Aircraft Review

CHALLENGER 600

The largest cabin cross-section in the heavy-iron class with unmatched fuel economy—for the price of a midsize jet.

Reams of documents chronicle the shaky start of the Canadair Challenger program. In the early 1970s, Canadair was a military contractor in a nose dive. Bent on saving the firm from almost certain bankruptcy, the Canadian government bought a controlling interest in the firm, but it had no money for new aircraft programs.

Undaunted, Canadair's management pressed on with a swords-into-plowshares conversion. The firm decided to enter the business aircraft market, even though it had no previous experience in this segment of the aerospace industry. Canadair bought the rights to William P. Lear's LearStar 600 design concept. With major changes, it eventually became known as the Canadair 600, and later the Challenger.

The Challenger was a revolutionary approach to business aircraft design with its unprecedented eight-foot, two-inch fuselage cross section, super-critical wing, high-bypass-ratio fanjets, and Boeing-like systems sophistication and redundancy. In essence, it was business aviation's first mini-airliner.

Just as impressively, it was the first large-cabin business aircraft to be designed to the FAA's then-new, fail-safe, damage-tolerant structure regulations for transport category aircraft.

Fred Smith at Federal Express ordered 25 Challengers, thereby launching the program. Smith got his choice of engines. Key Canadair managers favored General Electric's new CF34. Smith, soured on the GE CF700 engines on FedEx's Falcon 20 aircraft, insisted on using Avco Lycoming ALF502 fanjets. Rated at 6,200 pounds thrust for takeoff, the ALF502 had little margin for growth. That would prove to be a big problem.

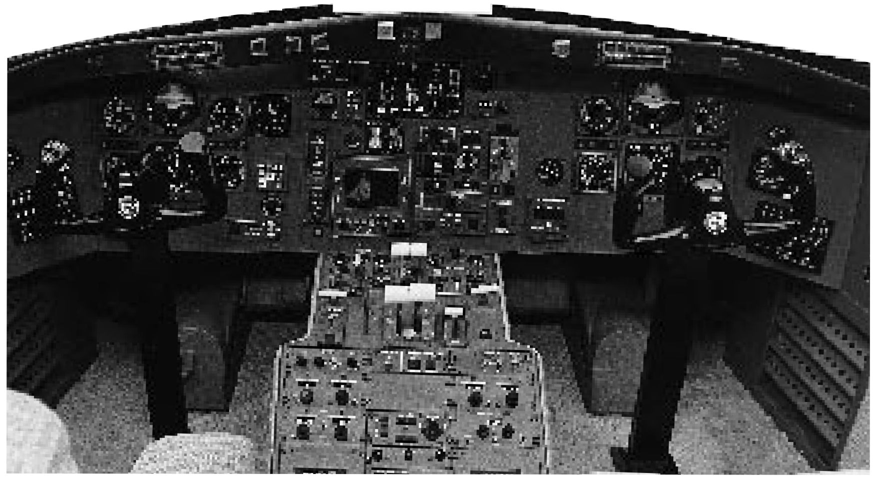
Photographs courtesy of Bombardier

As expected, the Challenger got heavier during development. The original 30,000-pound design concept was pure Pollyanna. Production Challengers grew from a 33,000-pound MTOW at certification in August 1980 to 40,400 pounds the following year. Two years into production, the MTOW had increased to 41,100 pounds, or 41,250 pounds with winglets.

Early in the development program, it became clear that the Challenger needed more thrust. Avco Lycoming responded by adding supercharger stages to the low-pressure compressor and eventually increased the engine's takeoff thrust to 7,500 pounds—21-percent more than the original engine. The ALF502 was rushed into production without much refinement. Its entry-into-service reliability record was dismal. Compounding these problems, the ALF502's cruise fuel consumption was higher than anticipated.

FedEx eventually canceled its contract for 25 aircraft, but by then, the Challenger's design was frozen. All Challenger 600s would be powered by the ALF502.

The Challenger's performance fell far short of the theoretical 3,500-nm tanks-dry range. To remedy the problem, Canadair offered its customers a no-charge choice of winglets or supplemental Branson fuselage fuel tanks to boost the range to the guaranteed minimum. Most operators opted for winglets because they made the aircraft more aerodynamically efficient. The ALF502 wasn't the only legacy of FedEx. As shown in the photo on page 45, serial numbers 1002 through 1023 would have an electrically-powered, upward-opening door, similar to a forward cargo door on an air freighter. The boarding ladder was wobbly and almost seemed like an afterthought.



The original cockpit was sparsely equipped by today's standards. Popular options included INS, VLF-Omega and HF transceivers. What about RVSM? Plan on as much as $250,000 for equipment upgrades and certification.

Canadair built 85 Model 600 Challengers from 1980 to 1983. Thirty-two were 1981 models, 44 were delivered in 1982 and a scant nine went to customers in 1983. By then, the substantially more-powerful and longer-range GE CF34-powered Challenger 601 was in full production, thereby sealing the fate of the Challenger 600.

The firm, however, was unconditionally committed to its first Challenger, especially regarding product support and improvement. The Challenger 600 eventually overcame its severe adolescent growing pains. The cabin door, for example, was converted to an air stair door at serial number 24.

AIRLINER SYSTEMS

The Challenger was the first business aircraft to use a 115-VAC, 400-Hz AC electrical system in place of a primarily DC power system. AC power and higher voltage allows the use of relatively lightweight AC generators, plus smaller gauge wire, thereby reducing wire weight. Each engine has an integrated-drive, constant speed AC alternator. The AlliedSignal GTCP 36-100E APU also has an AC alternator, thus providing a third, backup electrical power source. An emergency use, air-driven generator (ADG), similar to the ram air turbine fitted to many tactical aircraft, provides a fourth, emergency source of electrical power. Three transformer-rectifiers provide DC power.

The widebody cabin easily tops the list of Challenger 600 passengers' most-valued features.

The high-current-draw systems, such as the electrically powered hydraulic pumps, wing flaps, landing lights and electric anti-ice heat, are AC-powered. Relatively low-power systems, such as certain avionics and environment control, are DC-powered.

The APU also provides bleed air for engine starting and air conditioning. It's certificated for use up to 30,000 feet.

The fuel is contained in left- and right-wing tanks that transfer fuel to an auxiliary tank in the center wing section. The aux tank has left and right sides containing collector tanks that supply the engines.

Jet pumps, powered by motive flow pressure from the engine-driven pumps, transfer and scavenge fuel from the wings to the collectors and also move fuel from the collectors to the engines. DC-powered standby pumps supply fuel pressure for engine starting, cross flow and in the event of main jet pump failure.

A third DC pump in the right main fuel tank supplies the APU. A single-point pressure refueling port in the right wing root is used for refueling.

Challengers have a unique fuel-tank vent-tube system. All the tanks are vented through two NASA scoops on the trailing edges of the wings. This requires interconnecting vent lines. The left- and right-wing tanks, plus the optional Branson auxiliary tanks, are interconnected by means of inverted U-shaped, vent lines that run inside the fuselage.

There are three independent hydraulic systems, each having a primary and a standby pump. Left and right engine-driven pumps provide primary power for Systems 1 and 2, with left and right electrically driven standby pumps. Systems 1 and 2 power the primary flight controls and spoilers. System 1 also powers the spoilers and System 2 also powers the outboard wheel brakes.

Hydraulic System 3, which is essentially the utility system, has electrically driven primary and standby pumps. System 3 powers the flight controls, plus the landing gear, flaps, nosewheel steering and inboard wheel brakes. All three systems power the rudder. The ADG or APU furnishes power to the electrically driven hydraulic pumps if the engines aren't running.

The fully powered, hydraulically actuated primary flight controls use springs for artificial control feel. The super-critical wing's relatively aft wing loading makes manual controls undesirable because of the resulting high aerodynamic loads.

Bleed air, supplied by either the engines or APU, provides up 9.3-psid cabin pressurization. Two air-cycle machines supply refrigeration for air conditioning. Canadair obtained certification for a 41,000-foot maximum altitude, but FL 370 is the all-engine service ceiling on a standard day.

Bleed air also is used for wing leading edge and engine anti-ice. Some operators have reported problems with sticking wing-anti-ice bleed-air valves. They recommended cycling the system on every flight to keep the valves free.

BEST AND WORST FEATURES

Challenger operators rave about cabin size and interior quiet. Many also mention the aircraft's relative fuel economy and airliner-like systems, comparing the Challenger to a Boeing 737 or a Douglas DC-9. Pilots like the aircraft's ease of handling and soft-riding trailing-link main landing gear. They also praise the effectiveness of the wheel brakes and thrust reversers. Canadair product support received raves from many operators.

Most Challenger 600 operators with whom we spoke have enrolled their aircraft in Canadair's SmartParts program. Canadair supplies all rotable and consumable parts during a three-year contract period, except for engines, APU, secondary structures and lubricants. The base rate is $485 per hour for North American operators, assuming 300 hours per year minimum use. The rate is adjusted as much as 20 percent per year in years two and three, depending upon an operator's parts use history. The majority of operators told B/CA that they participate in SmartParts because it eliminates most of the operating cost risk, especially if (or when) an expensive component breaks. Operators who have not opted to enroll claim that their overall operating costs are lower.

Some operators also carped that the Challenger 600's systems favor redundancy instead of reliability, resulting in relatively high maintenance costs. (Our operating cost breakdown does not use the SmartParts program.)

Fuel economy may be one of the Challenger 600's best features, but its direct operating costs aren't significantly lower than other large-cabin business aircraft, as shown by the accompanying operating cost summary furnished by Conklin & de Decker Associates. Compared to other large-cabin business aircraft, the Challenger 600 has higher direct operating costs because of engine and maintenance reserves, but lower fixed costs because of lower capital depreciation and hull insurance expense.

Operators also carped about ALF502 parts availability from AlliedSignal. But, as one said, when AlliedSignal acquired Lycoming Turbine in October 1994, it inherited large-scale parts and spares shortages from Avco and Textron. It's going to take a while to increase the parts inventory, especially with the firm placing top priority on supporting airline customers.

SAFETY RECORD

Challenger 600s have been involved in twice as many accidents as the composite average for the business jet fleet, according to Robert E. Breiling Associates. There were four accidents involving operational Challenger 600

CHALLENGER 600 AVIONICS

Challenger 600 aircraft came furnished with a Sperry SPZ-650 analog flight guidance system, including dual electromechanical ADIs and HSIs, a single analog air data computer, a Primus 400 weather radar and a dual-channel SPZ-650 autopilot. The package also featured Collins Pro Line 1 comm/nav/ident radios, a Collins radio altimeter (dual displays), dual Aeronetics RMIs and a two-inch JET standby attitude indicator.

Popular options that were installed at completion centers frequently included a Delco Carousel VI spinning-gyro INS, a Global Navigation GNS-500 VLF/Omega nav system and HF transceivers with selective calling feature. Flight data and CVRs also were installed by completion centers.

Most of the remote boxes are mounted below the floorboards, where they're protected from altitude and temperature extremes, and they're shielded from precipitation.

A few Challenger 600s have been upgraded with EFIS, but virtually none are all-digital systems that might be eligible for RVSM certification. Retrofitting a Challenger with a digital air data computer and obtaining RVSM certification might cost as much as $250,000. As a result, most Challenger 600 operators don't intend to use their aircraft for transatlantic missions after RVSM is fully implemented.

CHALLENGER 600 OPERATING COSTS

Fixed Expense (Annual):	
Captain	$76,920
Copilot	56,520
Benefits	40,032
Hangar	17,816
Insurance—Hull	19,500
Insurance—Admitted Liability	2,750
Insurance—Liability ($50 Million)	16,000
Recurrent Training	34,100
Navigation Publications	6,935
Updates/Uninsured Damage	26,000
Refurbishing	35,280
Computerized Maintenance	6,200
Weather/Flight Planning	2,000
Total Fixed Expense	**$340,053**
Direct Expense (Hourly):	
Fuel	$595.90
Lubricants/Additives	0.00
Maintenance—Labor	187.60
Maintenance—Parts	557.75
Engine Restoration	623.76
APU	30.66
Landing/Parking	12.38
Crew Expense	135.00
Catering/Supplies	36.85
Total Direct Expense	**$2,179.90**

Source: Conklin & de Decker Associates

aircraft between 1980 and 1996. One accident and one incident were related to loss of directional control during takeoff. Canadair, without admitting liability, subsequently redesigned the nosewheel steering as a digital steer-by-wire system. One accident involving loss of directional control on landing was traced to a defective anti-skid brake system. Other incidents related to mechanical failures involved the collapse of a nose gear during landing roll out, an asymmetric flap deployment, a catastrophic engine failure and the loss of a cabin door in flight. Notably, there were no injuries or fatalities related to this group of accidents and incidents.

The only Challenger 600 or 601 fatal accident was caused by pilot error, according to Breiling's records. Both crewmembers died in a 1983 controlled flight into terrain accident at Hailey, Idaho during a low visibility approach to the Friedman Memorial Airport.

It should be noted, however, that the Challenger 600 accident rate has improved by almost 40 percent during the last five years. There have been no accident-related injuries or fatalities during that period.

HANDLING AND PERFORMANCE

In short, the Challenger is a delight for pilots. There's more room in the cockpit for charts, crewmembers and navigation gear than in virtually any other general aviation aircraft we've flown. The visibility is excellent, the controls, switches and knobs are logically arranged, and control forces are light. The aircraft subjectively feels much smaller than its dimensions and weight indicate.

Some of the checklists, though, are relatively long and complex, thus requiring plenty of crew practice and coordination. This is partly due to the need to check the triple redundancy built into many of the Challenger's systems.

At moderate weights, the takeoff V speeds range from the "teens" to the mid 130s. When the aircraft is loaded to maximum takeoff weight, the V_2 takeoff safety speed is 142 knots—mid range for an aircraft in this weight class. That's higher than a Dassault Falcon 50, but lower than a Gulfstream III.

When initially certificated, the Challenger 600 had longer takeoff field distances than the Falcon 50 or G-III when flying missions of equivalent length. Canadair fine-tuned its test procedures and reduced the TOFD within two years. Although it never quite closed the gap on its competitors, its standard-day TOFD at MTOW became a respectable 5,700 feet and the hot-and-high, 5,000 feet, ISA+20°C TOFD dropped to 8,750 feet.

A bleeds-off takeoff allows slightly higher power settings, thereby improving balanced field length and second-segment climb performance. As a result, many Challenger pilots opt to keep the APU running during the takeoff to provide bleed air for cabin pressurization and air conditioning.

Subjectively, the Challenger's control feel is lighter than a G-III's, but somewhat heavier than a Falcon 50's. It's well harmonized, and the triple-redundant, hydraulically powered rudder provides plenty of directional control authority in the event of an engine failure.

Using the yaw damper is a must. The aircraft is relatively short-coupled in yaw and the winglets increase the adverse yaw-roll coupling tendency.

On average, operators told B/CA that they are comfortable flying the Challenger 600 for as long as six hours at long-range cruise. Others expressed the maximum range as 2,750 to 2,800 nm (45-minute IFR reserve) at 0.72 to 0.74 Mach. When the aircraft is heavy, that's about as fast as it will go at maximum cruise thrust. As shown by the ALF502L-2 performance chart on page 46, these engines produce a considerable 1,380 pounds of thrust at altitude. The relatively low cruise speeds may be due in large part to installation losses, rather than lack of basic engine thrust.

Operators say to plan on 3,000 pounds of fuel for the first hour, including start, taxi, climb and cruise. For the second hour, it drops to 2,000 pounds. Plan on 1,900 pounds for the third and fourth hours, and 1,800 pounds for the last two hours. Maximum standard fuel capacity is 14,890 pounds.

According to operators, a fully loaded Challenger 600 will climb directly to FL 350 to FL 370, depending upon the outside air temperature. At warmer-than-standard temperatures,

KEY SERVICE BULLETINS AND INSPECTIONS

SB 600-0304	Branson auxiliary fuel-tank system
SB 600-0380	Steer-by-wire
SB 600-0401	Winglets
SB 600-0452	Automatic ground spoiler actuation
SB 600-0640	Aluminum wing access panels
SB 600-0613	Floor panel and floor beam anti-corrosion treatment
MM 24-15-51	ADG turbine-blade inspection
MM 28-10-31	Fuel-vent-tube shroud inspection
MM 78-30-26	Thrust-reverser wear inspection
MM 83-14-10	Windshield and side-window prism inspection

Top right: The first 23 Challenger 600 aircraft were fitted with an upward opening door and separate boarding ladder, both of which scored low marks with operators. Lower right: The Challenger 600's long travel, trailing link landing gear.

for example, the initial cruise altitude may be as low as FL 330.

First-generation Challengers reward pilots who watch their weights. When loaded to mid-range weights for 1,000- to 1,400-mile missions, a Challenger 600 can operate out of 4,000-foot runways. After departure, the aircraft can climb directly to the upper thirties. Challenger pilots report that the maximum useful cruising altitude is FL 410, which is attainable at light to medium cruise weights. On such missions, the aircraft will cruise at 0.77 to 0.80 Mach with an average fuel burn of 2,600 to 2,800 pounds per hour.

WHAT TO LOOK FOR

Challenger 600 operators and brokers told B/CA to look for used Challenger 600 aircraft that are enrolled in both the AlliedSignal Challenger Maintenance Service Plan (CMSP) and the Canadair SmartParts program. They said that the two programs greatly reduce risk for an operator who is new to the Challenger 600.

About 85 percent of the Challenger 600 fleet has been fitted or retrofitted with winglets, a must according to operators. The resulting drag reduction allows the aircraft to climb 2,000 to 4,000 feet higher initially. They also reduce fuel consumption by four to seven percent and increase the maximum range about 250 to 300 miles compared to aircraft without winglets.

The optional, 1,775-pound capacity Branson fuselage fuel-tank system is a mixed blessing. Operators say that while it provides an additional 45 minutes of range, the empty tanks add 300 pounds to the BOW. About one-third of the 600 fleet has been equipped with the supplementary fuel tank system.

Many early Challengers, along with other business aircraft completed in the early 1980s, have relatively heavy interiors. Brokers advise taking a close look at the BOWs of candidate aircraft. A lean 23,550-pound BOW, for example, allows a tanks-full payload of 2,800 pounds.

Lead-foil vinyl insulation, heavyweight cabinetry and older-generation furnishings add 500 pounds or more to the weight of an interior, increasing the BOW to well over 24,000 pounds. A modern interior completion weighing 4,000 to 4,200 pounds, in contrast, can boost the tanks-full payload by two to three passengers.

Operators say that some early Challengers may have a relatively forward center of gravity because of a heavy galley or lavatory in the forward section of the cabin. They recommended checking the empty c.g. to ensure that the aircraft won't have loading limitations because of a forward c.g.

Corrosion is another potential problem with early Challengers, but it's a relatively minor annoyance compared with other old heavy-iron business jets. Fluid spills from the lavatory or galley can seep into the gaps between the graphite-epoxy floor panels and aluminum floor beams, potentially causing galvanic corrosion. The floor panels and beams should be coated with sealant in accordance with a Canadair recommended service bulletin to prevent such corrosion.

Graphite-epoxy fuel tank access panels on the bottom wing skins also can cause corrosion problems because of chafing. Some operators have replaced the composite panels with aluminum panels to eliminate the problem.

Corrosion also can be a problem in the upper strut of the nose landing gear. Checking it is a must during a pre-purchase inspection.

The titanium blades of the air-driven generator are subject to FOD when the unit is deployed into the slipstream—especially after landing, when

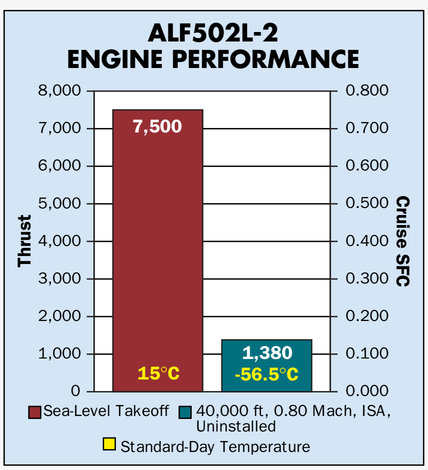
CHALLENGER 600'S ALF502L ENGINES

In the early 1970s, Avco Lycoming was as new to the commercial turbofan engine market as Canadair was to the business aircraft industry. The ALF502 was the firm's first turbofan engine. It used a military turboshaft engine's gas generator mated to a reduction gear box that powered the fan. It suffered from some of the worst growing pains of any new, light-turbofan engine in history.

Lycoming reacted by introducing an upgrade package that became known as the ABCD "punch list," a group of service bulletins that addressed problems with the oil system and bearings, seals, accessory gear box, fan frame and hot section. With these improvements, the engine became the L-2.

The ABCD punch list was hardly a cure-all for the engine's problems. The gas generator section, for example, has been the target of numerous ADs since 1983. As recently as 1996, certain compressor and turbine components have had their retirement life limits reduced because of unforeseen failure rates.

In 1983, Lycoming received approval for the L-2C upgrade retrofit. The modification includes improvements to the high-pressure centrifugal compressor, a redesigned high-pressure turbine nozzle and an upgraded high-pressure turbine section. The result is lower operating temperatures, improved high-altitude performance and longer engine life. As a result, AlliedSignal Challenger Maintenance Service Plan (CMSP) reserves charges for L-2C engines are $220 per hour, $10 per hour less than for L or L-2 engines.



Notably, CMSP does not cover the cost of ABCD punch list improvements, should they still be needed, or the L-2C retrofit upgrade. The L-2C upgrade costs about $140,000 per engine.

Since AlliedSignal acquired Lycoming Turbine in October 1994, the firm has placed high priority on ALF502 improvements. The engine now has chalked up a much better reliability record. The CMSP rate is $230 per engine, which many operators consider to be a bargain because of the short service life of some internal components. Major Periodic Inspections are at 2,000-hour intervals. The 4,000-hour "hard" TBO no longer applies.

the nosewheel can throw off dirt or gravel. It's important to check the ADG for proper operation and FOD. Repairs or replacement can cost $80,000 or more. The steer-by-wire system is another must according to Challenger 600 operators. The original cost of the system was $48,750.

Automatic ground spoilers is another useful option. The original cost was $16,300. Operators say that the Challenger tends to float on touchdown, and auto ground spoilers quickly dump residual lift, thereby improving wheel-brake efficiency.

Inspection intervals are grouped by flight hour, landing and calendar limits. The hourly inspections come at 300-, 600-, 1,200-, 2,400-, 4,800- and 9,600-hour intervals. The big inspections are at 15,000 hours, 15,000 landings and 15 years. Notably, the major inspections are individual tasks, each of which is defined by hours, landings and months.

K-C Aviation, Innotech and Bombardier Aircraft Services all offer pre-purchase inspections. The typical cost is less than $30,000 and, in our opinion, it's money well worth spending. See the "Key Service Bulletins and Inspections" table on page 45 for the top SBs mentioned by operators, as well as a few of the key inspections performed by K-C Aviation during a pre-purchase inspection.

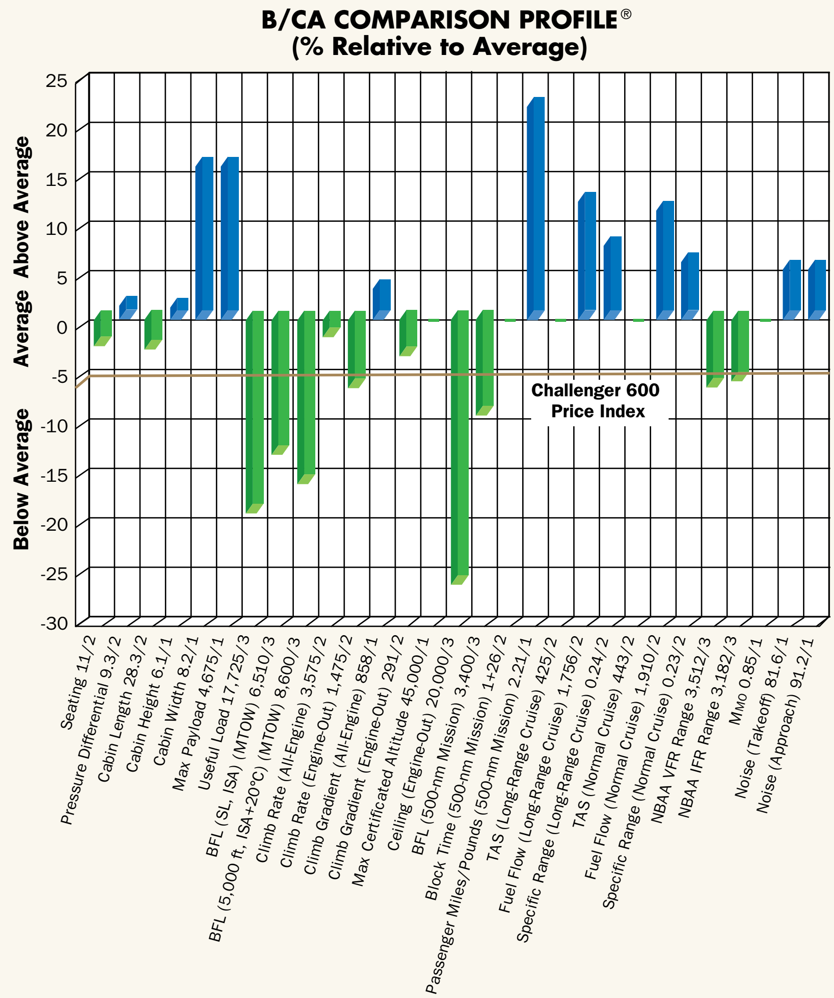
PRICES AND AVAILABILITY

At press time, there were four Challenger 600 aircraft on the market with asking prices between $6.4 million and $7.5 million. Aircraft availability fluctuates, and Challenger 600 asking prices have increased by more than $1 million during the past year.

These aircraft are becoming increasingly rare, but they represent an excellent value for operators in the market for used equipment. No wonder. The widest cabin in its class pampers passengers. The aircraft's handling characteristics make it feel like a much smaller airplane. It's one of the quietest business aircraft at noise-sensitive airports. And with fuel prices at over $2 per gallon at some airports, the 600's fuel economy is becoming a important consideration.

If cabin size is your passengers' top priority, the Challenger 600 is one of the most attractive aircraft in the used aircraft market. ■

By Fred George



Source: B/CA, September 1981

No aircraft can be all things to all people; each must be a compromise or tradeoff between the options that are available to the designer. But if it were possible to combine the capabilities of all the aircraft within a given class, the resultant vehicle might represent the closest thing to a no-compromise aircraft. At least the hypothetical aircraft would incorporate the average capabilities for its particular performance class.

In its Comparison Profile®, B/CA constructs the hypothetical "no-compromise" aircraft for a particular class of vehicles by averaging the characteristics of all relevant aircraft within that class. By comparing a specific airplane with the average, we can see where and to what degree compromises were made. Such an analysis is important in deciding whether the airplane satisfies a particular set of operational needs.

We have constructed the average line on a purely objective basis from hard data taken from flight manuals or from engineering projections.

Each bar in the Profile indicates the percentage by which each parameter exceeds or falls short of the average for the category.

The Price Index line indicates how much of a particular parameter the purchaser gets for his dollar relative to the average price for the feature or performance within the category. Where the Profile extends above the dashed line, the airplane offers more in that parameter per dollar of acquisition cost than the average for the category. If the Profile falls below the Price Index, the airplane offers less value per dollar in that parameter.

For this Profile, the category comprises the Canadair Challenger 600 and those airplanes most likely to be considered along with the Challenger—the Falcon 50 and Gulfstream III.

The actual specifications and performance numbers for the Challenger are included along the bottom of the Profile so that readers can easily make comparisons. The number for the Challenger is followed by a slash and the aircraft's standing in the particular category relative to the other two.

It must be understood that this Profile was not created as a tool for directly comparing the subject airplane with any other single airplane in the category. This is possible only if a Profile for the other aircraft based on identical criteria is available. This Profile compares the subject airplane with the average and thus establishes areas in which it is strong relative to the competition or in which it is compromised. Therefore, the Profile must be studied with the prospect's own needs and