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Pratt & Whitney PW6000 - Archived 6/2011

Outlook

- No existing orders for PW6000
- Remaining A318 backlog has CFM56 power

Orientation

Description. Axial-flow, two-spool, turbofan engine in the 20,000- to 24,000-lbst (88.9- to 106.7-kN) class.

Sponsor. The PW6000 aviation turbofan engine was privately funded and developed by the prime contractor.

Power Class. The power output range of this engine series is 18,000-24,000 lbst (79.2-106.7 kN).

Status. Engine is in extended development; certificated by U.S. FAA in November 2004.

Total Produced. As of April 2010, an estimated 47 PW6000 engines had been built.

Application. Aircraft with roughly 90-130 seats for the regional aircraft market.

Engine Variant	Thrust Rating	Application	Units per Airframe
PW6122	22,100 lbst (98.3 kN)	Airbus A318	2
PW6124	23,800 lbst (105.8 kN)	Airbus A318	2

Price Range. Initial price range estimated at $4.75-$5.0 million in 2010 U.S. dollars.

Competition. The PW6000 faces competition primarily from the lower-thrust-range CFM56 and IAE V2500 turbofans.

Contractors

Prime

Pratt & Whitney	http://www.pratt-whitney.com, 400 Main St, East Hartford, CT 06108 United States, Tel: + 1 (860) 565-4321, Email: info@pw.utc.com, Prime

Pratt & Whitney PW6000

Subcontractor

Hamilton Sundstrand	http://www.hamiltonsundstrand.com, One Hamilton Rd, Windsor Locks, CT 06096-1010 United States, Tel: + 1 (860) 654-6000, Fax: + 1 (860) 654-2621, Email: hs.general@hsd.utc.com (FADEC)
Hispano-Suiza	http://www.hispano-suiza-sa.com, 18, Blvd Louis-Seguin, Colombes, 92707 France, Tel: + 33 1 4130 5010, Fax: + 33 1 4130 5412 (Thrust Reverser Assembly)
Meggitt Aerospace Equipment, Dunlop Bestobell	http://www.dunlop-polymers.com, Holbrook Ln, Coventry, CV6 4AA Warwickshire, United Kingdom, Tel: + 44 1509 500 000, Fax: + 44 2476 668 793, Email: Ian.Hubbard@dunlop-precision.co.uk (Mid-Stage Bleed Seal)
Mitsubishi Heavy Industries (MHI) Ltd	http://www.mhi.co.jp, 16-5 Konan 2-chome, Minato-ku, Tokyo, 108-8215 Japan, Tel: + 81 3 6716 3111, Fax: + 81 3 6716 5800 (Combustor Components)

Comprehensive information on Contractors can be found in Forecast International's "International Contractors" series. For a detailed description, go to www.forecastinternational.com (see Products & Samples/Governments & Industries) or call + 1 (203) 426-0800.

Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

Technical Data

Design Features

Fan. Low-aspect-ratio, wide-chord, single-stage solid-fan blades are currently standard, but hollow-chord blades might be employed at a future date. Bypass ratio is 4.9:1.

Low-Pressure Compressor. The engine has a four-stage LP compressor, with a dirt ejector bleed duct after the fourth stage. Inlet vanes are made of titanium.

High-Pressure Compressor. The newest HPC is of a six-stage transonic design from Germany's MTU. A very high-pressure, 3D, aerodynamically optimized design, the compressor is expected to yield a pressure ratio near 20:1. Provisions are made to optimize the tip clearance of the HPC blades through use of a new air injection system and a specially designed casing configuration. Pressure ratio is about 11:1. Blade count of both compressor sections is to be 1,700 blades combined. Three stages have variable geometry. There is a split case around the first two HP stages, with a ring case around the last three stages.

Combustor. An annular low-NO_x burner is standard, and the combustor has made use of the TALON II impingement film FloatWall™ configuration that employs a multisectional air-cooled liner for greater durability.

The TALON™ (Technology for Affordable Low NOx) combustor takes the previous combustor design and basically adds a fuel-flow divider valve and new fuel nozzles, as well as a plug-in electronic engine control module to schedule fuel flow for the lowest possible gaseous emissions. The TALON is also used on the PW4098, while the TALON II (differing in mounting structure) is used on PW4158 engines on the Airbus A300 and PW4168 engines on the Airbus A330.

High-Pressure Turbine. Single-stage HP turbine of a low-cost, single-crystal alloy. The engine's blade life target is 17,000 hours.

Low-Pressure Turbine. A three-stage LP turbine is standard, with cooled first-stage vanes. A single-piece Waspaloy case encases both turbine sections.

Exhaust. Twelve-lobed exhaust mixer of Inconel 625. Single-piece exhaust case is made of C263 alloy.

	Metric Units	U.S. Units
Dimensions		
Length, flange to flange	2,784 ± 0.96 mm	108.208 ± 0.037 in
Nominal diameter (fan case)	1,585 mm	62.4 in
Maximum Radial Projection	1,153 mm	45.419 in
Weight, dry (basic engine)(a)	2,449 kg	5,400 lb

(a) Basic engine, including P&W-supplied engine build-up (EBU) components.

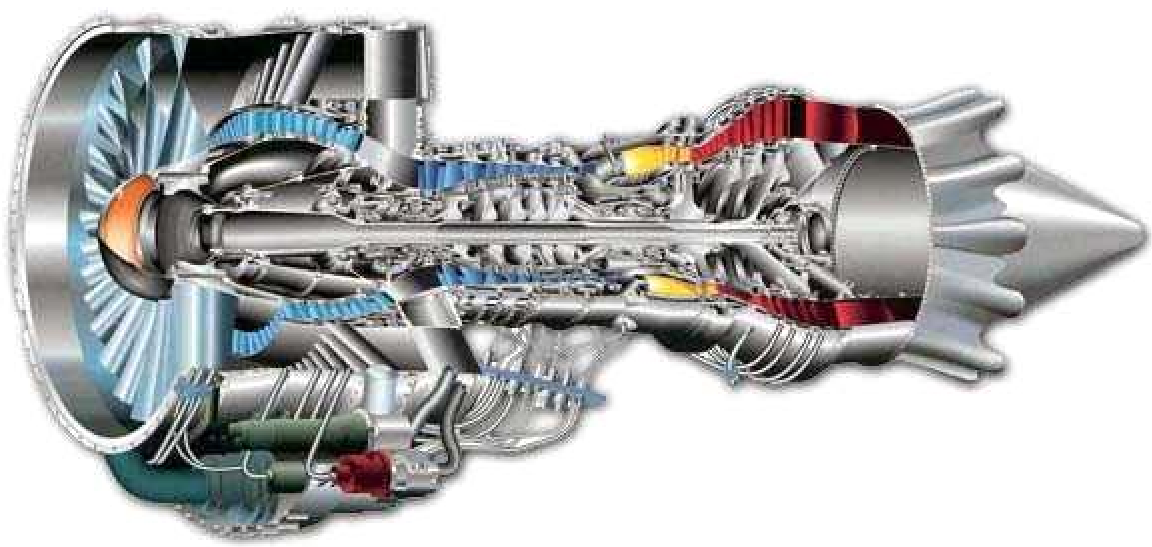
Performance. The following are performance data as contained in the U.S. FAA Type Certificate Data Sheet (TCDS) E00064EN, Revision 1, January 18, 2005:

	Metric Units	U.S. Units
S/L Static Thrust		
Maximum Continuous		
PW6122A	90.3 kN	20,300 lbst
PW6124A	98.3 kN	22,100 lbst
T-O (5 minutes)		
PW6122A	92.9 kN	20,900 lbst
PW6124A	105.8 kN	23,800 lbst
Turbine Exhaust Gas Temp.		
Maximum Continuous	727°C	1,340°F
T-O (5 minutes)	760°C	1,400°F
LP Rotor (N1) Speed		
LP Rotor Speed (maximum)	6,360 rpm	6,350 rpm
Ground Idle (minimum)	1,325 rpm	1,325 rpm
Flight Idle (minimum)	1,700 rpm	1,700 rpm
HP Rotor (N2) Speed		
Steady State (maximum)	18,850 rpm	18,850 rpm
Ground Idle (minimum)	11,000 rpm	11,000 rpm
Flight Idle (minimum)	11,000 rpm	11,000 rpm

Note: For both the PW6122A and PW6124A, the uninstalled thrust values are based on static test stand operation under the following condition: the engine inlet is a Pratt & Whitney production hardwall bellmouth (P/N XR-588946-2) with a 0.998 inlet recovery production exhaust system having no compressor air bleed and no accessory power extraction. The installed thrust levels are derived using engine performance simulation CCD826-01.1.

For the PW6122A. Installed values for T-O and maximum continuous thrust are 21,330 lbst and 19,570 lbst, respectively, at S/L static, ICAO standard atmospheric conditions.

For the PW6124A. Installed values for T-O and maximum continuous thrust are 22,980 lbst and 20,260 lbst, respectively, at S/L static, ICAO standard atmospheric conditions.



PW6000

Source: Pratt & Whitney

Pratt & Whitney PW6000

Variants/Upgrades

The PW6000 is available in two models for the Airbus A318: the PW6122A and the PW6124A. The basic PW6122-1D and PW6124 models were deleted from FAA TCDS E00064EN on December 22, 2004, at the request of Pratt & Whitney. The FAA applications for the PW6122A and PW6124A were made on June 30, 2003; their certificates were issued on November 10, 2004.

Program Review

Background. The PW6000 is based on several years' work by Pratt & Whitney on the best way to address the emerging 100-passenger market. In tailoring this engine specifically for this market, Pratt & Whitney is taking advantage of decades of experience with the JT8D engine, the most popular jet in commercial aviation history and the engine that created the 100-passenger market. This service experience with 350 operators around the world provides an enormous base from which to market a 100-passenger airplane.

"Like the original JT8D, we have designed the PW6000 just for the 100-passenger market," said Tom Davenport, vice president for Small Engines, who heads the PW6000 effort. "We have talked with airlines all over the world and the message has come in loud and clear."

Pratt had been trying to develop a successor to the JT8D for more than a decade, working alternately with MTU, then GE, and the Japan Aero Engine Corporation as well. It developed paper engines for new 100-seat designs, which were eventually aborted. New leaps in efficiency were attempted, but in the latest airline order cycle it became clear that airlines preferred reliability and maintainability improvements to efficiency. Pratt worked directly to those requirements in designing the PW6000.

The PW6000 has fewer compressor and turbine stages and relatively moderate operating pressures and temperatures to give dependable performance and long part lives. For instance, there are about one-third fewer blades and vanes in the PW6000 than in comparable engines.

Compressor airfoils are three-dimensionally optimized for high efficiency. The fan is a solid, shroudless, wide-chord design for performance and ruggedness. The PW6000 has a single-stage, high-pressure turbine built with conventional materials to keep down maintenance costs in this key engine module. The annular burner will achieve emissions well below current or projected regulations.

Pratt & Whitney created its own flying testbed for the new PW6000. P&W acquired a used Boeing 720 aircraft that was converted into a flying testbed with the installation of advanced test gear and the removal of one of the aircraft's four original Pratt & Whitney JT3D engines. In its place, a special pylon was mounted on the PW6000 for a series of developmental flight tests beginning in April 2000. The first flight on the A318 was made on January 15, 2002.

Northrop Grumman's Commercial Aircraft Division and Hispano-Suiza have designed, developed, and manufactured the PW6000 nacelle, thrust reverser, and associated hardware. Hamilton Sundstrand provides the Full Authority Digital Engine Control (FADEC), starter, gearboxes, and associated pumps, valves, and actuators. Mitsubishi provides combustor components.

Airbus A318. The Airbus A318 narrowbody regional aircraft has a maximum T-O weight (MTOW) of 149,915 pounds (68,000 kg) and a range with maximum passengers of 1,500-3,250 nautical miles (2,750-6,000 km).

The A318 was launched with the PW6000 engine as the sole, but not exclusive, powerplant. CFM International secured a position as the second engine provider with the CFM56-5BA in July 1999. At the start of 2005, 18 aircraft with CFM56 engines and two aircraft with PW6000s had been delivered.

Bombardier CSeries. Bombardier shelved plans for a 100+ seat BRJ-X regional jet in 2000 and made overtures to Airbus and Boeing regarding collaboration on a new family of regional jets to span the 110- to 135-seat-passenger-capacity spectrum. Neither the consortium nor the U.S. manufacturer chose to participate.

At the beginning of 2005, Bombardier had decided on a 110-seat version and a 130-seat version, with each to be available in long-range (3,000-nm) and short-range (1,800-nm) variants. The manufacturer is targeting the CSeries as the replacement for aging 737s, DC-9s, MD-80s, BAe 146s, and Fokker 100s.

Bombardier announced in January 2006 that it would not continue with development of the CSeries, as market conditions did not justify launching the program at that time. Instead, Bombardier's resources were being shifted to regional jet and turboprop opportunities.

Bombardier relaunched the CSeries program in July 2008 based on a Letter of Intent for up to 60 aircraft from Lufthansa. The new jet will be powered by Pratt's PW1000G geared turbofan and will be offered in 110- and 130-seat variants. The current world economic climate is not optimal for launching a new program such as this, but Bombardier is betting on the situation to improve. When fuel prices begin rising with an economic recovery, airlines will need to replace older, less efficient aircraft with new designs offering lower operating costs.

PW6000 Engine Assembly Location. In January 2004, P&W announced that it was transferring final assembly and testing of PW6000 engines to MTU in Germany as part of a cost-cutting and marketing effort aimed at boosting the sales potential of the A318. While MTU has assembled numerous military engines in the past, the PW6000 marks the first time it will assemble a commercial engine. MTU will assemble the engines in Hanover on a flowline currently used for engine disassembly, maintenance, and reassembly.

Funding

The costs to P&W of developing the PW6000 to this point have not been revealed. Pratt & Whitney estimates that the development cost of the PW6000 will reach $500 million. No U.S. government funding for the PW6000 has been identified.

Timetable

Month	Year	Major Development
	1995	Component testing begun
Dec	1996	Rig testing of PW6000's low-NOx annular combustor
	1997	Core testing
Jul	1998	Start of final detail design process
Sep	1998	PW6000 selected for Airbus A318
Nov	1998	ILFC becomes launch customer for Airbus A318/PW6000
Apr	1999	Airbus formally launches A318 program
Jul	1999	First Engine to Test
Aug	2000	Engine flight testing begun
Jan	2002	First flight on A318
Mid-	2002	Air China cancels order for eight PW6000-powered A318s
Early	2004	P&W decides to shift engine final assembly and test to MTU in Germany
May	2004	America West cancels order for 15 PW6000-powered A318s
Nov	2004	PW6122A, PW6124A certificated by U.S. FAA
Dec	2005	PW6000 receives EASA certification on Airbus A318
Mar	2007	First flight of A318 with production PW6000 engines
Jun	2007	PW6000-powered A318 enters service with LAN airlines
	2010	PW6000 assembly line on standby

Worldwide Distribution/Inventories

As of April 2010, at least 47 PW6000s had been built by Pratt & Whitney, including engines for development and testing.

Forecast Rationale

Pratt & Whitney's PW6000 series has one application, Airbus' A318. The A318 never lived up to its promise as a short-haul aircraft, instead losing out to regional jets from Bombardier and Embraer. Early issues with the PW6000's fuel consumption forced Pratt to redesign the HPC, adding a stage. During this time, several of the engine's original customers switched to the CFM56-5 engine also offered on the A318. Pratt's marketing focus was on the lower maintenance cost vs. overall fuel consumption. In the end, the A318 couldn't compete with the superior economics of regional jets.

With no current orders for the engine, the final assembly line in Hanover, Germany, is officially on standby.

Pratt & Whitney PW6000

Ten Year Outlook

We are not forecasting any production of the PW6000 series at this time.

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