Business & commercial Aviation
PILOT REPORT

Special Report: Cessna's Caravans

Cessna's single-engine "flying pickup trucks" are quietly lifting the air freight burden from airplanes of another generation.

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It wasn't too long ago that you could find at least one aging Beech 18 on the ramp at just about any airport attached to a town large enough to generate a few hundred pounds of air cargo daily. The marvelous Model 18s seemed to be the mainstay of the mail contractors and small cargo haulers.

Of course, Beech 18s received considerable help with their burdens from an assortment of other aging cargo-hauling machines. The single-engine Beavers and Otters have done yeomen's work moving the stuff of our commerce about the globe and have even made a buck now and then for their operators.

Even though it has been decades since any of these venerable aircraft have been offered (factory-fresh) as state-of-the-aircraft-making-art, they still represent excellent design, solid craftsmanship and durability that has become legend. Unfortunately, age takes its toll on all-even airplanes-and the ranks of these low cost, money-making, GA cargo haulers have been thinned severely.

Interestingly, similar images of the aging general aviation cargo fleet led Cessna management to develop an aircraft design concept that would slowly-almost shyly-replace the older fleet and, more importantly, make next-day package delivery service feasible for most communities around the United States.

Obviously, we're talking about Cessna's Caravan I family, a line of single-(turboprop)-engine "flying pickup trucks." These remarkable airplanes have become a common sight on cargo ramps all around the world. Indeed, Caravans have been working the airways competently and profitably in several configurations since 1985.

As the 225th Caravan enters service and as corporate operators consider this utilitarian vehicle for special industrial aid missions, it seems appropriate to bring you up to date on the Caravan family.

First though, let's dispel a myth. When folks talk about the Caravan I, the conversation usually includes mention of the largest user of these airplanes-Federal Express. FedEx wizard Fred Smith, it is said, saw the need in the early 1980s for an aircraft that could bring his overnight package service to the most modest size cities and still make money doing it. (Undoubtedly, that part is true.) What's more, the story goes, Smith told Cessna of this need, and the Caravan I was immediately whipped up to the FedEx spec. (Alas, this is not true.)

The truth is that the Cessna designers, all by themselves, dreamed up the Caravan with its high-cube fuselage and 3,000-plus-pound payload. They admit (although a bit red-facedly) that they never considered the overnight-delivery business as a possible big player in the Caravan's future. To give Smith his due, he took one look at the Caravan specification and decided it would be the perfect airplane for his company's special small-community applications-thus began the FedEx-Caravan love affair. (At press time FedEx had taken delivery of 105 of the 200 Caravans that it will receive under existing purchase agreements.)

Since the first two Caravans were delivered in February 1985 (one to FedEx, another to a small FAR Part 135 operator), the aircraft's production line has been the busiest turboprop fabrication facility in the United States. Indeed, in sheer numbers, it has been one of the

busiest general aviation production lines in the United States. Eight of the huge singles are made each month.

WHICH CARAVAN?

Caravans come in three flavors: A "short" passenger/cargo model with windows now called the "Caravan I"; a "short" version without windows called the "Caravan I Cargomaster" and a "long" version without windows called the "Caravan Super Cargomaster." Short Caravans measure 37 feet, seven inches from spinner tip to tail light and have a volume (aft of the pilot seats) of approximately 254 cubic feet. The long airplanes are stretched four feet, 20 inches forward of the wing and 28 inches aft. These airplanes have a volume of 337.7 cubic feet aft of the cargo barrier. Cargo pods are available for both airplanes. (We'll talk about them later.)

Standard empty weight of the short Caravan I is 3,865 pounds. The long airplane weighs 4,500 pounds, reflecting the weight of the extra fuselage length. Max ramp weights are 8,035 and 8,785 pounds, respectively. For all practical purposes, only cubic capacity is changed; payload capacity remains about the same. Of course, the longer Caravan is a little slower at max cruise weights and requires a bit more runway because of lower power and higher wing loadings.

It's probably best to ignore Caravan numerical designations-they're confusing. For the record, however, the short Caravan I started life as the Model 208. The first 39 windowless Caravans were made to order for FedEx and designated 208A. The "A" designation disappeared because of a change to certification paperwork after those initial 39 FedEx airplanes were delivered. In the meantime, stretched airplanes had been designated 208B. But with the "A" model gone, the "B" didn't make much sense. Cessna realized the numbers were getting pretty difficult to track, and thus adopted the three names listed previously.

While we're on the subject of confusing names, we should mention the Caravan II. This machine, produced only by Reims Aviation, S.A. (Cessna's associate company in France), really isn't a Caravan at all. It's a 400-series fuselage with turboprop powerplants. There are fewer than a handful in the United States (see the accompanying sidebar).

Returning now to the Caravan I story, there had been 128 short airplanes and 97 long airplanes delivered at this writing-a total of 225 Caravans of various descriptions.

The factors that have made the Caravan such a success all boil down to money, so we'll look first at the books. Initial acquisition is "generally doable" (as the bankers put it) for many small operators. A Caravan of any stripe usually can be bought off the shelf for under the magic $1 million mark, which in itself is quite a plus.

Base price of the short Caravan is $768,500. The long airplane lists at $885,600. While these airplanes come with basic avionics kits, most buyers install optional avionics and flight control systems packages ranging in cost from $20,000 to $100,000. A full de/anti-ice system carries a list price of some $30,000.

The standard Caravan I (window version) can be outfitted to carry a pilot and nine passengers for U.S. operations, or a pilot and 13 passengers for operations in many other countries. These seating packages range from $15,000 to $19,000. Alternatively, an operator can spec out options that facilitate loading and cargo

Figure 1

CARAVAN I OPERATING COST WORKSHEET

Direct Cost of Use per Hour		
Fuel (1)		$ 76.80
Oil		.20
Engine & Airframe Maintenance		
Labor (2) (0.6 hr./fit. hr.)		22.69
Parts		26.40
Avionics		1.89
Overhaul Reserves:		
Engine (3)		22.86
Propeller (4)		2.00
Starter/Generator (5)		2.66
Total Direct Cost per Hour (A)		$155.50
Total Direct Cost per nm (6)		.91

Fixed Cost of Use	**Per Year**	**Per Hour**
Crew	(B)	$XXX
Insurance	(C)	$XXX
Cost of Ownership	(D)	$XXX

Total Operational Hourly Cost (Sum A, B. C, D divided by total flight hours)
Total Operational Cost per Mile ($XXX)

Notes:
(1) $1.60/gal. at 48.0 gph (200-nm block fuel flow).
(2) $38/hr. labor rate.
(3) Engine OH at 3,500 hr. plus two hot-section inspections.
(4) Propeller OH at 3,000 hr.
(5) Overhaul exchange at 1,000 hr.
(6) 200-nm leg at 170-kt. block speed.

This worksheet is for approximations only. Actual costs vary due to differences in accounting methods, cost of fuel and oil, labor services, engine overhaul and type of avionics installed Additionally, the manner in which the aircraft is used will have a significant effect on actual cost of use. You can plug in your own cost figures to get an approximation of Caravan DOCs.

Figure 2

CESSNA CARAVAN I

Max romp	8,035 lbs	Max cruise	1,900 rpm
Takeoff	8,000 lbs	Max cruise @ 10,000 ft., zero wind, ISA	184 kts
Usable fuel	2,224 lbs		
Crew (one pilot)	210 lbs		

WITHOUT POD (EOW 4,300 lbs):

Distance (nm)	Payload (Lbs)	Flight Time	Fuel Used (lbs)	Fuel Expense	DOC
100	3,216	0:38	249	$ 60	$ 96
200	3,017	1:11	448	107	174
300	2,818	1:44	647	155	254
400	2,619	2:17	846	202	332

WITH POD (EOW 4,400 lbs):

Distance (nm)	Payload (lbs)	Flight Time	Fuel Used (lbs)	Fuel Expense	DOC
100	3,108	0:38	262	$ 62	$ 98
200	2,891	1:13	471	112	182
300	2,681	1:48	680	162	265
400	2,471	2:23	890	212	348

security. A cargo barrier and close-out net, for example lists at $2,735 '

The most popular options are fuselage-mounted cargo pods. The pod for short Caravans has a capacity of 83.7 cubic feet; the pod for the long airplanes has a capacity of 111.5 cubic feet. These options bring cargo area capacity of the standard Caravan I to about 338 cubic feet. A long Caravan with an external pod can handle 451.5 cubic feet. (Even at that size, most Caravans used in overnight package-hauling operations "cube out" before they "gross out." (But then again, package-hauling Boeing 737s cube out, too, before grossing out.)

BEHIND THE NAME

Simplicity of design and fabrication generates much of the Caravan's high dispatch reliability and relatively low maintenance costs. The Federal Express fleet has topped 110,000 hours and has enjoyed a dispatch reliability rate of 99.75 percent (99.81 percent since the first of the year). Figure 1 (based on information provided by Cessna) shows an operating cost breakdown for a Caravan I. You can use this table to develop an approximation of the operating cost for a Caravan in your operation.

The desire for simplicity and maintainability was a prime driver in the Caravan I design. As we pointed out earlier, the Caravan was intended to replace the world's aging flying pack horses. By definition these airplanes often are operated days away from the nearest sophisticated repair center, so the Caravan had to be maintainable in the field (or whatever passes for "the field" in the Third World).

The Caravan's 600-shp P&W PT6A-114 powerplant is one of the more significant factors in its maintainability equation. The engine has a 3,500-hour TBO, and the fleet is having no problems reaching that TBO. Then too, P&W powerplants are supported around the world, and any turboprop-qualified mechanic knows their innards well.

Using a single-engine aircraft in commercial service can present some interesting operational considerations and regulatory compliance challenges. For example, Part 135 regulations covering the carriage of ticketed passengers in single-engine aircraft under IFR are so restrictive that the Caravan is impractical for any but highly specialized domestic commuter operations. On the other hand, aviation regs in most countries permit commercial cargo operations at night or IFR in appropriately equipped single-engine airplanes.

From a real life (as opposed to regulatory) viewpoint, one turboprop engine especially a PT6A-is as reliable as any pair of recip engines, so the prospect of total power loss is not particularly bothersome to Caravan operators. Traditional two-engine installations, however, do provide system redundancy-an important safety feature for night and weather operations.

Caravan engineers addressed these challenges well. First, they looked at engine mechanical reliability statistics and discovered that the most vulnerable engine component (in a pretty invulnerable powerplant) was the pneumatically-driven control section of the fuel controller. If the diaphragm in the pneumatic section of the fuel controller fails, the engine spools down to flight idle. So, in addition to the familiar PT6A engine controls (power lever, propeller control lever and fuel con-

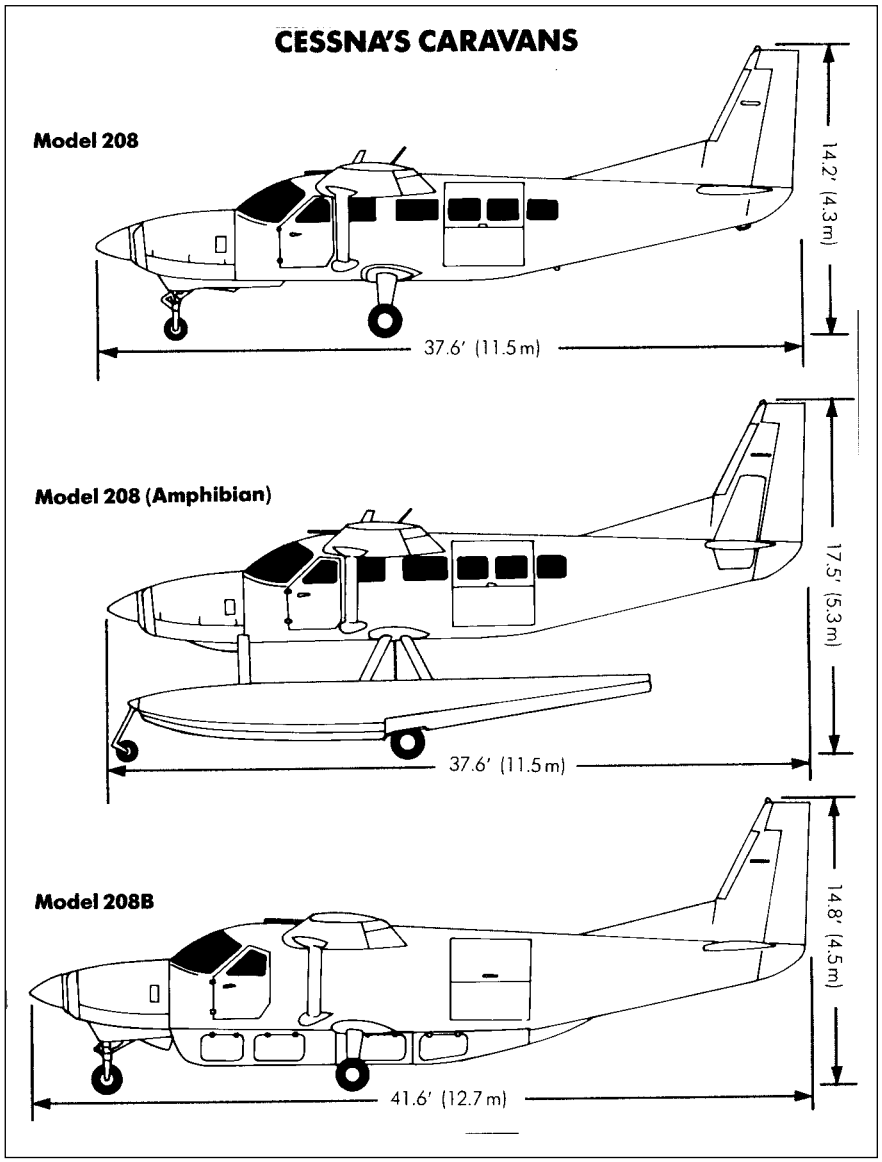
dition lever), Cessna installed an emergency power lever on the Caravan throttle quadrant.

The emergency power lever provides a mechanical link to the PT6A fuel controller thus bypassing the pneumatic link used by the normal power lever. (The emergency power lever gives the pilot full control of the engine fuel controller if the diaphragm fails.)

The Caravan's 28-VDC electrical system is a split bus design providing twin-engine-type redundant paths. Standard battery is a 24-volt, 45 amp-hour lead-acid unit. An optional 24-volt, 40-amp-hour Nicad is available.

A standard engine-driven starter/generator provides 200 amps to the bus. Most Caravan operators purchase an optional standby electrical system (about $3,000). This system includes a 75-amp alternator, belt-driven from an accessory pad on the rear of the engine. The standby alternator is wired into the buses through a controller so that power is provided to the buses automatically any time system voltage (provided by the starter generator) drops.

The reliability of the powerplant, its subsystems and the electrical system has enabled FedEx and Bendix/King to win full CAT-II certification for the Caravan. (So far as we know, the Caravan is the only single-engine aircraft in commercial service to have CAT-II authority. But when things absolutely, positively have to be there....)



The Caravan's structure is another important factor in both reliability and maintainability. Basically, this single-engine Cessna is designed and fabricated just like all other high-wing, strut-braced Cessna singles- only a lot larger. Any mechanic who knows his way around a CE-182 will feel right at home with the Caravan- more so, in fact, because he'll have significantly more room in which to maneuver.

Anyway, fuselage construction is entirely conventional-formed sheet metal bulkhead, stringer and skin design. The cabin is (almost) a rectangular box.

Interestingly, the airplanes that the Caravan is intended to replace are all tail draggers. Traditional engineering wisdom holds that only a tailwheel gear configuration can handle what pass for airports in the Third World. Undaunted, Cessna engineers decided to forge ahead with tricycle gear anyway. The result is a unique tricycle gear system that holds up to the meanest ground environments.

To accommodate rough (or no) field operations, the nose gear incorporates a unique drag link spring design. This element provides taxi spring function with aft displacement restraint. The spring is attached near the fork to reduce bending in the nosewheel strut. The link-spring itself is designed with "fail-safe" features so that it absorbs some energy even with loss of all strut oil, and it retains the nose gear in the event of a torque

Figure 3

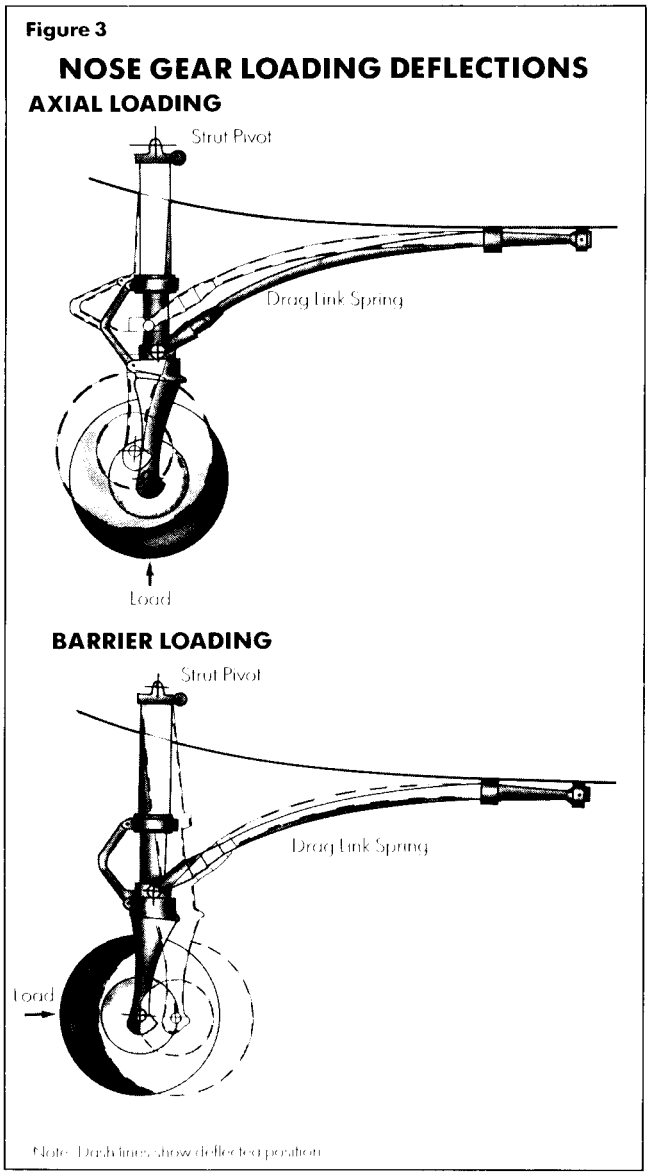
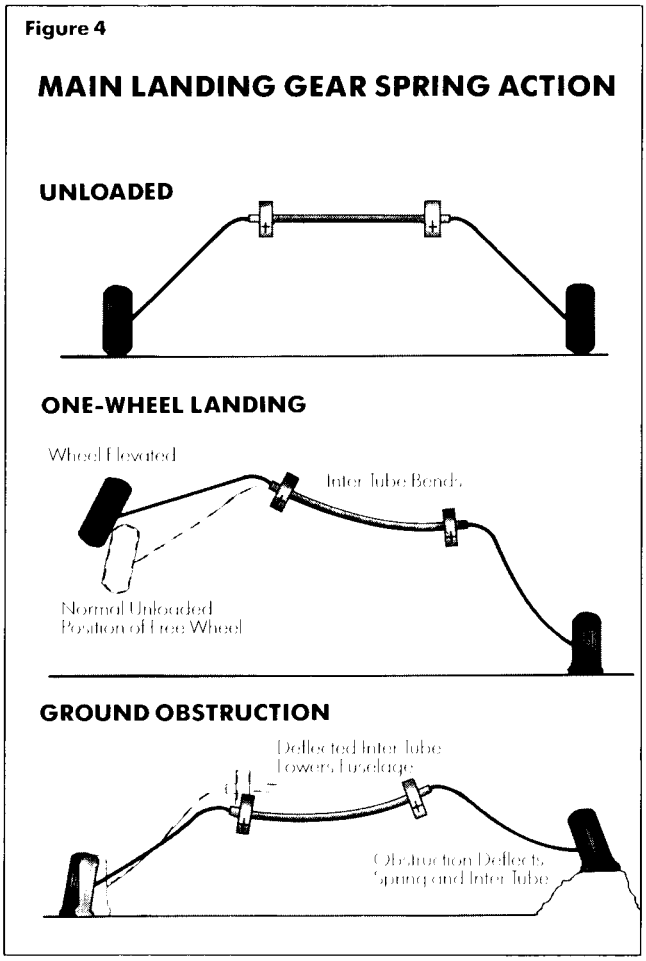


Figure 4



Special effort went into the design of the Caravan's tricycle gear system. The idea was to develop a tricycle gear that could go to places usually restricted to tail-draggers. To accommodate rough (or no) field operations, the nose gear (left) incorporates a unique drag link spring design. This element provides taxi spring function with aft displacement restraint. The three-piece, steel tube main gear (above) is designed to divert loads away from the fuselage.

link failure (see Figure 3).

The three-piece, steel tube main gear is designed to divert loads away from the fuselage (see Figure 4). The outboard main gear structures are connected under the fuselage by an "inter tube", which bends with deflection of the outboard units. This setup tends to reduce lateral motion of the fuselage during taxi over rough terrain. Keeping all main gear structure out of the fuselage also prevents expensive and difficult-to-repair fuselage damage in the event of a gear overstress.

A float version of the Caravan has been certificated, and several have been sold. Early on, some thought was given to outfitting the Caravan with skis. Engineers and marketers soon became disenchanted with the performance penalties and potential expense of a ski installation and abandoned the idea. Actually, many operations that would normally require skis can be undertaken by Caravans equipped with super-wide tires.

THE CARAVAN'S FUTURE

One of the questions that crops up regularly in Cessna planning rooms has to do with building a real Caravan "II"-that is, a Model 208 fuselage with two turboprop engines hung on a modified 208 wing.

Arguments for such an arrangement center around regulatory compliance (mentioned earlier) for IFR passenger operations, the possibilities of greater payloads

So What's a Caravan II?

If a Caravan I is a large-fuselage, Cessna-built, single-engine airplane with one turboprop engine, why isn't a Caravan II a similar machine with two turboprop engines?

A reasonable question to be sure.

The story began in 1982 when Cessna (U.S.) and Reims Aviation- Cessna's French associate- decided to build and sell a small turboprop transport in Europe.

The design would be based on Cessna's 400-series fuselage (the Models 402, 414, 421, etc.). The well-tested fuselage got a new mid-cruciform horizontal tail design and two P&W PT6A-112 powerplants rated at 500 shp each.

To be fair to the folks in Wichita, we should point out that most of the initial design work was done there. Indeed, most Caravan II parts are made in the United States and shipped to Reims for assembly.

Anyway, the Caravan II (CE-406) made its first flight in 1983 and received French certification in December 1984. (This event marked the first time that Cessna had certified an aircraft outside the United States before receiving FAA certification.) FAA certification was granted in mid-1986.

The Caravan II was designed to carry heavy loads of either cargo or passengers. Some European governments require two-engines on any airplane used for the commercial carriage of persons or property. It'll seat 12 commuter passengers. The French Customs Service bought several Model 406s for various civil and military applications. But the most important market still promises to be European light-freight haulers.

This airplane does help explain why Cessna is reluctant to twin the big-fuselage U.S. Caravan. First, the Caravan II carries a base price of $1.4 million. The European airplane weighs about the same as a short Caravan I, but has considerably less volume and payload/range capability. And, too, the European Caravan II carries the additional operational, maintenance and training costs that go along with two engines and their accompanying systems.

All those additional considerations are not to suggest that the Caravan II is not an excellent airplane for some applications. Rather, the truth in this case is that there's nothing whatsoever in a name.

and the very arguable perception held by some potential buyers that two engines are safer than one.

Arguments against putting two engines on the Caravan I all boil down to cost-cost of acquisition, cost of maintenance, cost of operation and cost of training. For the present anyway, the arguments for the status quo seem pretty persuasive.

Even if there's never a true twin-Caravan I, that shouldn't present a problem for the airplane's marketers in the foreseeable future. While Cessna management keeps the Caravan order book closed to public scrutiny, the best bet is that the market will support a production rate of eight per month or more for some time to come.

Remember that this airplane was designed originally to be a Third-World pack horse, a replacement for the Beech 18s, Beavers, Otters and other utility cargo haulers. The overnight rise of the domestic overnight package carriers diverted Cessna's attention for a while (and understandably so). The Third World still needs low-cost, highly reliable and maintainable pack-animal airplanes, however, and the Caravan I family fits that bill perfectly.

Then too, there is an increasing need for low-cost, (relatively) low-speed, high-cube aircraft for military and other specialized government operations. Cessna has a military reconnaissance version of the aircraft dubbed the U-27A, which is generating a lot of interest.

Finally, the corporate world is beginning to take a long look at industrial aid missions. Certainly, an airplane that can carry significant loads into ultra-short unimproved sites can be a boon to the mining, lumber and petroleum industries as those businesses get back on track. Land and resource management, aerial survey, special geological research also are operations in which the Cessna Caravans are finding a place and will continue to do so. **B/CA**