B/CA Analysis: Canadair Challenger 601-3A

Enhanced reliability plus the addition of several performance improvements and a Sperry FMS have made the 601-3A a more formidable challenger in the heavy-iron market.

By James R. Cannon

Over a decade ago an advanced top-of-the-line business jet was introduced that promised to usher in a new era in cabin comfort while flying great distances with significantly improved fuel efficiency compared to existing long-range corporate jets.

As fate would have it, the Canadair Challenger 600 had a hard time living up to its billing, and although the development of the General Electric CF34-powered CL-601 rectified some of the CL-600's most glaring deficiencies, the aircraft still lacked some of the things that were needed to make it a true challenger in the long-range corporate jet arena.

But with the advent of the 601-3A, Canadair may finally have the advanced aircraft that will ensure the company's lasting success in the business jet market. A refinement of the CL-601-1A and the latest in the logical development of the Challenger design, the -3A is an extremely comfortable and capable corporate aircraft.

According to Doug Adkins, director of flight operations and chief test pilot for Canadair, the main reasons why a potential client who is considering purchasing a Challenger 601 should choose a -3A over a used -1A are the performance increases that are offered with the newer aircraft and the Sperry flight management system that comes with the CL 601-3A. Also attractive is the incorporation of a variety of performance- and reliability-enhancing service bulletins as standard on the new aircraft.

"If a pilot were operating in a hot climate or out of high-altitude airfields," Adkins remarked, "the -3A offers improved performance through its flat-rated engines. The -3A will enable the aircraft to climb to a higher altitude sooner, which will allow more flexibility in the North Atlantic Track System and random tracks, and provide for increased weather avoidance initially during long flights." Adkins added that the -3A would also perform better than the -1A at cruise altitude in ISA-plus conditions. This can become very important during long overwater flights, he noted.

The -3A's advertised NBAA IFR long-range cruise distance with five passengers is slightly better (3,430 nm) than the -1A's, but long-range cruise is still a 0.74 Mach proposition. However, according to Adkins, what is significant is that the -3A will cruise at 0.77 to 0.78 Mach in ISA conditions at FL 390 from a max gross weight takeoff.

Performance Pluses

What actually makes the -3A a better performing aircraft than the -1A are a number of modifications:

➤**Flat-rated engine performance.** The -3A's General Electric CF34 powerplants are flat-rated to 70°F. This means that full takeoff thrust is available up to 70°F and that a reduction in takeoff distance is required at temperatures above 70°F.

Adkins indicated, "We are not saying that the engine is producing more than 8,650 pounds of thrust [or 9,140 pounds with automatic power reserve]. What we are saying is that we have flat-rated them out to a higher ambient temperature. The thrust-to-weight ratios for takeoff are the same as they were."

An example of the improvement is a max gross weight takeoff at sea level on an 80˚F day. The takeoff distance required for the -3A is 5,800 feet, compared to 6,180 for the -1A. And at 950F,

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the difference in takeoff distance between the two aircraft increases to 600 feet.

The -3A's N1 climb schedule is up three to four percent with no increase in temperatures. Limits are all higher. Climb schedule temperature limits are calculated on hot-end inspection life and not max continuous ITT limits. You still see about 800°F until reaching FL 300 or so, then the temperature will stabilize around 820°F with climb N1 set. Balancing of the fans has to be done a little differently, and this is accomplished at higher N1 rpm settings.

Time to climb is improved slightly on the -3A. At max gross on an ISA day, the -3A will reach FL 370 in 19.9 minutes, 1.4 minutes faster than the -lA. Canadair is also working on new engine mods to lower engine emissions to conform with projected regulations.

➤**Auto ground spoiler deploy.** In the past, to obtain ground spoiler extension after landing a Challenger, one pilot, usually the one in the left seat, would have to deploy the flight spoiler lever to the full aft position, depress a release button on the top of the lever, lift, the lever and move it farther aft through a gate mechanism to the ground spoiler extend position. If the button was depressed too soon (before reaching the full extend position), the pilot was prevented from deploying the ground spoilers unless the flight spoiler handle was retracted and the sequence repeated.

The manual deploy procedure can become cumbersome and sometimes cause confusion in the cockpit. Many operators require the pilot in the right seat to reach around and deploy the flight and ground spoilers on touchdown. In most other business jets, this maneuver is rather easily accomplished. The Challenger cockpit is so large, however, that in order to deploy the flight spoiler handle from the right seat, the pilot is required to lean left and reach around the throttle quadrant quite a distance.

The new ground spoiler system in the -3A is armed through a switch that is located on the left-hand side of the center console. This switch is placed in the armed position and remains there unless a ground test is being conducted. With a weight-on-wheels (WOW) signal from both channels of the system or wheel spin-up and throttle retardation to idle, the ground spoilers automatically deploy. This action hydraulically releases internal locks in each ground spoiler actuator and deploys one panel per wing to the 45-degree fully extended position.

This modification to the previous ground spoiler system is evident by the absence of the release button on top of the flight spoiler handle and the gate mechanism on the after portion of the flight spoiler quadrant. Challengers without the mod have an "ON" position in the same location as the "ARMED" position in the -3A.

In the 601-3A and other Challengers that have undergone this modification, flight spoiler extension after touchdown is used not only to extend the flight spoilers-one panel on each wing-but as a backup deploy for the ground spoilers in the event of a failure of the auto-deploy system.

➤**Powered main entrance door.** An optional item on the 601-1A, this feature is included as standard on the 3A. A DC motor powers the door up to a point where a crewmember can easily grasp and pull it to the proper position for latching into the safe and locked position. Hoisting is accomplished through a series of cables and pulleys. This system works very well and is much more desirable than the previous manual method.

➤**Windshield heat modification.** The windshield heat switches, which now incorporate "low" and "high" positions, are used in conjunction with a new procedure. After engine start, both switches are placed in the "low" position and remain there unless heavy icing is encountered in flight.

➤**Additional landing lights.** Two additional landing lights have been installed in the under portion of the nose cone to offer increased night-landing visual acuity.

The Sperry FMS Advantage

Doug Adkins is also very enthusiastic about the -3A's new avionics package: "The Sperry FMS is marvelous. It really allows you to do an awful lot by decreasing the crew workload and increasing their flexibility."

The Sperry SPZ-8000 includes dual flight-management systems with two alphanumeric keyboards, dual flight guidance computers, dual digital airdata computers, a five-tube EFIS with multifunction display and four-color digital radar. The 601-3A that B/CA flew had three inertial reference systems manufactured by Honeywell. A complete Collins Pro Line II navigation and communications package and a Fairchild A-100A cockpit voice recorder were also installed as part of the 601's standard avionics.

(Also standard on the 601, but not evaluated during this flight, are dual Collins HF-9000 fiberoptic high-frequency radios. These units, which have undergone extensive testing in anticipation of their initial installation in the Challenger 601-3A, have the capability to generate 10, 50 and 175 watts of power. The only difference between the 601-3A we flew and the standard factory -3A is that the test aircraft contains one additional IRS; the factory-equipped -3A has two.)

The Sperry FMS is designed to perform lateral and vertical navigation as well as aircraft performance calculations. The FMS determines its position through the use of inertial reference systems, VLF/Omega and VOR/DME updating. Global Positioning System data can be accommodated when available, but the system is not designed to accept Loran-C sensors.

The FMS is controlled through a CD810 control display unit, which uses colors to differentiate between functions and is similar to other long-range CDUs with the exception of the scratchpad and line-select features. The scratchpad is located in the bottom line of the CRT portion of the CDU and is used for data entry, to receive messages and to transfer data via the line-select keys.

The CDU contains four line-select keys on either side of the CRT for a total of eight selections. The line-select keys can be used to receive or to send information to the scratchpad as well as select certain modes without having to go through a series of index pages.

The CDU also has five mode keys directly under the CRT. Selections include: "Performance Index," Nav Index," "Active Flight Plan," "Progress" and "Direct/Hold/Intercept."

Above the CRT, the CDU incorporates six annunciators that alert the crew to FMS operations. One of these - "APRCH" - indicates that the FMS is operating in the high sensitivity mode: the aircraft is within 10 nm of the destination airport and speed is less than 200 knots.

Using the Nav Computer

The navigation computer, which contains a database consisting of Jeppesen information as well as a storage area for waypoints and flight plans, is the brain of the FMS. Jeppesen data include navaids, airports, runways, high-altitude airways, SIDs, STARs and named waypoints; they are updated every 28 days using a data loader. This feature can also be used to load long-range flight plans from a flight planning service.

Initialization is quite similar in logic to other long-range navs. One interesting feature is the automatic choice of "Origin" as the closest airport within three nautical miles of the initialized position. Once "Origin" and "Destination" are entered, the system will automatically search for a flight plan stored within the database.

The "Performance" feature is very useful. Within three data pages the computer will provide climb/speed, descent/speed, descent/angle, speed/ limit, BOW/gross weight, fuel management, cruise altitude/speed/fuel flow, and cruise wind data.

Following "Pre-Departure" procedures, the "Departure" feature can be utilized for entry of runway, SID, transition and flight plan information according to ATC clearance. Conversely, when within 200 run of a destination, the “Arrival” prompt will be illuminated. STARs may also be incorporated via the database for use in navigation through the FMS. Additionally, a “Weather Alternate” may be entered and a flight plan generated to be followed after a missed approach is executed.

The lateral navigation functions are excellent. The really exciting feature of the FMS, however, is its vertical navigation capability. The crew can designate a climb speed or a particular point at which they desire to be at a particular altitude. The computer will calculate, fly and display a “Top of Climb” point on the CRT. It will also provide the same functions during a descent. It will even fly to designated altitudes that comply with published SIDs and STARs.

Last but certainly not least for all of you who find it difficult to remember all of the proper procedures involved in holding pattern entry, the FMS will enter, display and maintain the appropriate holding pattern requested by ATC. You simply type in the inbound course, distance and direction of turn into the FMS. The FMS checks the aircraft’s airspeed 30 seconds prior to entering the hold and will illuminate via a high-airspeed warning whether the airspeed exceeds holding limits. The system also determines what type of holding entry is required, annunciating the appropriate procedure (teardrop, parallel, etc.) on the multifunction display.

Flying the -3A

When B/CA took the -3A for an evaluation flight recently above Dorval, Quebec, we filed into the Canadair test area (which was defined by radial and distances from the Mirabel VOR) at an altitude of 15,000 feet msl. The principal portion of the test area that we worked in was the airspace defined by the 340-degree and the 005-degree,radials (20 to 100 DME) for all altitudes above 12,500 msl. Once inside this designated airspace, a climb to FL 410 would be requested.

The flight was conducted aboard the first production 601-3A, serial number 5001. With all of the test and evaluation equipment onboard, the aircraft had a zero-fuel weight of 27,307 pounds with four crewmembers. The advertised typical BOW for a 601-3A is 24,685 pounds.

For the evaluation flight, we had a total of 8,500 pounds of fuel, which gave us a ramp weight of 35,787 pounds and a ramp c.g. of 26.5 percent MAC. The Challenger 601 has a maximum fuel capacity of 16,665 pounds.

Local barometric pressure was 30.18 with an OAT of 21°C. Our takeoff distance required 3,850 feet. V1 was 111 knots, VR 124 knots, V2 133 knots and takeoff power was 90.5 percent N1 with zero bleeds. In case of the need for an immediate return for landing, we were slightly under the maximum landing weight of 36,000 pounds and were targeting a VREF of 134 knots.

The Challenger 601 is very easy to taxi. There are no dead spots that cause constant input to the hand wheel, which is located on the left side of the console. Normal nosewheel steering, 55 degrees either side of center, is exact and positive but only has to be used when making sharp turns in and out of the ramp and runway/taxiway areas. The steer-by-wire system incorporated in the early 601s uses rudder travel to control the nosewheel steering up to seven degrees either side of center. An electronic control unit and potentiometer replace the mechanical linkage between the hand wheel and the steering control valve. Pilots who have transitioned from the Challenger 600 to the 601 will freely admit that this is one of the features they most enjoy on the aircraft. The steer-by-wire system is preferable for directional control during takeoff and landing.

With intermediate fuel loads, as in our case, the 601 does not require any power application to depart the parking area. We were underway after a simple brake release. The use of individual thrust reverse in the idle position during taxi is recommended by many operators as a means to prevent dragging of the brakes.

The radar system on the 601-3A is tied to the weight-on-wheels system so. that it cannot be inadvertently turned on while on the ground. It will also automatically switch to the standby mode immediately upon landing. Through a series of function selections, however, the pilot does have the capability to take a look at the radar picture prior to departure.

Following a thorough briefing from Doug Adkins and clearance from the local ATC facility, we departed on Runway 10 from Canadair's facility, just to the northeast of Dorval, Quebec at 1211 hours. Acceleration to V1 was no different than in the -1A. Time to rotation was 21 seconds and the rotation itself was typically Challenger: smooth and easy. The controls have a light and yet positive feel.

With gear and flap retraction accomplished prior to passing 500 feet agl, the aircraft requires a power reduction in order to prevent acceleration beyond 200 knots. That may give you some idea that the 601-3A is a very powerful aircraft. In less than two minutes from the initiation of the takeoff roll, we were passing through 4,000 feet, turning on course for the test area.

For those who are familiar with Gulfstreams or Falcons, the one noticeable difference in flying the Challenger is the lack of oral pitch trim feedback. You have a very positive sense that you are trimming out hydraulically dampened elevator forces; you just don't have the clacker sounding off or the trim wheel whining as you input pitch trim.

The outside visibility in the Challenger is excellent. With two large windshields and two side windows, the only limitation to maintaining an outside visual scan is the top portion of the windshield. To aide the captain in visual separation during a left turn, the copilot must lean forward and left in order to scan the horizon.

By 1217 hours we were level at 15,000 feet and accelerating past 292 knots to our target speed of 388 knots with an OAT of -30°C. In order to maintain 300 knots at this altitude and temperature, our N1s were 79 percent with an ITT of 660°C per side. A fuel flow of 1,400 pounds per side was required.

Testing the FMS

We then proceeded to the test area and initiated a series of vertical navigation climb programs that demonstrated the capability of the FMS during departure and climb out.

The climb portion of these VNAV demonstrations was initiated at 1231 hours; although we made intermediate stops at FL 220 and FL 290 using the FMS, the aircraft reached FL 410 16 minutes later, having consumed an additional 800 pounds of fuel since departing 15,000 feet. Maximum cruise power of 92.3 percent for an OAT of -62°C was set and 0.80 Mach (454 KTAS) was reached in six minutes and 40 seconds elapsed time from our programmed level-off speed of 0.70 Mach.

One interesting area for comparison of the 601-1A and -3A is the N1 target during climb at higher altitudes. Proper management of the aircraft during a climb to cruise altitude requires the monitoring of a climb N1 schedule that recommends an N1 setting for a particular passing altitude and OAT indication. During our flight, passing FL 350, target N1 was 95.4 percent, ITTs were 833 and 810, fuel flows were 1,230 and 1,200 pph, with an OAT of -52°C. Passing FL 380, target N1 was 94.0 percent, ITTs were 814 and 791, and fuel flow was 1,100 per side. The 601-1A N1 climb schedule will normally not allow ITT to exceed 800°C, and in many instances from FL 310 and above, the N1 target will bring the ITT below 790 degrees.

The -3A's autopilot is smooth and easy to use. The flight director system, which ties all available functions of the FMS and the autopilot to the primary flight control instruments, is new and admittedly difficult to use if you are used to the standard flight director in the 601- IA. One of the first things you become aware of is that the yaw damp and Mach trim are located in the center of the glareshield instead of in the lower portion of the pedestal.

The most distracting part of using the flight director, however, was the lack of positive feedback through illumination of the item when selected. Example: You may depress “Approach,” but the selection itself on the glareshield will not illuminate that selection. That feedback to the pilot is taken care of by the ID 802, located just above the radar. Altitude preselect on the autopilot is automatically armed when the preselect dial is reset to a new altitude. This panel acts as a master mode indicator. Items that are selected but are not yet providing guidance, are indicated in a white or amber color. Once an item in the flight director is providing guidance, it changes color and is also illuminated in the margin surrounding the attitude indicator.

The “Heading,” “Course” and “IAS/Mach” selection knobs are located on the glareshield directly in front of each seat position. One nice feature of this portion of the system is the push-to-center selection for heading and course. The heading bug and the course deviation indicator will automatically slew to the 12-o’clock position when depressed.

We stopped climbing at FL 410, the service ceiling for the Challenger 601, and set maximum continuous power, Which provided fuel flows of 990 and 980 per side. A vertical navigation descent was then initiated to demonstrate the top-of-descent feature of the FMS as well as the holding feature.

The descent was terminated at FL 310 in order to demonstrate the climb characteristics at altitude. With an N1 setting of 95.5 percent as our target, a climb was commenced back to FL 410. The elapsed time was less than nine minutes.

From this position, Adkins demonstrated the high-speed Mach characteristics of the aircraft. It has a slight rightwing heaviness at the Mach buffet, but the aircraft is completely controllable. This portion of the flight ended at FL 240, and we exited the test area in order to shoot an autopilot-coupled approach to a missed approach and finally for return to Canadair’s field for landing.

The Approach

One outstanding feature of the SPZ8000 is the capability of superimposing the approach criterion on the HSI while navigating using the LNAV, heading or nav modes of the FMS and flight director. The approach course, CDI deflection and glideslope indication all appear in a pinkish color and provide the pilot flying the aircraft with an excellent reference concerning his relational reference and alignment with the expected approach.

The first flap position selection - 20 degrees - is normally called for approaching 200 knots. Maximum airspeed for this selection is 238 knots. The autopilot performed this transition very smoothly and accomplished all functions well during the entire approach. Thirty-degree flaps and 45-degree flaps are airspeed limited to 198 and 190 knots, respectively.

Our target VREF for an approach weight of 31,707 pounds was 127 knots. The 601-3A handles just like a -lA in this phase of flight. Typically, the aircraft requires much less power than you would normally apply during maneuvering and initial approach configurations. This changes after final flap selection, however, when the airspeed has decreased to

VREF + 10 knots. If sufficient power is not stabilized at this point, deceleration to VREF Will occur rather quickly.

About two years ago, Canadair organized an interdisciplinary group, known as the Corrective Action Team (CAT), to accelerate the development of a mature aircraft and to improve reliability. The results of CAT’s efforts are seen in these graphs of removals per 1,000 hours for all components on the 601 series (top) and mean time between removals for -17 and-1 8 windshields (bottom) since the CAT began. The sidebar shown on this page lists some of the major service bulletins that emerged from the CAT program. These are standard on the 601-3A. Based upon the improved reliability of 601 components, Canadair offers Smart Parts, a fixed-cost per hour of $121 to cover the replacement or repair of 601-3A Challenger parts except engines, APU and IRSes. If the actual cost of repairs or replacement over a five-year period exceeds $121/hour, the operator pays nothing additional. If the actual costs are less than the fixed hourly charge under the Smart Parts contract, the operator receives a 60-percent rebate of the unused money.

The 601, when properly flown in the final landing configuration, is a noselow aircraft. The pilot will feel as if he has a flat or slightly nose-down attitude and thus has the potential to accelerate. The tendency is to want to decrease power slightly in order to regain a standard visual picture while maintaining target airspeed.

Very little flare is required during landing. Power must be reduced to idle prior to flare if flying above VRFF during the last 100 feet of the descent. If your technique calls for flying the aircraft at VREF during the final phase of the approach, then it is recommended that power be held until entering the flare.

The transition from idle throttles to flight spoiler deployment and back to thrust reverse application is relatively easy and not as cumbersome as it may first seem. With sufficient runway available, little or no braking is required. The 601's thrust reversers are very effective.

Adkins revealed that during certification testing and evaluation, the 601-3A was landed at maximum landing weight at a test field and made the first taxiway, some 1,650 feet past the approach end of the field. This was accomplished to demonstrate the shortfield landing capability of the aircraft.

We taxied back to Canadair's hangar and shut down with 3,500 pounds of fuel remaining. The elapsed flight time from first takeoff to final landing (three approaches and landings were made) was exactly two hours. Slightly less than 5,000 pounds of fuel had been consumed.

In terms of crew and passenger comfort (interior and exterior sound levels are the same for the -3A as the -1A) and pilot workload, the Challenger is a dream. The Sperry FMS reduces pilot workload and makes the -3A a joy to fly. And with improved performance and updated avionics, the Challenger 601-3A provides the flexibility and size required for the corporation looking to invest $12 to $14 million in a true state-of-the-art machine.

With the 601-3A, Canadair appears to have packaged the latest in technology for business aircraft within an airframe that is demonstrating significantly improved reliability. Cabin size and passenger comfort were always the Challenger's strong points, and -3A performance is adequate for the majority of operators with long-range needs. Considering these attributes in relation to the aircraft's acquisition and operating costs, the CL 601-3A offers much value for the dollars invested. **B/CA**