

# Advanced Airfoils Boost Helicopter Performance

## Originating Technology/NASA Contribution

Advanced rotorcraft airfoils developed by U.S. Army engineers working with NASA's Langley Research Center were part of the Army's risk reduction program for the LHX (Light Helicopter Experimental), the forerunner of the Comanche helicopter. The helicopter's airfoils were designed as part of the Army's basic research program and were tested

in the 6- by 28-inch Transonic Tunnel and the Low-Turbulence Pressure Tunnel at Langley. While these airfoils did not get applied to the Boeing-Sikorsky Comanche rotor, they did advance the state of the art for rotorcraft airfoils.

The improved blade offered significantly greater lift capabilities, less drag, and less pitch (alternating lift and descent of the nose and tail of an aircraft during flight)

than its predecessor and other conventional blades, when compared during high-speed flight-performance testing.

The Langley airfoil design, technically known as RC4, has managed to "lift off" and find much success in other applications.

## Partnership

[Carson Helicopters Inc.](#) licensed the Langley RC4 series of airfoils in 1993—2 years after the Comanche project commenced—and began development of a replacement main rotor blade for their helicopters. The new Carson composite main rotor blades did not receive full Federal Aviation Administration certification until 2003. Regardless, it was well worth the wait for Frank Carson, president of the Perkasio, Pennsylvania-based company and a longtime helicopter pilot and designer. "The NASA Langley airfoil is one of the best airfoils in the world. Almost no one realizes how good it is. It's better than most anyone else has yet to come up with."

## Product Outcome

Carson Helicopters provides a unique array of services that require hauling heavy loads. These services range from airlifting external cargo, suppressing wildfires, and carrying out emergency rescues, to performing high-rise rooftop installations, pouring concrete, and erecting steel structures and power lines in areas ground-based cranes cannot access (soft grounds and swamp areas, environmentally protected areas, and elevated/mountain terrain).

The company's entire fleet of Sikorsky S-61 helicopters has been rebuilt to include Langley's patented airfoil design on the main rotor. As a result of this retooling, the helicopters are now able to carry an additional 2,000 pounds (11,000 pounds total), fly 17 miles per hour faster, and travel 70 miles farther on the same fuel load. Additionally, the five blades on an S-61 main rotor are made from advanced composite materials that give them a



The NASA-developed rotorcraft airfoils permit greater lift and lower pitching-moments than other rotorcraft airfoils—ideal for heavy lifting operations.



20,000-hour service life—double that of the conventional metal S-61 blades’ life—which ultimately reduces the company’s operating maintenance costs.

In 2003, Carson Helicopters signed a contract with Ducommun AeroStructures Inc., to have the Gardena, California-based firm manufacture the composite blades for Carson Helicopters to sell. The commercial blades are due to fly on a U.S. Presidential VH-3 helicopter in late 2007, as part of the VH-3D Lift Improvement Program sponsored by the U.S. Naval Air Systems Command. Overseas, a customized set of blades is being tested for potential use on a British Sea King Royal Navy helicopter.

In aerial firefighting, the performance-boosting airfoils have allowed for a major modification to be made to a Sikorsky S-61 chopper, in order to help the U.S. Department of Agriculture’s Forest Service control the



The advanced airfoils, as applied to the main rotor of an S-61 helicopter, greatly increase the lifting capacity, operational envelope, and forward flight speed of the helicopter.

spread of wildfires. Because the airfoils permit heavier lifting than ever before, Carson Helicopters was able to install an oversized belly tank on its S-61 Fire King (or, as the company likes to call it, the “Swiss Army knife of helicopters”). With this modification, the Fire King is the only Type 1 helicopter (the heaviest type of helicopter, based on a scale of Type 1 to Type 3) that can carry up to

15 firefighters and hold 1,000 gallons of water in its belly tank at the same time. What’s more, the helicopter has an 8,000-pound onboard cargo capacity. There are currently eight Fire Kings flying with the composite blades and the 1,000-gallon belly tank. ❖