PurePower®
PW1000G Engine News

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This Changes Everything.™

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PurePower engine family continues to expand

PW1000G engine to power aircraft from 70 seats to well beyond 200 seats

This month, Airbus selected the award-winning Pratt & Whitney geared turbofan™ engine as an ultra-efficient new engine option (neo) for the A320neo aircraft family. This new option means that airlines and leasing companies around the world will now be able to choose PW1000G engine power, from 70-seat regional jets to 200-seat mid-range jets—and beyond. With this selection, the PW1000G engine family will become Pratt & Whitney's highest-volume program since the JT8D.

The PW1100G engine program for the A320neo family will range from 24,000 to 33,000 pounds of thrust. It will feature an 81-inch fan diameter and 12:1 bypass ratio, delivering double-digit improvements in fuel efficiency and environmental emissions, as well as a 50% reduction in noise. It will employ the same geared architecture which is now entering the engine testing and certification phase for the Mitsubishi Regional Jet and Bombardier CSeries aircraft families.

Pratt & Whitney's family approach to our geared turbofan engines means that operators can now rely on a common architecture throughout their fleet—not to mention the quietest, most fuel-efficient engines on the market. The PW1000G engine family is based on the scalable design of three systems, which have already been proven in unprecedented rig, ground and flight testing:

- A high-efficiency, super-quiet, lightweight geared fan, driven by the highly durable Fan Drive Gear System (FDGS),
- A state-of-the-art, high-speed low-pressure system, where each module achieves higher efficiency, lower weight, and reduced part count, when compared to conventional engine design,
- The high-performance PurePower engine core, designed to meet the high-cycle demands of short-haul operators.

Airbus A320neo aircraft, powered by the PurePower PW1000G engine.
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Update on PW1000G first engines to test

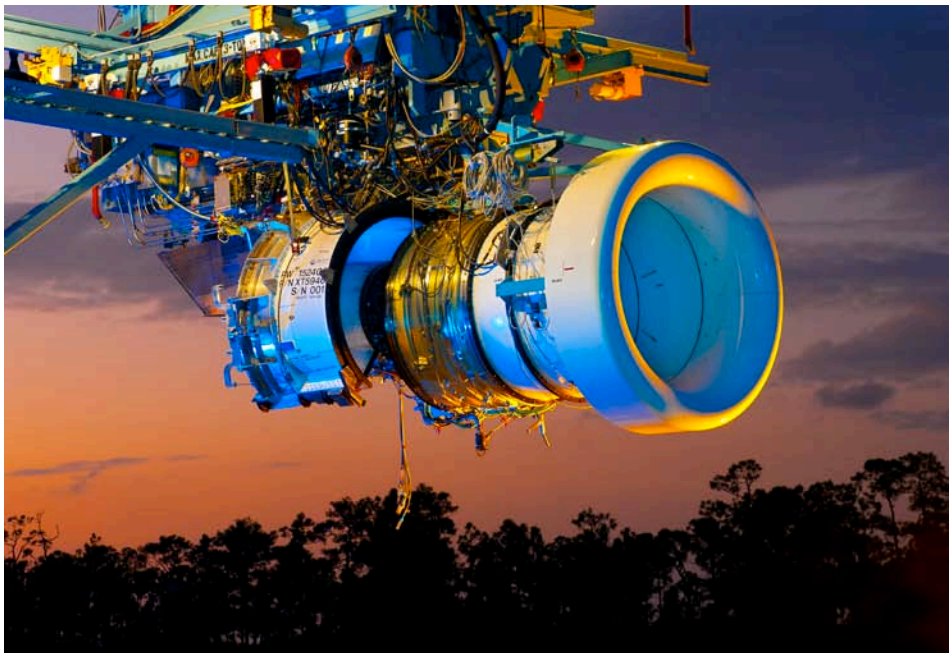
Testing continues for the first Bombardier CSeries engine, while the first engine for the MRJ is being built

Testing of the PW1000G first engine to test (FETT) continues on schedule. We are currently running the first PW1000G engine for the Bombardier CSeries aircraft family. The main objective of this test vehicle is to validate low rotor stress and vibration characteristics, from idle to full power. To date, we have completed more than 100 hours of testing at our outdoor facility in West Palm Beach, Florida.

The PW1000G FETT is demonstrating unprecedented levels of maturity. The Fan Drive Gear System (FDGS) and oil system are performing as expected, from idle to redline speeds, which repeats the high maturity confirmed in previous testing. Module-level performance is matching our pre-test forecasts. To date, we have validated full engine operability, fuel and lubrication systems, and overall mechanical characteristics.

In the meantime, we continue to build the first PW1000G engine for the Mitsubishi Regional Jet (MRJ), which will arrive at the test stand in early 2011. Both the CSeries and MRJ engine programs will run an eight-engine validation and certification program over 24 months. Each of the first four engines is dedicated to validation work, while each of the next four engines will conduct the formal certification testing. Certification and first flight of these initial PW1000G engine models is expected in 2012.

According to Graham Webb, Chief Engineer, Next Generation Product Family, "This engine is running so well, we've decided to extend the run program to include endurance testing. The years we've spent focused on technology development and maturation are clearly paying off."



The first PW1000G engine for the Bombardier CSeries aircraft family, running on the test stand in West Palm Beach, Florida.

Fan Drive Gear System (FDGS) passes fan blade-out demonstrator test

FDGS withstands 15,000 simulated take-offs after enduring fan blade release loads

Pratt & Whitney recently revealed to the public that it had built a second full-scale demonstrator engine in 2008. While the one engine took to the sky to prove the geared turbofan™ (GTF) engine architecture, the other—demo engine #2—was used for a load calibration test, which validated Pratt & Whitney's engineering models and demonstrated that the Fan Drive Gear System (FDGS) would safely withstand a fan blade-out (FBO) event.

Demo engine #2 was identical in construction to demo engine #1: a PW6000 core wrapped with the GTF architecture, including an 80-inch, solid titanium fan. After running about 30 hours, the FBO event was initiated at full redline speed. By inducing the liberation of a single fan blade, engineers were able to test the capability of the gear system to withstand forces that would be encountered under similar, real-world conditions. Testing results revealed that the FBO loads were not transmitted through the FDGS, but were instead transferred to the engine case, per design intent.

The FDGS was salvaged and inspected for wear and damage, which were both found to be at negligible levels. To further demonstrate the robustness of the gear design, the FDGS was re-assembled and re-installed in the FDGS rig. It then ran a 15,000-cycle endurance test, in which it performed flawlessly, with no part requiring replacement. This result is a testament to over 20 years of design maturation, and to Pratt & Whitney's commitment to deliver products worthy of the name "Dependable Engines."

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Pratt & Whitney opens new facilities for PurePower® engine testing

State-of-the-art Mirabel flight test operations and Manitoba icing facility

In October, we inaugurated the Mirabel Aerospace Centre at Montréal-Mirabel International Airport in Canada. This state-of-the-art facility will support flight testing for PurePower engine programs, as well as final assembly and test for production engines. It will be home to two Boeing 747SP flying test beds, which will be used in validation and certification testing of the PurePower engine family. The Mirabel facility will also house final assembly and test operations for the PurePower PW1000G engine for the Bombardier CSeries aircraft family, as well as for the PW800 engine, for the next generation of large business jets. This 300,000-square-foot, $360 million (CAD) facility will be capable of testing the full range of Pratt & Whitney engines, from turboprops to future geared turbofan™ engines generating up to 90,000 pounds of thrust.

In October, we also opened the Global Aerospace Centre for Icing and Environmental Research (GLACIER)*, a state-of-the-art cold weather testing and research facility for aircraft engines in northern Manitoba, Canada. Located in a sub-arctic climate zone, the Manitoba facility is an ideal location to test commercial aircraft engines using natural weather conditions, including the PurePower family of engines. This $42 million (CAD) facility will accommodate future engines of up to 150,000 pounds of thrust, with fan diameters of up to 140 inches—leaving plenty of room for the next generation of engines.

Pratt & Whitney 747SP flying test bed (FTB) in PurePower Engines livery. It will test PW1000G engines for the Bombardier CSeries, Airbus A320neo, and Irkut MC-21 aircraft families.

The new Pratt & Whitney Canada 747SP flying test bed (FTB). It will test the PW1000G engine for the Mitsubishi Regional Jet (MRJ), as well as the PurePower PW800 engine series, for the next generation of large business jets.

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* The Global Aerospace Centre for Icing and Environmental Research (GLACIER), Inc. is a limited joint venture company comprising Rolls-Royce Canada and Pratt & Whitney Canada.

PurePower® PW1000G Engine Product Card

A comprehensive family of engines

PurePower Engines are Pratt & Whitney's next generation of engines, which offer double-digit improvements in fuel consumption, noise, environmental emissions, and operating costs. To date, PurePower Engines comprise two engine families: the PW800 engine family by Pratt & Whitney Canada, which will power the next generation of large business jets, and the PW1000G—or geared turbofan (GTF)—engine family. Common between the PW800 and PW1000G engine families is the PurePower engine core: a high-performance core built for the demands of high-cycle, short-haul operation.

How can one core meet the demands of so many aircraft? The answer is two-fold. First, Pratt & Whitney and partner MTU Aero Engines collaborated to design a state-of-the-art core that would be fully capable from 10,000 to 40,000 pounds of thrust. Second, scaling an engine core over this range was further enabled by the unique advantages of GTF engine architecture. Because GTF engines can slow the fan while greatly increasing the speed of the low-pressure modules, the low-pressure compressor (LPC) is able to "supercharge" the air before it enters the high-pressure compressor (HPC). In turn, that means fewer HPC stages are required to accomplish the same work at an engine level. The end result for operators? A lighter-weight core with fewer parts, which is easier to maintain, with hundreds fewer airfoils and two fewer life-limited parts (LLPs). All this, with the same core across two families of engines, meaning operators will also benefit from the higher maturity that comes with so many more hours of experience.

The numbering scheme for each PW1000G engine model follows the same historical Pratt & Whitney pattern: the first number represents the generation—in this case, 1 or 1,000. The second number denotes the customer: 1 for Airbus, 2 for Mitsubishi, 4 for Irkut, and 5 for Bombardier. The last two numbers indicate the thrust class: 24 for 24,000 pounds of thrust, and so forth. And finally, the "G" stands for a geared turbofan engine. Below, the full PW1000G engine product table is listed in order of thrust.

PurePower® PW1000G Engine Family				
Engine Type	**geared turbofan™ (GTF) engine with scaled engine core** current models from 10,000 to 40,000 pounds of thrust			
Engine Program	PW1200G	PW1500G	PW1100G	PW1400G
Aircraft Family	Mitsubishi Regional Jet	Bombardier CSeries	Airbus A320neo	Irkut MC-21
Aircraft Models	MRJ70 MRJ90	CS100 CS300	A319neo A320neo A321neo	MC-21-200 MC-21-300 MC-21-400
Passenger Capacity	70-96	100-145	124-220	130-230
Engine Models (thrust in pounds-force)	PW1215G 15,000 lbs PW1217G 17,000 lbs	PW1521G 21,000 lbs PW1524G 23,300 lbs	PW1124G 24,000 lbs PW1127G 27,000 lbs PW1133G 33,000 lbs	24,000 lbs to 33,000 lbs
Architecture	1-G-2-8-2-3	1-G-3-8-2-3	1-G-3-8-2-3	1-G-3-8-2-3
Bypass Ratio (BPR)	9:1	12:1	12:1	12:1
Fan Diameter	56 inches	73 inches	81 inches	81 inches
Entry into Service (EIS)	2014	2013	Spring 2016	2016

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