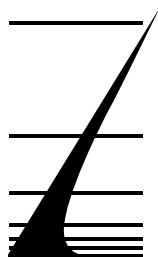


# The Market for Aviation Turbofan Engines

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Product Code #F640

A Special Focused Market Segment Analysis by:



**FORECAST** INTERNATIONAL



# Analysis 1

## The Market for Aviation Turbofan Engines

### 2010-2019

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# PROGRAMS

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The following reports are included in this section: (**Note:** a single report may cover several programs.)

Aviadvigatel JSC Turbofan Engines  
CFM International CFM56  
Engine Alliance GP7000  
Eurojet EJ200  
GE Honda HF120  
General Electric CF6-80C2/E1  
General Electric CF34  
General Electric F110  
General Electric F404/F414  
General Electric GE90  
General Electric GENx  
General Electric/Rolls-Royce F136  
GTRE GTX-35  
Honeywell HTF7000  
Honeywell TFE731  
International Aero Engines V2500  
Motor Sich/Progress (ZMKB) Turbofan Engines  
PowerJet SaM146  
Pratt & Whitney Canada JT15D  
Pratt & Whitney Canada PW300 Series  
Pratt & Whitney Canada PW500  
Pratt & Whitney Canada PW600  
Pratt & Whitney F100  
Pratt & Whitney F117  
Pratt & Whitney F119  
Pratt & Whitney F135  
Pratt & Whitney PW1000G  
Pratt & Whitney PW4000  
Pratt & Whitney PW6000  
Rolls-Royce AE 3007  
Rolls-Royce BR700 Series  
Rolls-Royce RB211/Trent  
Rolls-Royce Tay  
Rolls-Royce Turbomeca Adour  
Saturn Turbofan Engines  
Snecma M88  
Volvo/GE RM12  
Williams International FJ33/FJ44



## Introduction

This analysis explores the market forces influencing the aero-turbine engine market and indicates the direction in which the aero-turbine industry is headed over the next 10 years.

The programs reviewed for this analysis are covered in depth in the reports found in the *Aviation Gas Turbine Forecast*. These programs are:

Aviadvigatel PS-90A  
CFM56  
Engine Alliance GP7200  
Eurojet EJ200  
General Electric CF6  
General Electric CF34  
General Electric F110  
GE/Rolls-Royce F136  
General Electric F404  
General Electric F414  
General Electric GE90  
General Electric GEnx  
HAL GTX-35VS  
Honeywell HTF7000  
Honeywell TFE731  
International Aero Engines V2500  
Motor Sich/Progress D-18T  
Motor Sich/Progress D-436, D-436T  
Klimov RD-33  
Klimov RD-35

Klimov RD-93  
PowerJet SaM146  
Pratt & Whitney F100  
Pratt & Whitney F117  
Pratt & Whitney F119  
Pratt & Whitney F135  
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Pratt & Whitney PW4000  
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Pratt & Whitney Canada JT15D  
Pratt & Whitney Canada PW300  
Pratt & Whitney Canada PW500  
Pratt & Whitney Canada PW600  
Rolls-Royce AE 3007  
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Rolls-Royce RB211  
Rolls-Royce Tay  
Rolls-Royce Trent  
RR/Turbomeca Adour  
Saturn AL-31F/FN  
Saturn AL-55 F/I  
Sneema M88  
Volvo/GE RM12  
Williams International FJ33  
Williams International FJ44

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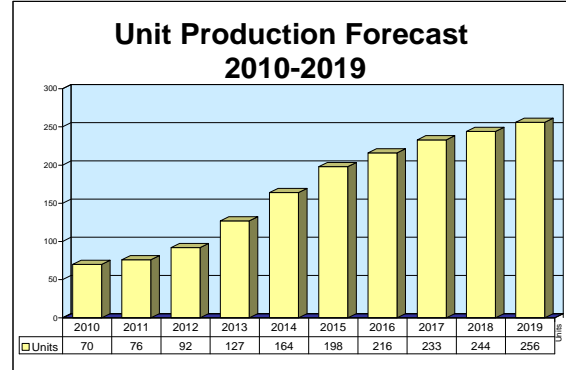




# Honeywell HTF7000

## Outlook

- Honeywell testing new Saber combustor for the HTF7500E
- Embraer Legacy 450/500 service entry coincides with forecast market recovery



## Orientation

**Description.** Two-shaft, axial-centrifugal-flow turbofan engine in the 6,500-7,500-lb class (29.2-33.7 kN).

**Sponsor.** The HTF7000 was privately developed by the prime contractor.

**Status.** Currently in production for Challenger 300.

**Total Produced.** As of June 2010, an estimated 613 engines had been produced, including 11 test units.

**Application.** Midsize business jets and 30- to 50-passenger regional jet aircraft.

**Price Range.** Estimated at \$1.7 million in 2010 U.S. dollars.

**Competition.** The HFT7000 faces competition from the 6,500-7,500 lb (28.9-33.3 kN) Pratt & Whitney Canada PW308, as well as from the 7,000-lb (31.1-kN) Rolls-Royce AE 3007.

## Contractors

### Prime

<b>Honeywell Aerospace, Engines, Systems &amp; Services</b>	<a href="http://www.honeywell.com">http://www.honeywell.com</a> , 111 S 34th St, Phoenix, AZ 85034-2892 United States, Tel: + 1 (602) 231-1000, Fax: + 1 (602) 231-5713, Prime
-------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

### Subcontractor

<b>AAC Action Air Corporation</b>	<a href="http://www.actionaircorp.com">http://www.actionaircorp.com</a> , 13864 Magnolia Ave, Unit E, Chino, CA 91710 United States, Tel: + 1 (909) 590-4889, Fax: + 1 (909) 590-4887, Email: <a href="mailto:sales@actionaircorp.com">sales@actionaircorp.com</a> (Fan)
<b>Barden Corp</b>	<a href="http://www.bardenbearings.com">http://www.bardenbearings.com</a> , 200 Park Ave, PO Box 2449, Danbury, CT 06813-2449 United States, Tel: + 1 (203) 744-2211, Fax: + 1 (203) 744-3756 (Main Shaft & Accessory Ball Bearings)
<b>Eaton Aerospace - Hydraulic Systems Division</b>	<a href="http://www.aerospace.eaton.com">http://www.aerospace.eaton.com</a> , 5353 Highland Dr, Jackson, MS 39206-3449 United States, Tel: + 1 (601) 981-2811, Fax: + 1 (601) 987-5255 (Vane-Type Fuel Pump)
<b>GKN Aerospace - Cowes, Integrated Propulsion Systems</b>	<a href="http://www.gknaerospace.com">http://www.gknaerospace.com</a> , Ferry Rd, East Cowes, PO 32 6RA Isle of Wight, United Kingdom, Tel: + 44 1983 294 101, Fax: + 44 1983 291 006 (Nacelle)
<b>Goodrich Fuel &amp; Utility Systems</b>	<a href="http://www.goodrich.com">http://www.goodrich.com</a> , 197 Ridgedale Ave, Cedar Knolls, NJ 07927 United States, Tel: + 1 (973) 267-4500, Fax: + 1 (973) 734-7982 (Wiring Harness)

## Honeywell HTF7000

<b>Industria de Turbo Propulsores SA</b>	<a href="http://www.itp.es">http://www.itp.es</a> , Parque Tecnológico, Edificio 300, Zamudio, 48170 Spain, Tel: + 34 9 44662100, Fax: + 34 9 44662193 (LP turbine)
<b>Unison Industries</b>	<a href="http://www.unisonindustries.com">http://www.unisonindustries.com</a> , 7575 Baymeadows Way, Jacksonville, FL 32256 United States, Tel: + 1 (904) 739-4000, Fax: + 1 (904) 739-4093 (Exciter)

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

## Technical Data

**Design Features.** The Honeywell Engines HTF7000 has the following design features:

**Fan.** Wide-chord fan of 34.2 inches (86.8 cm) diameter providing a bypass ratio of 4.2:1. Solid titanium blades. The fan is driven directly by the LP turbine.

**LP Compressor.** Four-stage axial LP compressor with integrally bladed rotors. Two variable stator stages.

**HP Compressor.** Single, centrifugal HP compressor.

**Combustor.** Effusion-cooled combustor.

**HP Turbine.** Two-stage HP turbine.

**LP Turbine.** Three-stage LP turbine.

**Accessories.** Dual-channel FADEC with built-in diagnostics.

**Performance.** Flat-rated at 6,500 lbst (28.6 kN), the HTF7000 delivers 1,910 lbst (8.4 kN) at cruise with a specific fuel consumption of 0.642 lb/hr/lbst (0.291 kg/hr/kgst).



HTF7000

Source: Honeywell Aerospace

## Honeywell HTF7000

## Variants/Upgrades

**AS907.** Honeywell's former AS907 (now HTF7000) is flat-rated to 7,595 lbst (33.8 kN). The first certificated variant, the AS907-1-1A, is rated 6,944 lbst (30.89 kN) at takeoff at sea level, ISA +20°C. Powering the Bombardier Challenger 300, the engine is flat-rated to 6,500 lbst. The engine has fewer parts than its LF507 predecessor, and is made of conventional hot section materials offering wide operating margins and a 15,000-cycle disc life. The engine's fan, LP turbine, accessory gearbox module, and main shaft bearings and seals are all "maintenance on condition" rated, and can be inspected on-wing. The engine has extensive diagnostic/troubleshooting capabilities and can undergo

maintenance at fixed intervals, or be serviced under an "on-condition" maintenance program.

**AS977.** The AS977 was selected to power the British Aerospace Regional Aircraft (BAE) Avro RJX over the P&WC PW308. The engine was to provide 15 percent lower SFC, 5 percent more thrust on climb-out, and a 20 percent maintenance savings compared with the Honeywell LF507.

Development of this engine variant was suspended upon termination of the BAE RJX program. The remaining variant is now known as the HTF7000.

## Program Review

**Background.** The AS900 was conceived as a successor to the LF500 series of engines that power the British Aerospace Avro RJ series of jets.

Development of the AS900 began in 1996, and a test unit for gas generator technology validation was developed in 1997. Bombardier formally launched the AS900 development program in 1998 when the engine was selected to power its new Continental (now Challenger 300) medium business jet. Shortly thereafter, at the 1998 Farnborough Air Show, the AS900 was announced as the engine that would power the RJ series successor, the RJX 70-, 85-, and 100-seat aircraft.

The key development driver of the AS900 is low cost of ownership. An 11-member airline advisory board made it clear to Honeywell that low cost of ownership was its primary consideration when comparing the new engine with the LF507 powering the BAE/Avro RJ series aircraft. The desired reductions in ownership costs were stated as being 20 to 30 percent lower direct maintenance costs and 15 percent better fuel consumption. A minimum 12,000-hour on-wing time was also specified. The engine's fan, low-pressure turbine, high-pressure turbine, and combustor can all be replaced on-wing. Only 13 standard tools are required for maintenance of an engine. All discs are designed for 25,000 cycles (takeoffs and landings), rising from 15,000 hours at service entry.

Looking at Honeywell's partners, AIDC of Taiwan is designing and building the engine's fan, Techspace is building the rotating LP turbine hardware, ITP is producing the static structures of the LP turbine, and GKN Aerospace is developing the engine's nacelle as a partner to Honeywell. The engine, developed as a fully integrated powerplant system, includes the nacelle, thrust reverser, and engine mounting accessories.

**Applications.** Applications for the AS900 engine include the following:

**Bombardier Challenger 300.** Bombardier announced the Continental Jet (since renamed Challenger 300) at the 1998 NBAA show. The jet seats eight and offers a cruising speed of Mach 0.8 and a range of 3,100 nautical miles with seats filled. The aircraft is targeted at the so-called super midsize market segment, which is occupied by types such as the Citation X and Citation Sovereign, Falcon 50EX, Gulfstream G200, and Hawker Horizon. Sovereign and Horizon are seen as the closest competitors.

For the Challenger 300, the HTF7000 is flat-rated to 6,500 lbst, ISA +15°C, with 10 percent thrust growth possible through Full Authority Digital Engine Control (FADEC) rescheduling.

The Challenger 300 first flew in August 2001. Bombardier twice slipped the aircraft's certification target date, first into the first quarter of 2003 and then to the second quarter. In May 2003, the first AS907 Integrated Propulsion System, including engine, nacelle, thrust reverser, and accessories, was delivered to Bombardier for installation aboard a Challenger 300. Receiving FAA and JAA certification in 2002, the AS907 won *Flight International's* Aerospace Industry Award for Business & Corporate Aviation after moving from announcement to certification in just 40 months. The engine's designers were commended for achieving a high level of durability and ease of maintenance. All line-replaceable units can be changed using just 13 simple hand tools.

**Name Changed to HTF7000.** In late 2003, Honeywell revamped its designation protocol, changing the AS907's name to HTF7000 (HTF for Honeywell Turbo Fan and 7000 for the thrust class in pounds).

## Honeywell HTF7000

Honeywell models already in production were not renamed, but the AS907 had not yet entered service, and was redesignated using the new naming protocol, which would be applied to all forthcoming Honeywell engines.

**BAE Systems Avro RJX.** The Avro RJX craft were essentially re-engined Avro RJ-design aircraft of 70, 85, and 100 seats. The four-engined aircraft were to be short-haul regional jets with exceptionally low-noise and short-field performance, particularly in hot or high-altitude situations.

The first RJX, an RJX-85, flew for the first time in 2001.

In November 2001, BAE announced it was shutting down its Regional Aircraft Ltd division and terminating the RJX programs. The decision was made in the aftermath of the events of 9/11. Demand had softened for the RJ series, and the manufacturer had lined up only 14 firm RJX orders at that time.

BAE completed two RJ85s and two RJ100s that were on the line at Woodford; the unfilled RJX orders were canceled.

**Gulfstream G250.** Gulfstream announced its new G250 at the NBAA show in October 2008. The G250 is a super midsize jet offering the longest range in its class, along with the largest cabin and the fastest speed. Gulfstream selected the 7,445-lb HTF7250G for the new jet; first flight occurred in December 2009 and certification is scheduled for 2011.

**Embraer Legacy 450/500.** Embraer announced the names of the newest additions to its executive jet product line at EBACE in Geneva in May 2008. The Legacy 450 and Legacy 500 will compete in the mid-light and midsize business jet segments; both are powered by Honeywell's HTF7500E, although the 500's engines have a slight increase in thrust. The Legacy 500 is expected to enter service in the second half of 2012, and the Legacy 450 in the second half of 2013.

## Funding

No development funding for the HTF7000 has been identified, though Honeywell has stated that development costs could exceed \$250 million.

## Contracts/Orders & Options

No recent contracts for the HTF7000 series have been identified.

## Timetable

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
early	1996	AS900 development begun
Dec	1997	First run of technology validation core
3Q	1998	AS900 program launched
3Q	1999	First engine to test
Jan	2000	First flight of AS900 on testbed aircraft
Apr	2001	Avro RJX-85 makes first flight
Aug	2001	First flight of Challenger 300
Nov	2001	RJX program terminated
Jun	2002	FAA certification of AS907
Dec	2002	JAA certification of AS907
Dec	2003	AS907 redesignated HTF7000
Jan	2004	HTF7000 enters service on Challenger 300
May	2008	Embraer adds Legacy 450 & 500
Oct	2008	Gulfstream announces G250
Mar	2009	HTF7000 fleet passes 500,000-hour mark
Thru	2016	Continued production/support of HTF7000

## Worldwide Distribution/Inventories

As of June 2010, an estimated 613 HTF7000 series engines had been produced to support the Challenger 300 program, as well as several other aircraft and R&D/test programs.

## Honeywell HTF7000

## Forecast Rationale

Honeywell's HTF7000 series picked up three new applications from Gulfstream and Embraer over the last two years, and continues on Bombardier's Challenger 300.

**Newest Engines to Power Embraers**

The new HTF7500E will appear on Embraer's mid-light Legacy 450 and midsize Legacy 500 jets and feature an upgraded Saber (single annular burner for emission reduction) combustor. The first versions of this combustor will appear on other HTF7000 variants, expected to enter service in 2011. As of this writing, the final combustor design had not been finalized. Honeywell's first-generation RQL (rich/quench/lean) combustor is nearing certification (expected in Q3) and promises a 25 percent reduction in nitrous oxide (NOx) emissions compared to comparable current engines. This new combustor will be incorporated into production engines early in 2011. A more advanced combustor that is expected to reduce NOx emissions to around 50 percent is in development.

**HTF7250G in Flight Testing**

Gulfstream's super midsize G250 is in flight testing, powered by the 7,445-lb-st HTF7250G engine. The program involves three aircraft and will reportedly last 1,300 hours. Certification is expected in 2011, with service entry occurring later that year. The G250 will replace the Pratt Canada-powered G200.

**Honeywell Awarded FAA Contract**

Honeywell has been awarded a contract from the FAA for the development of engine technology to reduce fuel consumption and test aviation biofuels. The five-year agreement is valued at \$27 million, and was awarded under the Continuous Lower Energy, Emissions and Noise (CLEEN) program. Honeywell will use its HTF7000-based TECH 7000 test engine as a technology demonstrator.

Overall, we estimate HTF7000 production at 1,676 engines over the next decade.

## Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program	High Confidence					Good Confidence			Speculative			Total
	Thru 2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
<b>Honeywell Aerospace</b>												
<b>HTF7000 &lt;-&gt; Challenger 300</b>												
	607	64	62	61	67	68	71	71	74	74	73	685
<b>HTF7250 G &lt;-&gt; G250</b>												
	4	5	9	13	19	32	43	54	59	60	63	357
<b>HTF7500E &lt;-&gt; Legacy 450</b>												
	0	0	1	6	13	25	38	41	46	50	56	276
<b>HTF7500E &lt;-&gt; Legacy 500</b>												
	0	1	4	12	28	39	46	50	54	60	64	358
<b>Subtotal</b>	611	70	76	92	127	164	198	216	233	244	256	1,676
<b>Total</b>	611	70	76	92	127	164	198	216	233	244	256	1,676



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