues with the engine. After resolving those though, at the end of the day it has turned out to be a really great engine. Then we had about half a year spent resolving an issue at the blade-trim tab interface.” Considering that most new aircraft programs span around ten years from concept to production, having worked through all the issues the team feels that they have developed a great aircraft. Now it only remains to be seen if the features and expanded performance envelope of this new model prove equally attractive to new and existing clients.”
ou wouldn’t trust your helicopter with just anyone... would you?

That’s why technicians at our authorized Customer Service Facilities have been trained at Bell Helicopter’s industry-leading training academy. As factory-trained maintenance technicians, they are dedicated to providing you with the highest level of service using Bell Helicopter’s rigorous standards of quality. With more than 100 Customer Service Facilities across 35 countries, you’ll get the best support in the industry.