B/CA Analysis: Canadair Challenger

New engines have given the Challenger competitive performance, and new ownership has given Canadair a clean financial slate, but will that be enough for success?

By John W. Olcott and Richard N. Aarons

Canadair's Challenger 601 represents a strong case for aviation pundits and hangar fliers who claim that powerplants, not aerodynamics, dictate the pace of aeronautical progress. Although aerodynamically only slightly different than the Avco Lycoming ALF 502L-powered Challenger 600, the 601 with its General Electric CF34-1A turbofans appears to possess the performance and appeal that marketers promised and operators anticipated when the Challenger was announced in 1976.

Of the 100 Challengers delivered by late March 1984, only 17 were 601s, and only two of those were completed and in operation. Yet it is the GE-powered aircraft that has captured center stage in Canadair's performance before the business aviation audience. Four of the six Challengers that were sold by Canadair in 1983 were 601s, and the lone aircraft ordered during the first quarter of 1984 also was a 601.

While the typical flight department has very few nonstop trips over 2,000 nm, aircraft in the Challenger class often are judged (at least initially) on their maximum range with an 800-pound payload. When the weight of the Challenger 600 grew by about one-third during its development, causing the aircraft to fall woefully short off its original range projections of about 3,900 nm with four passengers and NBAA IFR fuel reserves and a bit over 4,200 nm with VFR reserves, interest in the aircraft started to wane. And when the 601 was introduced in March 1980, reception for the GE-powered Challenger rapidly eclipsed the 600. Market enthusiasm for the 600 continued to erode as delays in obtaining ALF 502s from Avco Lycoming bogged down production of the aircraft, and a rash of airworthiness directives and service bulletins pertaining to early 600s followed the aircraft's certification three years ago. The recession also had an overall negative effect, and potential Challenger operators became even less enchanted.

Consequently, Avco Lycoming-powered versions of the Challenger are no longer in production, although orders for the 600 could be fulfilled since both it and the 601 share the same production line.

Concept Sound

Canadair billed the Challenger as a wide-body business aircraft that would provide a high level of passenger comfort, and in that regard the 600 lived up to its advance notices. Operators of the aircraft who were surveyed by B/CA (September 1983, page 37) gave the aircraft high marks for many of its characteristics. As expected, they emphasized cabin size and passenger acceptance, but they also liked the 600's system redundancy and reliability, ease of maintenance and inflight handling. Also praised was Canadair's responsive product support.

The fact that the operators questioned by B/CA found little reason to complain about the 600's practical range — which they felt was between 2,600 and 2,800 nm for flight planning with NBAA IFR reserves under typical operating conditions — is not surprising. A study of over 1,100 chief pilots conducted about two years ago by *The Wall Street Journal* indicated that the median stage length of a trip in a business aircraft was 383 miles, and only 29.5 percent of such journeys were 500 miles or more.

In spite of the Challenger 600's ability to perform most of the missions typically flown by busi-

ness aviation, the aircraft's range just didn't live up to original projections and was between 500 nm and 1,000 nm less than the 600's competitors: the Dassault Falcon 50 and the Gulfstream Aerospace G-III. Range is what the corporate crowd wants, and range is what attracts them to a new machine, particularly when overseas missions are on the itinerary (even if only occasionally).

Quest for Range

Range is determined primarily by three factors: (1) the aircraft's ratio of lift to drag; (2) the amount of fuel available for the mission and (3) the engine's specific fuel consumption. Canadair had to address all three factors if it was to improve the Challenger's weak link: its lack of competitive range.

But few practical options were available to Canadair. Reducing drag by designing a smaller-diameter fuselage obviously was out of the question. Aside from being prohibitively expensive, such a move would have beep counter to the Challenger's primary appeal: its spacious, comfortable cabin. Similarly, designing a larger wing (such as Gulfstream did when it created the G-III) — so that the 600 could carry its unanticipated weight in a more favorable fashion and fly higher — was not practical either.

In the area of aerodynamics, Canadair selected the only option that made sense: add winglets to reduce the losses associated with wingtip vortices, thereby reducing the wing's induced drag and increasing its lift-to-drag ratio.

There were numerous reasons for adding winglets to the Challenger: Winglets were easier to install on the 600 than were wingtip extensions, there was less likelihood that the stall characteristics of the aircraft would be altered due to tip stall, the original wing structure had sufficient strength margin to accept these surfaces and there would be no adverse effect on handling qualities. Furthermore, winglets often improve aileron effectiveness.

Since the contribution of winglets on performance tends to be optimum at one weight and Mach number, Canadair selected 0.74 Mach as the design point and realized a range improvement estimated to be about 130 to 140 nm at that speed. The company says, however, that some benefits are experienced at all speeds.

A range enhancement of under 150 nm wasn't sufficient to make the 600 competitive with the other corporate jets that offer intercontinental capabilities. Obviously, an aerodynamic solution alone wasn't enough. Hence the need to address the powerplant side of the equation.

More power was needed to lift the weight that had accumulated as the Challenger 600 went from design to reality. Since the aircraft first appeared as a preliminary offering in. the B/CA *Planning and Purchasing Handbook* in 1978, its basic operating weight grew 32 percent (from 17,523 pounds to 23,170 pounds). More power also was needed to carry the additional fuel, which more range requires, and to climb to higher altitudes, where the aircraft could use the extra fuel more efficiently. (Canadair decided to increase the aircraft's fuel capacity from 14,900 pounds to 16,665 pounds by making the 600's optional extended-capacity fuselage tank standard on the 601.) And obviously, a decrease in specific fuel consumption would be beneficial.

Canadair selected the General Electric CF34-1A turbofan, which develops 8,650 pounds of thrust and is capable of generating 9,140 pounds of thrust for five minutes to provide an automatic power reserve for single engine operation. Thanks to its 6.3 bypass ratio, highest among turbofans used in business aviation, the CF34-1A has a specific fuel consumption of 0.36 at takeoff thrust; the Avco Lycoming ALF 502L, which develops 7,500 pounds thrust, has an sfc of between 0.414 and 0.424.

Thus the GE powerplant provides 15 percent more thrust (without APR) and 16 percent better sfc than the ALF 502L used on the Challenger 600. Furthermore, the CF34 has acquired con-

siderable field experience in the Fairchild A-10, where it is designated the TF34-GE-100 and develops 9,065 pounds of thrust, and in the Lockheed S-3A, where it is designated the TF34-GE-2 and develops 9,275 pounds of thrust.

Although the CF34 was a mature engine that offered the characteristics sought by Canadair, fixing the heavier powerplants to the 600 fuselage took time and considerable engineering effort. The mounting arrangement for the GE engines differs from that employed on the 502, and the bleed-air characteristics reflect the differences in bypass ratio between the two engines (the ALF 502L has a bypass ratio of 5.0). Canadair had to redesign the rear fuselage area in the vicinity of the engines as well as use new engine pylons and nacelles. The integrated drive for the 30-kVa generators, which supply three-phase, 400-Hz, 115/200 VAC power (as they do on the 600), had to be altered due to the difference in running speed between the 502L and the CF34. The air conditioning system also needed to be redesigned.

For the most part, however, the 600's systems were retained. In fact, the official designation for the GE-powered Challenger is 600-2A12; the Aveo Lycoming version is designated 600-1A10.

What Was Achieved

As can be seen in the performance charts contained within this B/CA Analysis, the Challenger comes significantly closer to the range projections Canadair originally presented for the CL-600. Maximum range still is about 500 nm fewer than those overly optimistic projections, but the 601's reach is marginally better (by about two percent) than the Falcon 50's and comes within about 300 nm of matching the range of the G-III. Specific range, however, is about four percent less than that of the Falcon 50, but it is 50 percent greater than the G-III's. While such range performance gives the Challenger 601 an improved stance with respect to its immediate heavy-iron competition, it falls short of the 3,800-nm, NBAA IFR range projected by Dassault for their new, wide-body Falcon 900 and is about 1,000 nm fewer than the NBAA IFR range that Gulfstream projects for its new G-IV.

The airport performance of the 601 is better than that of the 600, and a 3,440nm mission with NBAA IFR reserves can be flown from Denver on a day with an ambient temperature of 25°C without reducing the aircraft's takeoff weight of 43,100 pounds; approximately 9,500 feet of runway is required.

The fine handling qualities of the Challenger have been retained or improved, depending on the phase of operation under consideration.

Ground handling, for example, has been enhanced measurably by a new, steer-by-wire" nosewheel steering system that uses rate feedback to achieve smooth, pleasantly responsive (but not overly sensitive) control. Ten degrees of steering for runway operations is available through the rudders, and 55 degrees of authority is controlled via a hand wheel. If the system fails, the nosewheel reverts to a full-castering mode. We found the system to be a significant improvement over the 600's nosewheel steering. (For the operator who is willing to pay about $40,000, the "steer-by-wire" system is available as a retrofittable option for the 600.)

Flying the 601

Aside from using a trim setting that compensates for the nose-down effect of the more powerful GE engines on the aircraft rotation characteristics, the 601 feels like a 600 during the takeoff. Climb performance is enhanced, and the roll control appears to be slightly improved by the winglets, but otherwise there is little change. The aircraft still possesses the good pitch stability that allows a pilot to enjoy fine speed stability if he chooses to hand fly a Challenger to altitude.

In atmospheric conditions that were equal to ISA up to about 25,000 feet and then averaged about three to five degrees below standard, and with normal handling, we climbed directly to FL 410 14 minutes after departing at a gross weight of 32,000 pounds. At its max takeoff weight of 43,100 pounds, the 601 can reach FL 370 directly, and can climb to FL 390 at 41,000 pounds and FL 410 when the aircraft's weight is reduced to about 36,000 pounds. As a rule of thumb, the 601 can climb 2,000 feet higher, 2,000 pounds heavier than the 600.

Currently, the aircraft is certificated only to FL 410, in part because the CF34's fan is ahead of the rear pressure bulkhead, but Canadair hopes to obtain approval for operations to FL 450. The 601 has flown to FL 500 at light weights during flight tests. (Note, however, that the performance charts presented in this report are based upon the ability to step climb to FL 430).

The 601 enjoys good lateral-directional handling qualities that are enhanced slightly by the winglets. The 601 seems to have a bit more directional stability than the 600, and its lateral control in crosswind situations is better than the ALF 502L-powered aircraft, according to the Canadair test pilots who demonstrated crosswind limits to the FAA. The 601 can be dispatched with one of the channels in its dual-channel yaw damper inoperative, and full-flap approaches and coupled approaches are approved with the yaw damper failed. We found the 601 to be easily controllable, in a lateral-directional sense, with the yaw damper disengaged at altitude.

Workload associated with the GE engine was low. Acceleration appeared to be smooth and linear. However, an engine synchronizer would 1be a welcome addition, Above about 80 percent fan speed, the CF34's electronic fuel controller becomes operational, and it causes N1 to wander as temperature changes.

The CF34 appears to be free from high-altitude compressor stalls such as were experienced on the 600 under certain conditions. Windmilling airstarts, however, require an airspeed of 330 knots and an N1 speed of 14 percent. Furthermore, they must be initiated within 10 minutes of inflight shutdown.

Spoiler deployment for rapid descents presented no unusual pitch responses or reduction in roll effectiveness. Nor was the vibration excessive, either in the cockpit or in the passenger cabin.

The Challenger 601 handled nicely on the approach and landing, with good response from the engines for minor corrections in glidepath. Pitch control was more than adequate for the flare, and the Challenger's gear, which is beefier than the 600's due to the 601's greater weight, provided a smooth touchdown. We found the manipulation required to deploy reverse thrust to be a bit awkward, however, due to a rather unusual sequence of pull and lift actions that, if they were done out of order, would prevent the timely use of reverse thrust.

Deployment of the thrust reversers is slower than on the ALF 502Ls, and if bleed air is being used for engine cowl and wing anti-ice, the deploy delay is rather noticeable. Challenger 601 operators are advised to inhibit wing and cowl anti-ice while activating the thrust reversers. Unlike the 600, which required weight on the wheels for deployment, the 601's reversers are functional once the wheels spin up.

Benefits of Being Second

The 601 certainly has benefited from the experiences of the 600. It has taken the best of the earlier model and changed or replaced those elements that did not fare well in service. But there are still several aspects of the 601 that are in the refining stage as this aircraft goes through the trials that only operational experience provides. Most of these items relate to operational procedures.

For example, the method for testing automatic power reserve before takeoff requires N1 to be at about 83 to 85 percent, which is awkward because the aircraft should be on the runway when it is producing that much power; pilots would like to know the status of the APR earlier in the pre-

takeoff sequence. Also, if the APR is to be used in conjunction with a single engine approach, special performance charts should be consulted to establish power limits, which also is awkward. Bleed air is not available for takeoff due to a lack of performance charts, but they are being developed by Canadair.

Fortunately, the list of yet-to-be-done items is relatively short and well within the grasp of Canadair.

In the area of passenger comfort, the 601 retains, and in some cases, improves upon all the elegant features of the 600. The interior of the aircraft B/CA flew was beautifully finished and effectively soundproofed by KC Aviation. Noise levels in the passenger area ranged from 73 dBA to 76 dBA, which is quieter than the average for corporate jets in general and competitive with other aircraft in its class. And the character of those readings, if not the readings themselves, should improve slightly if engine sync is made available.

There is no question that the Challenger 601 provides features that attracted operators initially to the 600, and it also offers capability that the Aveo Lycoming-powered aircraft promised but couldn't provide. Canadair's Challenger is now highly competitive with the current fleet of heavy iron, long-range business jets, thanks to its General Electric CF34s.

Who said aviation progress isn't beholden to powerplants? B/CA

THE FUTURE OF CANADAIR

In late March, Canadair delivered the 100th Challenger — a General Electric CF34-powered CL-601. It was a bittersweet milestone because the delivery was overshadowed by concerns about the future of the Challenger, and the company that designed and built it.

Earlier that may, in a report to the Canadian Parliament (Canadair is a "Crown, corporation" and, as such reports its financial performance to its sole shareholder-the Canadian Government), Canadair disclosed that it lost $334.2 million (Canadian dollars) in 1983. In a year when U.S. corporate profits posted strong gains and year-end tax buying substantially reduced the inventories of many business aircraft manufacturers, Canadair sold only six Challengers — about a quarter of what each of its two primary competitors moved.

Ironically, Canadair's poor sales record seems not to have been caused by the recession, or inept salesmen, or by any significant shortcomings with the CL-601 itself.

Indeed, the Challenger 601 appears to be a strong contender in the marketplace. The engines are no longer the bones of contention they once were. With over a decade of military service behind them, the General Electric CF34s are one of the stronger points of the CL-601. With the addition of winglets and another fuselage fuel tank, the range of this latest Challenger is no longer the sour issue it once was with the CL-600. In short, the GE-powered Challenger is a capable aircraft. No, what has dampened the 601's marketing fire is concern over the long-term survivability of Canadair itself.

And with good reason. If Canadair receives the $310 million it has requested (as it most likely will), the Canadian Government will have invested — in total equity and guaranteed loans — $2.146 billion Canadian dollars in Canadair, and the financial well that the company has been tapping may be running dry.

Canada's national debt is larger, on a per-capita basis, than the United States'. Nevertheless, the Liberal Party, which has held a majority in Parliament for nearly all of the last two decades, has decided that Canada should be a world leader in the aerospace industry, and for some time has been allocating massive amounts of money toward that goal. De Havilland, another Crown corporation, has cost the Government $991 million so far. Also, Bell and MBB have recently signed accords for the production of helicopters on Canadian soil.

This is, however, an election year. Prime Minister Pierre Trudeau, Liberal Party leader and Canadair supporter, has announced his retirement. As might be expected, the question of his successor has created a bit of uncertainty within the Liberal Party.

Of perhaps greater significance, however, is the increasing strength of the opposition. For over a year now, the Conservatives, have held a substantial lead in public-opinion polls, and many observers expect their lead. at, Brian Mulroney, to be elected Prime Minister later this year.

Although the Conservatives have been grudgingly supportive of Canadair in the past, once in power they could privatize the company, claiming that the program has been a Liberal boondoggle. Ultimately, support for the Challenger program within the new Government would depend upon the managements of Canadair and the Canada Development investment Corporation (CDIC) — Canadair's holding company — proving their competence to the Conservative leadership.

If Canadair stays in the aircraft business, the real winners may be those who have already bought Challengers. With development costs of over $2 billion absorbed by the Government, customers have paid far less for the Challenger than they would have if a private company had produced it.

As for the current situation, the CDIC and Canadair's present management, in concert with the Government, has proposed a financial restructuring of Canadair. Under the plan, a "new" Canadair will be formed (although the new company will still be known as Canadair Limited), and the new firm will acquire nearly all the assets of the existing corporation. The "old" Canadair will be left to deal with $1.35 billion in Government-guaranteed debts incurred developing the Challenger.

This financial shell game will leave the new company free of debt and should make it profitable by 1985, according to Senator Jack Austin, who represents the Government in its dealings with the CDIC and Canadair. Gil Bennett, Canadair's interim president, and other Canadair supporters contend that the financial restructuring, along with new leadership on Canadair's board of directors, assures potential Challenger customers that the company will remain in business.

One of the tangible measures, of a company's commitment to the future, however, is the amount of money that it devotes to research and development. In Parliamentary hearings, Canadair officials conceded that they had no money for development of derivative designs or new models. Such funds would have to come from profits, although a strong financial showing by the "new" Canadair might prompt the Government to finance the development of new aircraft.

Canadair's woes are compounded, by the vagaries of Parliamentary politics. Ideally, both the Conservatives and Liberals would reach a consensus to ensure that Canadair prospers not only over the short term, but over the long term as well. But in an election year, Canadair, with its spectacular and politically lethal financial problems, has become a political football. The highly publicized and less-than-advertised performance of the Challenger 600 eroded public, market and Government confidence, in the company's prognostications.

The ultimate success of the Challenger may well rest on Canadair's ability to convince the market that it is indeed, "here to stay," as Gil Bennett contends. The restructuring of the company's finances may help, but near-term solutions are no substitute for long-range planning. Potential Challenger operators will continue to ask, "Will the company be around five years from now?"

Canadair officials respond by saying that after restructuring, it will require only 15 Challenger sales a year to break even. Given the improving economy and an estimated market for 76 to 110 Challenger-class aircraft per year, the likelihood that Canadair can improve its market share and remain in the Challenger business seems promising. Unfortunately, market projections do not

always match actual sales, and even if the market for long-range business jets is as large as some experts claim, there is no guarantee that Canadair can garner enough sales to remain viable. ''

As for now, the Canadian Government seems prepared to forgive Canadair's burdensome debt and to sustain the Challenger program, thereby saving the jobs and technology. B/CA