

# ARCHIVED REPORT

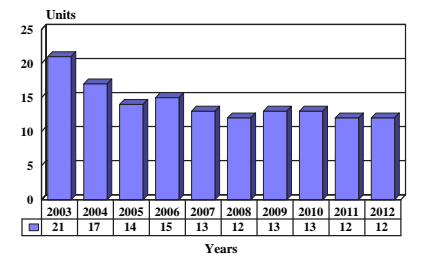
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## Sikorsky S-76/H-76 - Archived 11/2003

### Outlook

- The forecast calls for production of 142 S-76s during the next 10 years
- Deliveries of a new version are to begin in 2005

10 Year Unit Production Forecast  
2003 - 2012



### Orientation

**Description.** Twelve- to 15-place, twin-turbine, single main rotor commercial and military helicopter.

**Sponsor.** S-76 development was privately sponsored by Sikorsky Aircraft.

**Contractors.** United Technologies Corp, Sikorsky Aircraft; Stratford, Connecticut, USA.

**Status.** Production

**Total Produced.** Through 2002, approximately 525 S-76s had been produced.

**Application.** Civil applications include passenger transportation, offshore oil and gas support, law enforcement, and EMS. Military applications include counterinsurgency (COIN), troop/logistic support, medical evacuation, search-and-rescue (SAR), air ambulance, airborne assault, observation, and light anti-tank. In addition, naval applications include anti-submarine warfare, surface attack, SAR, and anti-ship surveillance and targeting.

**Price Range.** S-76C+, \$6.0-\$8.0 million, quoted in 2002 U.S. dollars.

### Technical Data

(S-76C+)

**Design Features.** Single-main-rotor helicopter with four titanium/composite material blades and a fully articulated aluminum rotor head with elastomeric, unlubricated bearings. The tail rotor is a four-blade

unit, located on the port side of the vertical fin. The fuselage is constructed of composite materials and light aerospace alloys. The landing gear is retractable tricycle type, with single wheels on each unit.

	<u>Metric</u>	<u>U.S.</u>
<b>Dimensions</b>		
Length overall <sup>(a)</sup>	16.0 m	52.50 ft
Fuselage length	13.21 m	43.33 ft
Max height <sup>(b)</sup>	4.42 m	14.50 ft
Main rotor diameter	13.41 m	44.0 ft
Tail rotor diameter	2.44 m	8.0 ft

	<u>Metric</u>	<u>U.S.</u>
Main rotor blade chord	0.39 m	1.29 ft
Tail rotor blade chord	0.17 m	0.54 ft
<b>Weight</b>		
Weight empty, executive configuration	3,731 kg	8,227 lb
Max T-O weight	5,307 kg	11,700 lb
Useful load	1,575 kg	3,473 lb
<b>Capacities</b>		
Standard fuel	1,064 liters	281 U.S. gallons
Cabin volume	5.78 cu m	204.0 cu ft
Baggage volume	1.08 cu m	38.0 cu ft
<b>Performance</b>		
Max cruise speed, SL	287 km/h	155 kt
Service ceiling	3,871 m	12,700 ft
Max climb rate at SL	495 m/min	1,625 ft/min
Range with standard fuel, no reserves <sup>(c)</sup>	813 km	439 nm
<b>Propulsion</b>		
S-76 Mk II	(2)	Allison 250-C30S two-shaft, free-turbine turboshaft engines rated 485 kW (650 shp) each for take-off.
S-76A+	(2)	Turbomeca Arriel 1S turboshaft engines rated 508 kW (681 shp) max continuous.
S-76B/H-76	(2)	UTC Pratt & Whitney Canada PT6B-36A two-shaft, free-turbine turboshaft engines: 732 kW (981 shp) five-minute take-off rating; or
	(2)	UTC Pratt & Whitney Canada PT6B-36B turboshafts: 732 kW (981 shp) five-minute take-off rating.
S-76C	(2)	Turbomeca Arriel 1S1 turboshafts rated 539 kW (723 shp) each for take-off.
S-76C+	(2)	Turbomeca Arriel 2S1 turboshafts rated 639 kW (856 shp) each for take-off.

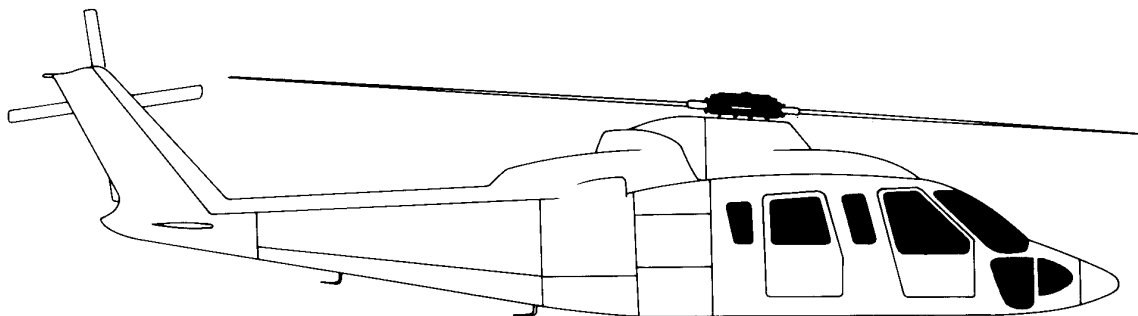
**Seating**

Crew of two plus 12 passengers maximum in S-76 Mk II; crew of two plus 12-13 passengers in S-76B/C/C+.

<sup>(a)</sup>With rotors turning.

<sup>(b)</sup>With tail rotor turning.

<sup>(c)</sup>At 139 knots at 4,000 feet.



SIKORSKY S-76

Source: Forecast International



S-76

Source: Sikorsky

## Variants/Upgrades

S-76. Original Allison-powered model known as the Spirit. Production of this version was completed in March 1982.

S-76 Mk II. Production model from March 1982, with improved Allison engines. No longer in production.

S-76 Mk II Utility. A basic variant of the Mk II, this version could be used in a variety of roles. The Utility version had sliding doors, dual controls, and a cabin floor strengthened for cargo loading of up to 976 kilograms per square meter (200 pounds per square foot). Optional features included non-retractable landing gear, an auxiliary fuel tank holding 416 liters (110 U.S. gallons), crash-resistant fuel tanks, armored crew seats, a cargo hook, a rescue hoist, engine air particle separators, and adaptive equipment for stretcher installation. The Philippine Air Force took delivery of 17 military S-76 Utility models: 12 were configured for use in COIN, troop/logistic support, and medevac duties; two were SAR-configured; and three were passenger transports.

S-76B. A version of the S-76 using two Pratt & Whitney Canada PT6B-36 turboshaft engines. Flight

testing began in June 1984, and FAA certification was granted in 1987. The S-76B's maximum take-off weight was increased by 635 kilograms (1,400 pounds) over that of the Mk II, and the main transmission rating was increased to 1,118 kW (1,500 shp). Other modifications included a 15 percent reduction in the area of the tail rotor pylon and reconfigured engine exhaust fairings.

The S-76B was the first U.S.-produced helicopter to have a full-authority dual-channel digital engine fuel control system, manufactured by another United Technologies division, Hamilton Standard. It also had a Honeywell SPZ-7000 digital automatic flight control system (AFCS) as a factory-standard option and a Universal Navigation UNS-1 Junior flight management system (FMS). The S-76B was originally certified to a maximum gross weight of 5,171 kilograms (11,400 pounds), up from 4,672 kilograms (10,300 pounds) for the S-76 Mk II. The certification qualified the S-76B for category B day/night, VFR/IFR flight, with take-offs and landings from sea level to 975 meters (3,200 feet) and en route to altitudes of 3,047 meters (10,000 feet). An increase in maximum take-off weight to 5,307

kilograms (11,700 pounds) received FAA approval in June 1988.

Sikorsky ceased production of the S-76B in late 1997.

S-76A+. This was the basic S-76 Mk II fitted with twin Arriel 1S powerplants. It was marketed in both new production and retrofit form.

S-76C. Arriel 1S1-powered version of the S-76B first announced at the 1989 Paris Air Show. Certification and initial deliveries in 1991.

S-76C+. Improved S-76C powered by twin Turbomeca Arriel 2S1 turboshaft engines. This version entered production in 1996. The Arriel 2S1 incorporates full-authority digital engine control and single-crystal turbine blades.

S-76N. A marinized and weaponized version of the commercial S-76.

H-76 Eagle. A military variant of the P&WC-powered S-76B, the Eagle could be rigged for such roles as airborne assault, air observation, combat SAR, evacuation, ambulance, and conventional SAR. Possible armament included Fabrique Nationale or Maremont M60D 7.62 mm machine guns; .50 caliber machine guns; 2.75-inch and 5-inch rocket pods;

Oerlikon 68 mm rockets; HELLFIRE, TOW, Sea Skua, and Stinger missiles; and Mk 46 torpedoes. Other equipment could include a mast-mounted or roof-mounted sight, and the capability to carry air-to-air missiles (up to 16). In March 1988, Sikorsky completed airborne firing trials using an H-76 Eagle equipped with Fabrique Nationale .50 caliber guns, a 2.75-inch rocket launcher, and other weapons systems at the Mojave, California, test range. The demonstration successfully tested an improved Integrated Armament Management System (IAMS) developed by Lear Siegler's Avionic Systems Division and included a pilot Head-Up Display (HUD) and automatic weapons pod selection features.

H-76N. A naval version announced in early 1984. Among its intended roles were anti-ship surveillance and targeting, anti-submarine warfare (ASW), surface attack, search-and-rescue (SAR), and generalized utility duties. Over-the-horizon targeting (OHT) and anti-ship variants were to be available with Ferranti Seaspray 3 and MEL Super Searcher radar in mounted pods. The anti-ship H-76N could be armed with BAe Sea Skua air-to-surface missiles. The ASW variant was to have a dipping sonar processing suite and two Mk 46 or Sting Ray torpedoes. Initial H-76N flights began in mid-1986; the aircraft was marketed with either the 250-C<sup>3</sup>4S engine or the PT6B-36.

## Program Review

**Background.** The S-76 is Sikorsky's first helicopter designed from the outset as a commercial machine. The manufacturer unveiled a full-scale mock-up of the all-weather, multipurpose S-76 in February 1975 and moved the program into the prototype construction phase the next year. The aircraft first flew in March 1977, two months ahead of the original schedule, and received its FAA certificate in November 1978. Initial deliveries were made in February 1979.

**Design Features.** The original design parameters for the S-76 called for the carriage of two pilots and 12 passengers over a distance of 741 kilometers (400 nautical miles) at 231 km/h (125 knots) on a 32.2°C (90°F) day with 30 minutes fuel reserve. Substitution of one additional fuel tank for two passenger seats increased the range to 926 kilometers (500 nautical miles), while a second tank in place of two more seats extended the helicopter's range by 20 percent.

Power for original helicopters was provided by a pair of Allison 250-C30 turboshafts. However, beginning in March 1982, production aircraft were powered by refined -C30S engines developing 485 kW each at take-off. These aircraft were designated S-76 Mk II. The Mk II incorporated more than 40 improvements over its predecessor, and early models could be brought up to

Mk II standard with retrofit kits. Each engine in the twin powerplant installation had its own ice protection system, with provision for an optional engine air particle separator. The powerplant package was designed for one engine inoperative (OEI) flying, and each engine had an independent fuel supply source and a separate fire detection/extinguishing system. For enhanced reliability and safety, dual hydraulic and electrical systems were also incorporated.

The S-76's 12-passenger cabin is laid out in three rows, four abreast, and is entered through a wide door on either side of the fuselage. Cockpit access is gained either from the main passenger cabin or directly via individual fuselage doors. A door on each side of the aft fuselage opens to a 1.08-cubic-meter (38.0-cubic-foot) baggage compartment. A number of executive layouts have been marketed, as well as quick-change convertibility.

Design of the four-blade main rotor includes titanium spars, fiberglass skin, swept tips, and elastomeric elements to accommodate the required blade motions. The main rotor is essentially a scaled-down version of the type developed by Sikorsky for the YUH-60A

UTTAS prototypes. Sikorsky claims that the combination of the low tip speeds of the main and tail rotors, plus the bifilar vibration absorber, ensures a smooth and quiet ride. The aircraft also incorporates a fully retractable, tricycle-type landing gear.

Enter Pratt & Whitney Canada. Operational difficulties with some Allison Model 250s, and limited payload and single-engine hover performance capability, led Sikorsky to launch a PT6B-powered version of the S-76 in October 1983, with flight testing beginning in June 1984. Certification was received in 1987.

Turbomeca Engine Option. In October 1985, Societe Turbomeca of France signed an agreement with Sikorsky to study the development of an engine modification kit that would allow the French company's 508-kW (681-shp) Arriel 1S to be installed in the S-76, the new aircraft being designated S-76A+. The Arriel-powered S-76 received its FAA certification in April 1988, and was marketed as new production or as a retrofit option to S-76 owners. Operators were able to purchase the engine kit from Sikorsky and perform the retrofit in the field, or could have the refit done by the manufacturer at its West Palm Beach Completion Center in Florida.

The A+ was replaced at Sikorsky on the production line by the newer, improved S-76C. This second Arriel-powered S-76 was announced in 1989. It was essentially an S-76B airframe/drive train combination with twin Arriel 1S1 engines. Production deliveries began in 1991.

South Korean Joint Venture. In 1986, Sikorsky announced a joint venture arrangement with Daewoo Heavy Industries Ltd of South Korea. The resulting firm was called Daewoo Sikorsky Aerospace Ltd, in which each company owned a 50 percent share. In March 1989, Daewoo Sikorsky submitted a proposal to the South Korean government to produce the H-76 at a facility in Changwon. The H-76 had been competing to fill a South Korean Army requirement for up to 200 light utility helicopters. However, Daewoo Sikorsky never undertook H-76 production.

Originally, Daewoo Sikorsky was to gradually assume all S-76B production as Sikorsky concentrated its

domestic capacity on U.S. and international military demand for Black Hawk, Seahawk, and Super Stallion helicopters. Those S-76Bs sold in the U.S. were to be shipped green from South Korea for final assembly and delivery by Sikorsky. However, this never occurred.

S-76 Improvements. In 1993, Sikorsky began a major series of improvements to the S-76. The baseline S-76 now has a number of standard features that were previously marketed only as options, such as an electronic flight instrumentation system (EFIS) and dual digital automatic flight control systems. A liquid crystal Parker Gull integrated instrument display system (IIDS) has been approved by the FAA for installation. This system replaces 18 instruments with three displays.

On the S-76B, the PT6B-36A powerplant was replaced with the PT6B-36B in new-production rotorcraft. The -36B had the same power rating as the -36A but provided greater power margins.

New S-76C+. In June 1996, Sikorsky received FAA certification of the S-76C+, which is powered by Arriel 2S1 engines. The Arriel 2S1 is approximately 18 percent more powerful than the Arriel 1S1 that powered the S-76C. Other improvements in the C+ include full-authority digital engine control and single-crystal engine blades. A C+ retrofit package for existing S-76Cs may also eventually be marketed.

The initial production S-76C+ was delivered in July 1996 to Norsk Helicopters of Norway for use as an offshore oil field transport.

Production Reorganization. In April 2000, Sikorsky announced an agreement with Keystone Helicopter Corp under which Keystone now performs all S-76 completions at a Keystone facility in West Chester, Pennsylvania. The helicopters were formerly completed at a Sikorsky facility in West Palm Beach, Florida.

In June 2000, Sikorsky signed a deal worth \$230 million with the Czech company Aero Vodochody for the latter to manufacture S-76C+ airframes. Under the agreement, Aero is to produce more than 100 airframes over a period of seven years. Sikorsky continues to produce dynamic components and perform final assembly. In September 2001, Sikorsky delivered the first S-76C+ produced with a fuselage built by Aero.

## Recent Contracts

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Not available.

## Timetable

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<u>Month</u>	<u>Year</u>	<u>Major Development</u>
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<u>Month</u>	<u>Year</u>	<u>Major Development</u>
Jan	1975	Program go-ahead announced
Feb	1975	Full-scale mock-up displayed
May	1976	Prototype construction begun
Mar	1977	Prototype first flight
Nov	1978	FAA certification obtained
Jan	1979	IFR certification obtained
Feb	1979	Initial production deliveries
Mar	1982	S-76 Mk II deliveries begun
Early	1987	S-76B awarded FAA approval
Apr	1988	S-76A+ certificated
Jun	1996	S-76C+ awarded FAA certification
Beyond	2003	Production to continue

## Worldwide Distribution

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### Military/Government Operators

<b>Philippines Air Force</b>	14
<b>PRC Government</b>	4
<b>Spain Air Force</b>	8
<b>Taiwan Government</b>	2
<b>Thailand Navy</b>	6
<b>Trinidad &amp; Tobago Government</b>	4
<b>U.S. Federal Aviation Administration</b>	1

## Forecast Rationale

S-76C+ production is currently sold out at least through the first quarter of 2004. The helicopters scheduled to be built in the 2003-2004 time frame include four for Brazilian operator Senior Taxi Aereo, one each for corporate customers in the U.S. and South Korea, and a number for Louisiana-based Offshore Logistics Inc. The latter company, which provides offshore oil helicopter transportation services, ordered 15 S-76C+ helicopters in February 2003 for delivery over five years, and took options for an additional 24 helicopters within the same time frame.

As for potential future sales, Petrobras in Brazil may acquire 12-20 S-76C+ helicopters to begin service by the end of 2004.

Sikorsky expects to deliver more than 20 S-76C+ helicopters in 2003. The company delivered six in 2002, two fewer than in 2001.

In March 2003, Turbomeca received an order from Sikorsky for 20 Arriel 2S2 engines to power a new version of the S-76C+. The Arriel 2S2 will provide 6 percent more power than the 2S1 currently utilized on the S-76C+, and also includes a dual channel digital engine control.

In addition to uprated engines, the new version will also have other new features, including a quieter tail rotor and a de-icing system. Increased cabin comfort is to be achieved by a combination of additional passive noise reduction technology and a low noise main transmission. Deliveries of the new version are scheduled to begin in 2005. The new model has been tentatively called the S-76C++, although this may not be its final designation. Therefore, in the forecast chart below, the S-76C+ forecast line includes both the current production version and the new model.

Sikorsky had considered installing a new cockpit with flat panel liquid crystal displays in the new S-76 version, but ultimately decided against it. The new cockpit could become part of the S-76D that is currently being studied by Sikorsky. The new S-76D has yet to be fully defined. Pratt & Whitney Canada has proposed its 670-kW (900-shp) PW209 engine for use on the S-76D.

The potential markets for the S-76 include law enforcement, emergency medical service (EMS), corporate transport, and offshore oil support. The commercial airline market has provided some sales for the S-76. At least six airlines use the S-76 for scheduled passenger operations.

In 1999, Sikorsky launched a fractional ownership program, called Sikorsky Shares, using S-76 helicopters. Fractional ownership has proven to be a successful concept in spurring sales of business jets but has yet to really make an impact on the helicopter market. Sikorsky Shares has been introduced in the

northeastern U.S. Eventually, Sikorsky plans to expand the program to other parts of the U.S. and Europe.

During the next 10 years, Sikorsky is projected to build a total of 142 S-76 helicopters. As the new S-76D is not yet fully defined, no specific forecast has been prepared for this model.

## Ten-Year Outlook

### ESTIMATED CALENDAR YEAR PRODUCTION

Aircraft	(Engine)	<u>High Confidence Level</u>				<u>Good Confidence Level</u>				<u>Speculative</u>			Total 03-12
		thru 02	03	04	05	06	07	08	09	10	11	12	
SIKORSKY													
S-76	250-C30	178	0	0	0	0	0	0	0	0	0	0	0
S-76 MK II	250-C30S	113	0	0	0	0	0	0	0	0	0	0	0
S-76A+/C	ARRIEL 1S/1S1	75	0	0	0	0	0	0	0	0	0	0	0
S-76B	PT6B-36A/36B	93	0	0	0	0	0	0	0	0	0	0	0
S-76C+	ARRIEL 2S1/2S2	66	21	17	14	15	13	12	13	13	12	12	142
Total Production		525	21	17	14	15	13	12	13	13	12	12	142