Business & commercial Aviation
INFLIGHT REPORT

Inflight Report: Dassault Falcon 900B

In the world of high-altitude, long-range flight, additional power offers noticeable benefits, even for a proven performer such as the Falcon 900.

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Power sets the pace of aviation's progress. Each advancement in aircraft performance has been led by powerplant development. While aerodynamicists can argue that without area-ruling and efficient airfoils powerful engines would be wasted trying to push drag-laden aircraft through the skies, history has shown that the most effective way to improve an aircraft is to add more power.

Adding more power is precisely what Dassault Aviation has done to improve its flagship aircraft, the Falcon 900. Now designated the 900B this three-engine business jet is powered by Garrett's new TFE731-5B turbofans which provide 4,750 pounds I thrust at sea level, ISA + 10° C conditions and 1,050 pounds thrust at FL 400, 0.80 Mach cruise. Compared to the TFE731-5A engines that are installed in the Falcon 900, the -5B offers 5.5 percent more takeoff thrust, 6.5 percent more thrust at altitude and nearly two percent better specific fuel consumption.

Small power advantages never produce large changes in top speed, however, since the power required to overcome drag increases as the cube of the speed increases. For example, eight times more power is required to double speed; even more if drag rises excessively due to Mach effects.

Thus, the added power of the Falcon 900B's TFE731-5B turbofans offers only marginal increases in cruise speed-something on the order of 2.0 percent at 0.80 Mach. But in terms of climb and initial altitude performance, the improvements seem to be significant.

At a constant climb speed and weight, any increase in power produces a corresponding increase in rate of climb. Double the available power and an aircraft ascends at twice its previous rate of climb, provided the weight and climb speed remain unchanged.

Therefore, the greater takeoff power and thrust at altitude available from the Falcon 900B's new Garrett -5B turbofans produces noticeable improvements in the aircraft's operational capabilities in terms of airport performance, time to climb and initial cruise altitude-all very important parameters for today's long-range business aircraft.

GO HIGHER, YOUNG MAN

Higher is better when it comes to turbine aircraft. Specific range, the efficiency with which a turbine engine produces power for each pound of fuel consumed, increases with altitude. Consequently, range is increased. The air is thinner, thus the aircraft's profile drag is less. The winds often are not as strong above FL 400, which can be an advantage on westbound flights.

Under standard conditions a fully loaded Falcon 900B can climb to FL 390 in 26 minutes and achieve an initial Mach number of 0.795, according to Dassault Aviation. The manufacturer says the 900A reaches the same flight level in 29 minutes and has an initial cruise Mach number of 0.764 with ISA temperatures.

By the time each aircraft is prepared to start its first step to a higher altitude, the 900B has reached a speed of 0.811 Mach, compared to the 900A's 0.782 Mach. Specific range for the 900B cruising at 0.80 Mach at FL 410 is 0.244 nm per pound of fuel burned-nearly four percent greater than the 900A's at the same speed. At FL 430 and long-range cruise (0.75 Mach), the 900B will fly 2.51 nm for each 10 pounds of fuel consumed, compared to 2.43 nm per 10 pounds of fuel burned for the 900A.

The quicker climb and faster initial cruising speed of the 900B (compared to the 900A) combine with the Garrett TFE731-5B's higher fuel efficiency to produce greater range, which can be seen graphically in the accompanying performance graphs on page 68.

The 900B's added power is most appreciated when the atmosphere is warmer than standard. With ISA +10° C prevailing, and taking off at maximum gross weight (45,500 pounds for each aircraft), the 900B can reach FL 390 in 33 minutes while its 900A predecessor is unable to climb above FL 370. Such additional performance is especially appreciated during Atlantic crossings where it is not practical to change flight levels once assigned to a specific track.

One engine inoperative ceiling is increased by 2,000 feet at mid weights-from FL 330 for the 900A to FL 350 for the B model in ISA conditions.

Using its ability to climb faster and often higher, the more powerful 900B provides greater operational flexibility than the 900A. As seen in the graphs, the 900B enjoys a range advantage of about 100 nm on trips where the speed and payload of the two aircraft are identical.

For the same payload and range, the 900B can cruise faster-ranging from 0.79 Mach for conditions where the 900A would cruise at 0.75 Mach, to 0.83 Mach where the 900A would achieve 0.82 Mach. If flight is planned for the same cruise speed and range with eight passengers, the TFE731-5B-powered 900B can carry from 900 to 1,800 pounds more payload than the 900A departing from runways of equal length.

IMPROVED AIRPORT PERFORMANCE

Operators may find the 900B's improved airport performance its most useful advantage, particularly when temperatures are above standard. When departing from a sea level airport, the 900B suffers no decrease in range due to elevated temperatures, even when conditions reach 50° C and the aircraft is at its maximum gross weight.

Above 46° C, the 900A experiences a loss in range performance for sea level departures. For example, the 900B can leave Muscat, Oman (elevation 48 feet, runway length 11,760 feet) when the temperature is 50° C and reach London (3,720 nm still air equivalent distance, 85-percent wind reliability) with eight passengers and NBAA IFR reserves and land with about 300 miles of range to spare. Under the identical conditions, the 900A's range is 3,335 nm.

The Falcon 900B'sB's increased power makes a noticeable difference when runway length is short. Departing from a 4,000-foot runway at sea level, ISA+7° C, the 900B with eight passengers and NBAA IFR reserves can fly 3,100 nm, compared to the 900A's range of 2,700 nm. Departing from a relatively short, high and hot airport, such as St. Moritz, Switzerland (elevation 5,600 feet, runway length 5,900 feet) in ISA+12° C conditions, the 900B has a range with NBAA IFR reserves of 3,815 nm, sufficient to reach Montreal, Canada considering 85-percent wind reliability. The 900A's range under identical conditions is 3,400 nm. If atmospheric conditions and range are identical, the 900B requires about 10 to 15 percent less runway, depending on temperature; the higher the temperature, the greater is the 900B's advantage over the 900A.

Since operators rarely use long-range aircraft solely for transoceanic trips or require maximum-range performance on every flight, the ability to tanker fuel or to make a short repositioning flight without refueling prior to a longer leg is a distinct advantage. The 900B, for instance, can depart Washington National with eight passengers and sufficient fuel to fly nonstop to London after an intermediate landing at Teterboro, New Jersey. Such is the aircraft's operational flexibility.

POWERPLANT DIFFERENCES

Garrett succeeded in generating more thrust from the -5B without changing the physical dimensions of its predecessor, the TFE731-5A. Fan speed (N_1), however, was increased 2.4 percent by changing its gear ratio. High-pressure spool speed (N_2) was increased 2.0 percent, and maximum allowable inter turbine temperature (ITT) was increased by 38° F.

A low-pressure compressor fourth-stage disk labyrinth seal was added for better turbine cooling, and means were designed to increase high-pressure turbine blade cooling. The HP turbine nozzles are being manufactured with a new process that offers improved durability, and the first-and second-stage LP nozzles have been strengthened.

Thrust increases come primarily from the -5B's higher fan speed, while the power to drive the fan comes from the higher operating temperatures of the turbine.

To improve fuel efficiency, Garrett engineers made a software change in the TFE731's digital electronic engine control (DEEC), added a fan baffle to reduce windage losses and an aerodynamic fairing to the rear bearing support to reduce pressure losses and

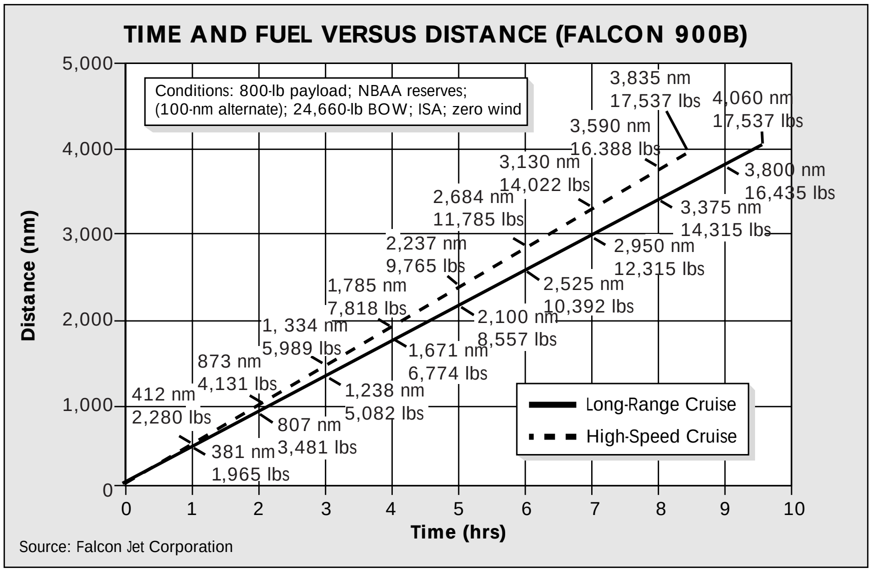
Dassault Falcon 900B

These graphs present range, fuel and payload information that is designed to show the capabilities of the Falcon 900B. The first "Time and Fuel vs Distance" chart depicts the characteristics of the Falcon 900B; the second the 900A. As can be seen, the newer aircraft flies about 100 nm further on essentially the same fuel.

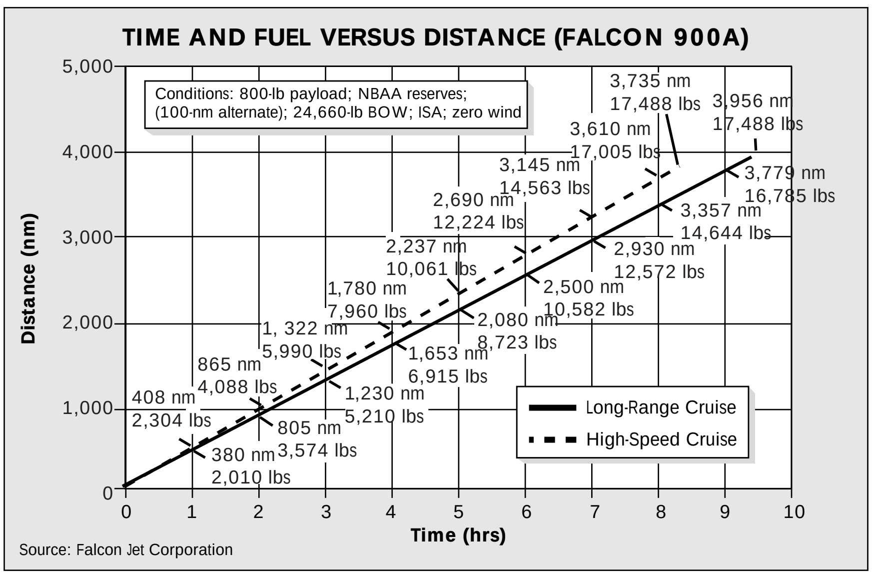
Time and Fuel Versus Distance—These graphs can be read from either axis to determine how far you will go and how much fuel you will consume in a specified time or how much time and fuel are required to travel a desired distance. For example, a mission of about 2,700 nm could be flown in the 900B in approxiamtely six hours while consuming a little less than 12,000 pounds of fuel at high-speed cruise. The same trip in a 900A would require over 400 pounds more fuel to accomplish in about the same time.

Range/Payload Profile—This graph enables you to simulate trips under a variety of payload and airport restrictions at long-range cruise. For example, if you want to estimate the time, fuel and runway requirements for a 900B departing from a sea level airport with a 1,600-pound payload and traveling 3,00 nm, you can find that the trip requires a runway of approximately 4,000 feet, will take about seven hours and consume a bit more than 12,000 pounds of fuel.

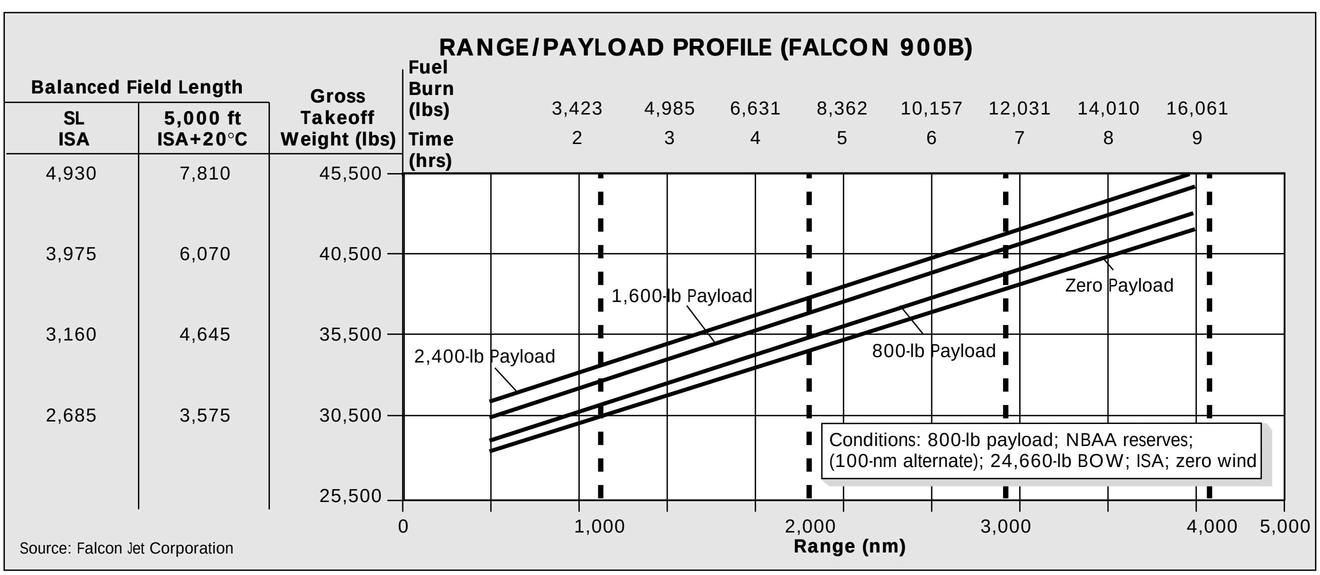
Note–These graphs were prepared by Falcon Jet and are not to be used for flight-planning purposes. Precise performance data will not available until the first five 900Bs are operational and actual data are available from several operators.



TIME AND FUEL VERSUS DISTANCE (FALCON 900B)



TIME AND FUEL VERSUS DISTANCE (FALCON 900A)



RANGE/PAYLOAD PROFILE (FALCON 900B)

Enhanced Warranty

Falcon Jet has enhanced noticeably its warranty program in a concerted effort to improve its reputation in the area of service. The 900B, like other Falcon products, is offered with a parts warranty that covers major airframe items for 10 years or 10,000 flight hours, whichever comes first.

Components manufactured by Dassault or to Dassault specifications are covered for five years or 5,000 flight hours. Standard avionics receive a two-year, 2,000 flight hour coverage. Engines are warranted for three years or 1,000 flight hours. Labor charges are included for the first six months or 500 flight hours after purchase.

Service support also has been given an overhaul in recent years. Over 50 percent of Falcon components and large structural items, have been relocated from the Dassault factory in Bordeaux, France to the United States, and delivery times for all parts ordered have been reduced. In 1989, 12 percent of all items requested were not available to be shipped when ordered, and the average time to fill non-availables was 132 days. Comparable figures today are four percent not available to ship, and 54 days to fill non-available items (including parts that are not inventory and must be manufactured). Items on customer back order today are running at about 25 percent of their 1989 levels.

improved clearance control of the h HP turbine tip shrouds.

Like the -5A, the TFE731-5B is t maintained "on condition" and thus has no TBO. Routine inspections and lubrication are performed at 150 hours with the engine in place. Interim inspections at 600 hours also are accomplished "on the wing," and major periodic inspections (hot sections) are required at 2,100 hours.

Owners of the 900A can upgrade their -5A powerplants to the -5B version for a cost that ranges from $158,500 to $173,500 for each engine currently operating under Garrett's Maintenance Service Program (MSP) and $249,500 for a non-MSP engine. The work typically is done at the time of an engine's major periodic inspections (MPI), and the non-MSP price includes the MPI plus Compressor Zone Inspection (CZI) signoffs. Thus the owner departs with powerplants that have new inspection intervals.

In addition to Garrett charges, there are a number of minor instrument and documentation costs for which Falcon Jet or Dassault are paid. Conversion time takes three weeks, and all engines must be converted at the same time.

FLYING THE 900B

B/CA's opportunity to experience the latest Falcon coincided with the Paris Air Show in June. The 900B we flew had a basic operating weight of 25,186 pounds and was configured with forward and aft lavatories, large forward galley with two high-temp ovens, four meal containers and the normal assortment of accessories, plus an entertainment console featuring the Airshow 200 video system.

Passenger accommodations consisted of four 20-inch seats and two adjustable tables in a forward compartment, two double 20-inch seats and expandable conference table that raises and lowers electrically in a middle compartment, and an aft compartment with two three-passenger sofas, large adjustable table and an electronically controlled clear/opaque glass divider.

Falcon Jet provides many interior options, but the aircraft we flew was considered in keeping with typical configurations being ordered.

Avionics included a complete array of the latest in electronics for flight and navigation. In addition to the standard Honeywell SPZ-8000 Flight Management System, Collins Nav/ Com, Bendix/King high frequency transceiver and Fairchild CVR and FDR, the aircraft was fitted with a Collins TCAS II, Honeywell GPS, a Racal-Dassault Electronique Satcom system, and a Sundstrand MK5 GPWS, among several other attractive electronic goodies. A standard 900B lists for $22.5 million; the aircraft we flew was quoted at approximately $24.2 million.

Departing from Le Bourget and following the standard instrument departure through Parisian airspace, we reached FL 410 in 24 minutes in spite of several climb interruptions caused by ATC and temperatures that reached 11° C above ISA. Our weight at top of climb was 33,436 pounds and our Mach number at 100 percent power was about 0.81.

Adjusting power to high-speed cruise in temperatures that averaged ISA +13° C, we stabilized at 0.80 Mach with ITTs of 868° F; true airspeed was 465 knots and total fuel consumption was 1,959 pounds per hour. Interior sound readings taken in this cruise configuration ranged from 74 dbA in the cockpit to a low of 69.5 dbA in the forward passenger compartment.

Climbing to FL 430 and powering back to achieve a long-range setting of 0.75 Mach, we stabilized at 430 KTAS on a fuel flow of 1,729 pounds; the air-

SPECIFICATIONS
DASSAULT FALCON 900B

B/CA equipped price	$22,350,000
Seats	2+12/19
Engines	
Model	3 GED TFE731-5B
Power	4,750 lb ea.
TBO	OC
Design weights (lb/kg)	
Max ramp	45,700/20,729
Max takeoff	45,500/20,638
Max landing	42,000/19,051
Zero-fuel	28,220/12,800
BOW	24,660/11,186
Max payload	3,560/1,615
Useful load	21,040/9,544
Max usable fuel	19,165/8,693
Payload (max fuel)	1,875/850
Fuel (max payload)	17,480/7,929
Loading	
Wing (lb/ft^2)	86.3
Power (lb/hp)	3.4
PSI	9.3
Limit speeds (KCAS)	
M_{MO}	0.870
V_{MO}	370
V_{FE} (app.)	200
V_2	132
V_{REF}	106
Performance (SL, ISA, MGTOW)	
BFL (h/m)	4,950/1,509
BFL, 5,000 ft ISA+20° C (ft/m)	7,795/2,376
Climb (fpm/mpm)	
All-engine	4,000/1,219
Engine-out	2,000/610
Certificated ceiling (ft/m)	51,000/15,545
All-engine service ceiling (ft/m)	41,000/12,497
Engine-out service ceiling (ft/m)	31,000/9,449
Part 121 landing distance (ft/m)	2,300/701
NBAA IFR range (nm)	4,011/1,223

craft's weight at that time was 32,840 pounds. Adding power and consuming 1,922 pph, we reached 0.80 Mach even though our weight exceeded by 800 pounds the maximum for that speed. Clearly, the 900B we flew had no problem achieving book performance at mid weight.

Descending through FL 320, we shut down the number two engine so we could initiate a relight at FL 300, the top of the air start envelope. The procedure was accomplished without any discrepancies.

The 900B handles just like the 900A. All the aircraft responses to control inputs and atmospheric turbulence are well damped and comfortable for pilots and passengers. Control feel is pleasantly solid and aircraft response to control input is precise. Workload of the 900B's new TFE731-5B turbofans is very low, indeed.

The Falcon 900B is another example of the time-proven adage that to improve a good aircraft, add more power. **B/CA**