The twin-turbine 429 lifts off the ground "wings level" and just slightly nose up.

PHOTOS: YVES BEAULIEU

Bell 429

Bell's new light twin nears FAA certification

by R. Randall Padfield

By the time you read this, it is likely that Bell Helicopter will have received Transport Canada type certification for its twin-turbine Bell 429 light helicopter. Though not quite as likely, the FAA might also have validated Transport Canada's TC, since the U.S. agency has been following the process closely. The European Aviation Safety Agency (EASA) is expected to add its own validation a few weeks later, after EASA pilots do their own certification flight testing.

Anticipating the imminence of type certification, Bell Helicopter invited four aviation journalists to its assembly facility in Mirabel, Quebec, in May for Bell 429 briefings and demonstration flights. The flights took place in Bell 429 S/N 57002 (C-FTNB), which the company brought to the Paris Air Show last month to fly in the daily flight display and provide more demonstration flights. This "mostly production aircraft" will eventually be sold to a customer.

The 429's flight-test program has accumulated more than 1,800 hours using two prototypes and three pre-production aircraft since the first prototype flew on Feb. 27, 2006. When Bell announced the 429 in February 2005 at Heli-Expo in Anaheim, Calif., the company estimated it would receive Transport Canada and FAA certification in the first quarter of 2007 and begin first deliveries later that year. As Neil Marshall, Bell Helicopter program director for the Model 429 and MAPL (modular affordable product line), explained, "The delayed certification of the 429 has been a talking point for the last year or so. We wanted to hit the mark with this aircraft–to under-promise and over-deliver–and I think the only area we missed was the schedule. It has taken a bit longer than expected."

By the end of this year, Bell expects to deliver eight to ten 429s and have three or four in customer service. The first aircraft will be going to U.S. airmed operator Air Methods, which will fly the helicopter for an undisclosed hospital. Ramping up to a full production rate of 96 in 2012, Bell is planning some 40 deliveries next year and 70 to 80 in 2011, Marshall said.

A Brand-new Design

While the 429's resemblance to its Bell 206 JetRanger heritage is unmistakable, Bell officials insist "the 429 is essentially brand new." Conceptual work on the 429 began in 2003 after Bell accepted that its twin-turbine, dual-pilot IFR Bell 427, certified in 1999, did not meet the needs of air medical operators, who wanted single-pilot IFR capability, better performance and a flat-floored, open cabin with room for two patients on stretchers and two attendants. Company executives looked to the MAPL research team for a solution and found the modular cabin design well into development. That led to a decision to scrap plans for the 427i, which would have brought some of the above improvements to the 427 design. (Production of the 427 will end later this year as 429 deliveries increase.)

Though the Bell 429 is being certified as a light helicopter under FAR Part 27 (which limits mtow to 7,000 pounds), Bell contends that its cabin is closer in size to that of an 8,000- to 9,000-pound intermediate-size helicopter, which would be certified under Part 29. "We see the 429's cabin size as comparable to the [Eurocopter] EC 145's and about 30 percent larger than the EC 135's and [Agusta] A109's cabins," Marshall said. While various factors make precise comparisons of these helicopters' cabin volumes difficult, there's no doubt the 429's 204-cu-ft cabin is a huge improvement over the 427's 102-cu-ft cabin. Regarding price, Marshall said, "The 429's price is just slightly higher than that of the EC 135 and much less than the 145's and 109's pricing."

Useful load of the 429 when certified will be 2,590 pounds, though Bell expects to increase this to 2,640 pounds. Eurocopter reports the useful loads for the EC 135 and 145 as 3,208 pounds and 3,953 pounds, respectively. Marshall explained that the 429's useful load includes the weight of equipment for single-pilot IFR, two pilot seats, six passenger seats and a standard interior, while the Eurocopter numbers do not. He said, "We have established that the EC 135 has about 120 pounds more useful load today than the 429, when compared apples-to-apples. But the 429 has greater speed, hover performance, fuel capacity and range." He also said the 429 already meets most Part 29 requirements, simplifying certification of future, heavier derivatives. Currently, the aircraft seats a maximum of six in the cabin and two in the cockpit.

The 429's flat floor and wide-open cabin (an aluminum sub-structure with graphite skins) provide mission flexibility unmatched in previous Bell light helicopters. Engineers opened up the space by eliminating the vertical structure behind the cockpit seats (the "broom closet" that holds the flight-control rods in earlier Bells) by routing the control rods

Bell 429 Specifications and Performance

	Goal	Actual
Max takeoff weight	7,000 lb	7,000 lb
Empty weight	4,300 lb	4,410 lb
Useful load	2,700 lb	2,590 lb
Max cruise speed w. skids (mtow, SL, ISA)	142 kt	150 kt
Max speed (Vne)	n/a	155 kt
Long-range cruise speed	n/a	130 kt
Max operating altitude	20,000 ft	20,000 ft
Hover out of ground effect (mtow, TOP, ISA)	9,300 ft	11,280 ft
Hover in ground effect (mtow, ISA)	12,000 ft	14,130 ft
Range (mtow, SL, ISA)	350 nm	368 nm
Endurance with IFR reserve (mtow, SL, ISA)	2.25 hr	2.26 hr
Direct operating costs (Fuel $3/gal, labor $75/hr)	$667	$664
Price	**$3.95 million***	**$4.865 million****

*Goal price when 429 announced at Heli-Expo in February 2005.

** Actual/current price in 2007 dollars. Bell Helicopter plans to announce a revised price after the model receives its type certificate.

Bell test pilot Leo Meslin (left seat) describes the 429's cockpit to the author. Three large Rogerson Kratos displays, a Garmin 530 and a Garmin 430 dominate the instrument panel.

for the main rotor up the sides of the fuselage behind the cockpit doors, and by changing the directional-control rods to push-pull cables and directing them from the tail-rotor pedals up through the post in the center of the windshield. While Part 27 does not call for compliance with the birdstrike requirements of Part 29, at the request of the FAA Bell demonstrated by analysis (though not testing) that the windshield center post would resist a strike by a "spec-size" bird and that no unsafe condition would result, such as loss of directional or engine control (since the engine N1 cables are also routed through the post).

Fastening points on the floor accommodate various seating arrangements and seat widths (15.5 in., 18.5 in. and 21.5 in.). Six of the narrowest seats in two rows can be positioned facing forward, airline-style, as is apparently the preference of air-tour passengers. The front row can be turned around to face backward in a club-seating arrangement, illustrations of which show the passengers' knees intermingling. Two each of the wider seats fit into one row. A user can select an almost unlimited combination of seating arrangements, for example two 21.5-in. seats in the front row and three 15.5-in. seats in the rear, or vice versa. One layout can also add a stretcher to the mix. Eliminating the copilot seat adds floor space for the cabin.

A removable graphite partition separates the cabin from a baggage area, which takes up 74 of the fuselage's 204 cubic feet of usable space. An optional 40-gallon auxiliary fuel tank can be mounted on the floor of the left side of the baggage area, leaving room for a narrow stretcher on the right. Baggage, cargo and even another stretcher can be placed on top of this load-bearing fuel tank. The standard 215 gallons of fuel is stored in four interconnected tanks under the cabin floor.

The standard Bell 429 has seven graphite doors: on each side of the fuselage there are a cockpit door, a hinged cabin door and an integrated sliding cabin door; the seventh door (for the baggage area) is on the aft right side. Opening both a hinged and sliding cabin door on either side creates access nearly five feet wide, enough to load or unload a stretcher and a nod to those airmed operators who don't want the optional aft-fuselage doors. While resembling the familiar

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Flying the Bell 429 S/N 57002

Bell experimental test pilot Leopold Meslin demonstrated the preflight walkaround of the Bell 429, which is straightforward. Most checklist items are visible from the ground and there are viewing ports for oil levels so that no panels require opening. Steps and handholds integrated into the fuselage allow inspection of the upper section and rotor head without a ladder.

The real action starts in the cockpit. The 16.5-inch pilots' seats are adjustable fore and aft and include an adjustable lumbar cushion. The right seat put me in perfect position to the controls and I was comfortable during the 90 minutes or so that I occupied the seat, though I was grateful I could adjust the lumbar cushion about halfway through the flight.

Dominating the instrument panel are the Rogerson Kratos flat-panel displays. S/N 57002 (C-FTNB), has three such displays, while a standard, single-pilot IFR 429 would have only two. As with most newer glass cockpits, the screens in front of the pilots are designated as primary flight displays, while the screen in the center is the multi-function display. Meslin explained several features of the system, including its integrated caution/advisory system, multiple-fail reversionary modes (meaning one screen will display all information if the others fail), system synoptic pages, checklists, electronic logbook, chip-detector history and built-in test equipment for continuous in-flight monitoring. Though it won't be available until post-certification, the system includes a page that allows the pilot to input weights and then automatically calculates weight-and-balance. A standard I/O bus is available for easy up- and downloading to aircraft maintenance computers. This aircraft also features a Garmin 530 and a 430, instead of the standard two 430s. It is equipped with a four-axis Sagem autopilot in place of the standard three-axis autopilot.

Probably the single most important feature of the MFD for pilots is the power situation indicator, or PSI, which provides a measure of torque (Tq), gas-producer rpm (N1) and measured gas temperature (MGT). The indicator shows both a numeric readout and a digital version of a "steam gauge" dial display, automatically displays the particular parameter that is reaching a limit first and then changes color from green to yellow to red as it goes into the max continuous, transient, takeoff and maximum limits.

The checklist up to engine start requires surprisingly little button pushing, not much more than switching on the battery. Most of the time seems spent waiting for various systems to run their self-checks, which the pilot or pilots can monitor on the MFD. Engine start is as automatic as it gets: rotor brake off, twist-grip throttle on the collective to the idle position, hit the start switch and watch the PSI as it monitors how well the Pratt & Whitney Canada PW207D1's fadec regulates the start. Then start the second engine the same way. After it's running at idle, increase the twist-grips to the flight position and watch rotor rpm increase to 100 percent on the PSI.

During my one-hour sortie in the right seat, I flew normal and max-performance takeoffs, steep turns, climbs and descents, an acceleration to maximum airspeed and several traffic patterns, including one with a simulated single engine failure. During this flight and a second one while I rode in the cabin, I watched Meslin demonstrate a coupled, four-axis ILS approach and go-around at Mirabel International, an out-of-ground-effect hover, a simulated autorotation with power recovery and more precise steep turns than I had done. The field-of-view from both the cockpit and the cabin is superb.

Lifting into the hover gives the first indication of the stability of the 429. The stability control augmentation system (SCAS) dampens external and internal (pilot-induced) turbulence, giving the helicopter the feel of a much larger and heavier machine. The 429 lifts off the ground almost skids level, just slightly nose high and with no discernible latitudinal preference. Solid control and stability while hovering and in sideward and backward flight made my lack of recent helicopter time irrelevant.

Meslin described the standard takeoff from a hover as a level acceleration past 25 knots and a climb at 60 knots (Vy). For category A takeoffs Vtoss is 45 knots. Normal speed on downwind is 120 knots, approach speed 60 knots and normal landing descent angle from 5 to 8 degrees. Minimum speed IFR is 45 knots, helicopter instrument approaches are flown at 70 knots and normal instrument approaches at 70 to 130 knots. Initial go-around and missed-approach speed is 70 knots. Normal autorotation speed is 60 to 100 knots.

Most of our flying was at near maximum takeoff weight. Without a doubt, this helicopter has a lot of power (see tables "Bell 429 Specifications and Performance" and "Some Observed In-flight Numbers"). The live-mount vibration dampers on the main gearbox do an efficient job of reducing vibration so that cruising at 140 knots is perfectly comfortable and even at 150 knots is not bad at all, though I'd expect it would get fatiguing after an hour or so.

Despite being somewhat rusty, I quickly became comfortable with the flight controls and found flying the 429 a delight. The systems were another matter for me. As intuitive as the flat screens may be, I felt myself behind the aircraft for much of the time. When Meslin flew the ILS approach, for example, he did it essentially as a single pilot, as I could do little more than watch him and look for traffic. I know learning the systems and procedures is a matter of training and flight time, and I suspect that active helicopter pilots with good turbine experience–in particular those with Bell time–will have little difficulty making the transition to the 429.

I can safely say that Bell Helicopter has now, at long last, designed a real light-twin contender for its product line-up. *–R.R.P.*

When You Must Land Right Away

The fewer "land ASAP" emergencies in any aircraft's emergency checklist, the better. Here is a summary of what the Bell 429 has for "land as soon as possible" and "land as soon as practicable." Not indicated is dual engine failure, which would obviously result in an immediate autorotation and landing.

Land as soon as possible

- Engine fire.
- Total loss of transmission oil pressure.
- Transmission oil temperature hot.
- Main gearbox chip detected again after using the fuzz burner.
- Loss of one hydraulic system (oil pressure).
- Rotor brake warning light on.
- Tail-rotor chip detected.

Land as soon as practicable

- Single engine failure
- Electronic engine control unit (ECU) failure, or degraded, or engine in manual mode.
- Engine indication and crew alert system (Eicas) mis-compare (invalid information detected between sources)
- Engine oil hot
- Engine oil pressure low
- Engine fuel pressure low
- Fuel hot, cold or low
- Dual or single generator failure
- Engine or transmission chip detectors inoperative
- Emergency or essential Bus 1 or 2 (loss of electrical power to emergency or essential buses)

Some Observed In-flight Numbers

Performance parameter	Conditions*
150 kt	94% Tq, level flight, two engines, 2,000 ft
140 kt	82% Tq, level flight, two engines, 2,000 ft
95 kt	Max Tq single engine, level flight, 2,000 ft
4,200-fpm climb	100% Tq, two engines, cyclic climb starting at 150 kt, 1,000 ft, trading airspeed for vertical speed
2,600-fpm climb	60 kt, 98% Tq, two engines, 2,000 ft
1,200-fpm climb	60 kt, max Tq, single engine, 2,000 ft
1,900-fpm descent	60 kt in autorotation, from 2,000 ft
Hover OGE	71% Tq, two engines, 1,500 ft

** General conditions: Aircraft close to max takeoff weight of 7,000 lb; altimeter setting 30.22; all altitudes msl; Bell Heliport (CSW5) elevation 221 ft; OAT at heliport +10 deg C.*

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clamshell doors on other helicopters, the 429's rear doors open wide and then slide forward using hinges cleverly designed to hold them parallel with the fuselage. Under development is an optional guard for the tail rotor, which is primarily of interest to operators selecting the aft-fuselage doors and, according to Marshall, a preference of airmed operators in Europe and Asia. In addition to cost, the guard will extract a weight and possibly a performance penalty.

YVES BEAULIEU

Versatility describes the 429's open cabin. Shown here are 18.5-in. seats in the front row and 21.5-in. seats in the back. Removing the back wall provides enough room for two stretchers and two attendants.

Power comes from two Pratt & Whitney Canada PW207D1/D2 fadec-controlled engines, each rated at 620 shp for takeoff, essentially the same PW207D turboshafts in the Bell 427, which has a takeoff rating of 550 shp. The -D1 version is standard, while the -D2 version comes with an optional fuel-oil heater, which eliminates the need for anti-ice additive in the fuel.

The 429's main gearbox is rated at 1,100 shp for takeoff (compared with 800 shp for the 427) and Bell has run it without oil during a ground test for an unspecified length of time. The helicopter also features a new four-blade, rigid, composite main rotor; upgraded 407/427-style composite main rotor hub; four-blade, composite tail rotor; graphite tail boom and graphite tail-rotor driveshaft. Also standard are dual hydraulics, three-axis Safran Sagem Avionics autopilot, two Rogerson Kratos flat-panel flight displays, and two Garmin GNS 430s with Waas capability. The skids are embedded in the fuselage, in part to provide better aerodynamics. Optional wheeled landing gear, now in detailed design, is expected to fly next year, be available in 2011 and increase max cruise speed by three knots.

The long list of Bell 429 kits and options (in addition to those already mentioned) includes air conditioning; floats (with or without a life raft); cargo hook (rated at 3,000 pounds); a rescue hoist (rated for 600-pound loads and operating outside the skids); a second engine fire extinguishing bottle; searchlight; dual controls; four-axis autopilot; a third Rogerson Kratos display; GNS 530 (with Waas); and weather radar.

LOIs Soon Converting to Purchase Agreements

Bell currently holds letters of intent (LOIs) for 301 multi-mission 429s, and the company will begin converting them to purchase agreements as soon as it receives type certification. While the LOIs are backed by $125,000 refundable deposits, their conversion to firm orders will require customers to add another $125,000 deposit, with the subsequent $250,000 total deposit becoming nonrefundable. At the same time, Bell plans to announce a revised price for the aircraft, now quoted at $4.865 million (2007 $).

According to Marshall, "Traditionally, we get a 95-percent conversion rate of our letters of intent," although he admitted the current state of economies around the world could have a negative effect on this rate. Last year, Bell was reporting LOIs for more than 350 copies of the 429; as late as February this year, it reported 330.

Of today's LOIs, North American customers account for 117 helicopters (about 40 percent), 76 (25 percent) are from Europe/Africa/Middle East customers, 59 (20 percent) from Asia/Pacific and the remainder (49, 16 percent) from Latin America. With deliveries of the 301 helicopters so far spoken for expected to stretch through 2013, Marshall said many customers have yet to indicate specific missions for their aircraft. Thus far, 71 are tagged for airmed operations, 49 for utility/offshore and 17 for law enforcement. Bell has grouped the other 164 as corporate, other or unspecified.

Customer pilot and mechanic training is due to start in September at the Bell Helicopter Customer Academy in Fort Worth. Frasca International is building the Bell 429 level 7 flight training device. ❑