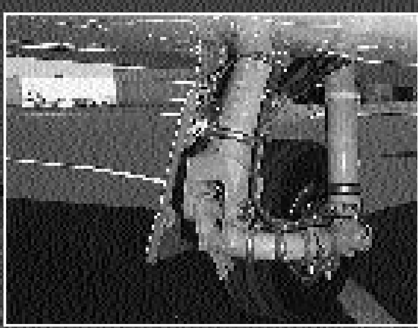
Analysis

CESSNA CITATION BRAVO

The Citation II's sprightly successor has better than forecast speed, fuel economy, and altitude performance; plus improved range/payload flexibility.

Clockwise from left: Bravo's four, big cockpit windows provide excellent visibility. The 28.2-cubic-foot aft, unheated and unpressurized luggage compartment holds 500 pounds. A redesigned airstair has wider treads and gas-pressure dampers that make it easier to use. Long-travel, trailing-link landing gear smooth out bumps and cushion touchdowns. The large vertical fin and rudder result in superb yaw stability and low-speed directional control.



Cessna (7)

The Bravo's seats, cabinets and furnishings are top notch. The standard configuration features a center club section with three additional passenger seats.

First impressions are powerful. When we first slipped into the Citation Bravo, it was as though we had just put on our favorite pair of old shoes. This was better than going barefoot.

Bruno Magli, eat your heart out, we thought. This is like slipping into a Made-in-USA, glove-leather moccasin wrapped in a business loafer.

Our second impression, however, overshadowed the first. The Bravo wasn't what it first appeared. This wasn't the same old shoe with new packaging. Its performance and versatility were head-and-shoulders above its predecessor, the Citation II. Apparently, competition in the business aircraft market is as tough as it is in the shoe business.

Cessna knew it had to make changes in the Citation II where they would count the most: engines and avionics (see sidebars). But the Bravo would have to be a design-to-cost aircraft to be competitive with turboprops as well as in the hotly contested light-jet class. Frills were out. Function was in.

The Bravo incorporates high-value improvements that operators will likely appreciate. Thrust reversers are standard equipment. Long travel, trailing-link main landing gear replace the notorious stiff, straight MLG struts of the first-generation, straight-wing Citations. The passenger seats, cabinetry and furnishings now are first rate, substantially upgraded from those in the Citation II. Bagged insulation and an isolated interior shell remove much of the low frequency engine-fan noise that used to permeate the cabin, especially in the rear.

Some changes are more subtle. A new secondary door seal reduces wind noise. The airstair door has wider treads for easier passenger boarding.

Pilots will appreciate the additional legroom in the cockpit. The forward cabin bulkhead has been moved aft three inches and there's now room for three chart books behind each pilot seat.

Preflight, servicing and maintenance chores are easier. The PW530A engines have oil sight gauges on the oil reservoirs to eliminate the need for those hard-to-read dipsticks found on the JT15D turbofan oil reservoirs. Fuel heaters eliminate the need for an anti-icing additive. The wingtip light lenses and radome have been redesigned to speed removal and replacement. Cessna even installed

BRAVO AVIONICS

Cessna

Step into the cockpit of the Citation Bravo and, at first, you're likely to think you're in an Ultra. No wonder. The Honeywell Primus 1000 system has the same three, eight-by-seven-inch display tubes and the familiar layout. A closer look reveals that AlliedSignal CNI 5000 SilverCrown panel-mount radios are installed in place of the Ultra's remote-mount CNI radios. There is a single AlliedSignal GNS-Xls in the console.

The package is as integrated as the one in the Ultra, even though it's based on the same hub-and-spoke avionics architecture, which has an IC-600 integrated avionics computer at the center. The CNI 5000 radios aren't connected to the GNS-Xls, thus the FMS is limited to GPS navigation only. It cannot use the CNI 500 radios for VOR/DME navigation in lieu of GPS and it cannot channelize the nav receivers for VOR, ILS or localizer approaches. In addition, the GNS-Xls essentially is a lateral navigator. There is no coupled VNAV function.

Cessna officials say they have no plans to offer the Universal UNS-1K as an option. However, insiders told B/CA that such a plan is in the works.

Other features of the avionics system include a Primus 650 weather radar, dual digital air data computers, dual flight directors and a single three-axis autopilot. Popular options include the AlliedSignal Flitefone VI, TCAS II, 117-VAC, 60-Hz cabin power outlets, cabin entertainment system and a Primus 870 Doppler turbulence detection weather radar.

gas struts on the nose baggage compartment doors, thereby eliminating the need for the thumb-release uplocks.

In May, Cessna added even more utility to the Bravo. Its maximum ramp and takeoff weights were increased by 500 pounds, resulting in a boost in seats-full range by up to 215 miles. Or with full fuel, the Bravo now can carry seven, 170-pound passengers, each of whom brings along 22 pounds of luggage.

FAMILIAR STRUCTURE AND SYSTEMS

All of Cessna's current production, straight-wing Citations use a circular cross section, conventional aluminum fuselage, as they have for the past 25 years. The cabin layout makes the most of the available 4.9-foot cross section. The Bravo's five-inch dropped aisle extends throughout most of the normally occupied section of the cabin, increasing the maximum headroom to 56.3 inches. But the wing spar carry-through structure reduces the headroom in the full width, aft lavatory to 47.6 inches.

The vault-type cabin door is 50.7 inches high and averages 21.6 inches wide, being about four inches wider at the bottom than at the top. A 35-inch-wide, two piece, clamshell door is optional. There is an FAA Type II emergency exit located directly across from the main cabin door.

The two-spar wing has a proven 23000-series NACA airfoil shape, which has relatively benign low-speed handling characteristics, especially considering the Bravo's relatively low wing loading. Low wing loading also makes for a relatively low angle-of-attack, thereby improving high-altitude performance.

Compared to laminar flow wings, the 23000-series airfoil is more tolerant of ice buildup, but the drag rises substantially above 0.65 Mach. The wing is fitted with electrically powered, trailing edge flaps along with manually actuated ailerons and hydraulically powered upper and lower speed brakes.

The primary flight controls are manually actuated with trim tabs in all three axes controlled by wheels on the pedestal. Electric pitch trim is standard and useful because of the relatively large pitch moments associated with landing gear and flap configuration changes. An angle-of-attack referenced, stall-warning stick shaker has been added to augment the aerodynamic stall warning buffet.

The rudder pedals provide up to 20 degrees of nosewheel steering by means of bungee linkages to the nose gear. Differential power and braking can provide up to 95 degrees of steering authority.

Compared to the Citation II, the Bravo has larger wheel wells to accommodate the trailing-link landing gear. They reduce the fuel capacity of each wet wing tank by 74 pounds, but the

CITATION BRAVO OPERATING COSTS

Fixed Expense (Annual):	
Crew + Benefits	$110,607
Hangar	34,728
Insurance—Hull (30%)	13,650
Insurance—Admitted Liability	2,250
Insurance—Liability	14,000
Recurrent Training	11,150
Navigation Charts	2,338
Updates/Uninsured Damage	18,800
Refurbishing	27,440
Computerized Maintenance	1,500
Weather Services	2,000
Total Fixed Expense	**$238,463**
Direct Expense (Hourly):	
Fuel (@ $2.02 per Gallon)	$265.20
Maintenance—Labor	72.80
Maintenance—Parts	73.18
Engine Reserves	132.30
Thrust Reverser	11.00
APU	0.00
Landing/Parking	4.29
Crew Expense	135.00
Catering/Supplies	30.15
Total Direct Expense	**$723.92**

Source: Conklin & de Decker Associates, Inc., Orleans, Mass.

BRAVO'S PW530A ENGINES

Pratt & Whitney Canada's PW530A may be an evolutionary engine, but the performance numbers indicate how far light-turbofan engine technology has come in three decades. The PW530A, rated for takeoff at 2,887 pounds to 79°F (26°C), is the first application for the 3,000- to 4,500-pound-thrust PW500 engine family that is being developed with the Bavarian firm Motoren-und-Turbin Union, which is a 25-percent partner.

The PW530A features a one-piece, integrally bladed fan wheel driven by a two-stage, uncooled low-pressure turbine. The high-pressure compressor has two axial stages and one centrifugal stage, thereby helping to achieve a 16-percent higher pressure ratio than the JT15D-4. The engine also has a 3.23 bypass ratio versus 2.62 for the JT15D-4, in part because it doesn't have a supercharger stage driven by the low-pressure spool. Those are two prime reasons why the new engine has 13 percent better specific fuel consumption at altitude. The PW530A chalks up a 0.768 lb/lb/hr SFC score at the industry standard, 40,000 feet, 0.80 Mach (installed) benchmark. That's the best of any engine in the PW500 family.

The higher pressure ratio and improved fan, along with a deep fluted mixer nozzle, also mean that up to 23-percent more thrust is available for high-altitude cruise. That's apparent when you see 405 KTAS on the EFIS display. The more-robust core and more-efficient fan also improve hot-and-high takeoff performance compared to the JT15D-4.

Cessna opted for a conventional hydromechanical fuel control to help

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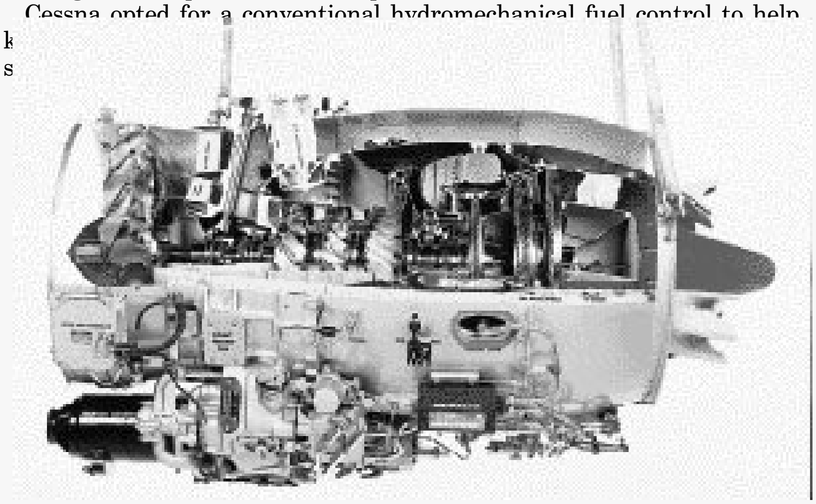


Pratt & Whitney Canada

greater fuel efficiency of the engines more than makes up the difference.

Jet pumps in the fuel tanks normally supply fuel to the engines. Electric boost pumps provide fuel pressure for engine start, cross feed and in the event of a jet pump failure. The Bravo is refueled through conventional, over wing ports.

The engines have 28-VDC starter-generators that are the main source of electrical power. These are fitted with new long-life brushes that also greatly extend armature life. Two 250-VA inverters supply AC power for the VHF nav receiver and gyro analog interfaces to the flight guidance system.

A 24-volt NiCad battery provides power for engine starting and acts as an emergency power source. It's rated at 44 amp/hours compared to the 39 amp/hour battery installed in the Citation II.

The Bravo's open-center, on-demand hydraulic system is virtually identical to that of its predecessor. It powers the landing gear, speed brakes and thrust reversers. A separate, electrically powered hydraulic system provides power for the anti-skid wheel brakes. A pneumatic bottle provides emergency power for landing gear extension and wheel braking.

The pressurization has been bumped up 0.2 psi to 8.9 psi to provide an 8,000-foot maximum cabin altitude at FL 450. A digital pressurization controller turns cabin altitude management into a no-brainer. Set the landing airport pressure altitude prior to takeoff and the controller, in concert with the Honeywell digital air data computers, does the rest.

An air cycle machine in the tail cone provides air conditioning, but a vapor-cycle air conditioner is available as a 91-pound, $36,625 option. Based on previous Citation experience, we recommend the vapor-cycle air conditioning option for anyone who routinely operates from warm airports, especially in areas of high humidity.

Ice and rain protection remain unchanged. Bleed air is used for engine and windshield anti-ice, and windshield rain removal. The air data and angle of probes, along with the inboard sections of the wing leading edge, are electrically heated. The outboard sections of the wing and the empennage are de-iced by pneumatic boots.

FLYING THE BRAVO

Straight-wing Citations are among the easiest aircraft to fly, and the Bravo is no exception. Preflight chores are easier than they are with the Citation II because of the aforementioned system improvements. However, the Bravo still doesn't have an oxygen pressure gauge near the filler port in the nose baggage compartment, thus requiring the crew to check the one in the cockpit during preflight or servicing.

The Bravo has forward and aft unpressurized and unheated external baggage compartments. The 17.6-cubic-foot nose compartment holds 350 pounds, but it's better to load the aircraft from rear to front to optimize the center of gravity. The 28.2-cubic-foot aft compartment holds 500 pounds. The optional, factory-installed ski tube is installed in the aft compartment of the demonstrator aircraft.

The demonstrator has seven seats in the main cabin: a center club section of four seats, two forward-facing seats in front of the lavatory, plus one aft-facing seat behind the copilot. A refreshment center is installed aft of the pilot and forward of the cabin door.

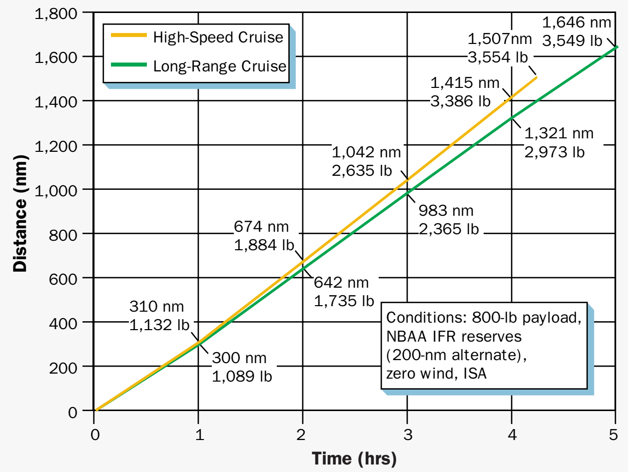
If an eighth seat is needed, the potty seat is certificated for occupancy during all phases of flight. There is 27.7 cubic feet of baggage volume in the aft lavatory, providing space for carryon items and coats.

The demonstrator has a 9,342-pound BOW. Options—such as vapor-cycle air conditioning, an HF radio, TCAS II, an air-to-ground radio-telephone, and various cabin amenities—added 521 pounds to the Bravo's BOW as listed in the *1997 Planning & Purchasing Handbook*.

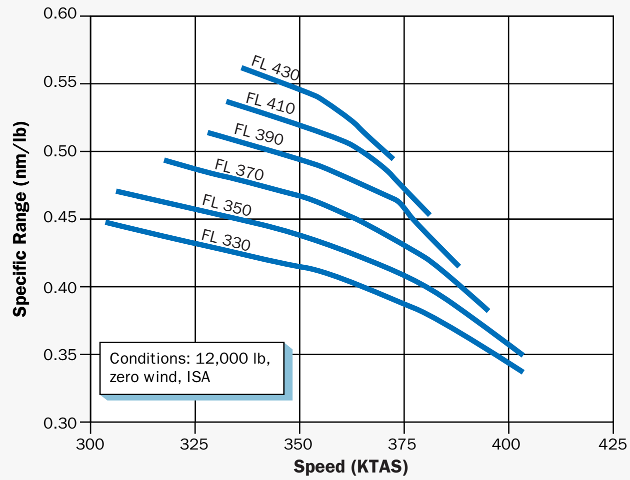
With 2,900 pounds of fuel, our ramp weight was 12,242 pounds. Based on a 12,000-pound takeoff weight, we set the airspeed bugs at 97 KIAS for the V1 takeoff decision speed, 102 KIAS for rotation and 114 KIAS for the V2 one-engine-inoperative takeoff safety speed. The takeoff field length was 2,940 feet. The Citation AFM is easy to use because the numbers are in tables. There are no split-hair, fine-line graphs to plot, thus eliminating a frequent source of errors.

The cockpit layout is familiar to anyone who has flown a straight-wing Citation. It's even less cluttered than the original Citation II because of the Bravo's large-format displays and panel-mount radios. In our opinion,

TIME AND FUEL VERSUS DISTANCE

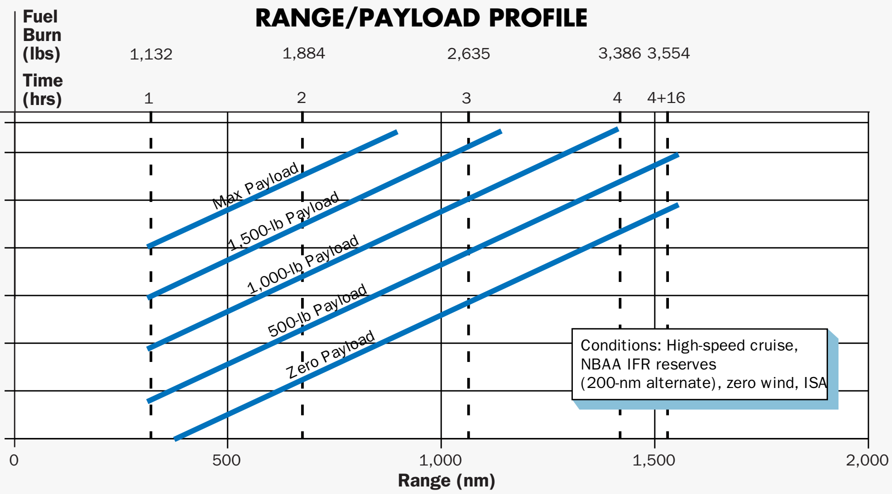


SPECIFIC RANGE



RANGE/PAYLOAD PROFILE

Balanced Field Length (ft)		Gross Takeoff Weight (lbs)
SL ISA	5,000 ft ISA+20°C	
3,600	5,520	14,800
3,480	5,270	14,500
3,310	4,880	14,000
3,150	4,510	13,500
3,000	4,180	13,000
2,860	3,890	12,500
2,720	3,630	12,000
2,600	3,400	11,500



Data Source: Cessna

CESSNA CITATION BRAVO

These three graphs are designed to be used together to provide a broad view of Citation Bravo performance. Do not use these for flight planning. For a complete operational performance analysis, consult the flight planning and cruise performance manuals, as well as the FAA-approved flight manual.

Time and Fuel Versus Distance—This graph shows two mission plots. The upper line represents high-speed cruise and the lower line represents long-range cruise. The numbers at the hour lines indicate cumulative miles and fuel burned for those two cruise profiles. The intermediate points only are accurate for the full trip. They can, however, provide a rough approximation of the time and fuel required for trips of intermediate length. These data exceed Cessna's original performance predictions for the Bravo. The chart assumes a four-passenger, 800-pound payload.

Specific Range—The specific range of the Citation Bravo, the ratio of nautical miles flown to pounds of fuel burned (nm/lb), is a measure of its fuel efficiency. This graph shows specific range values at several altitudes at a mid-range, 12,000-pound cruise weight. These data illustrate that the Bravo's fuel efficiency improves markedly at its highest cruise altitudes and that its specific range performance falls off sharply above 350 to 360 knots.

Range/Payload Profile—The purpose of this graph is to provide rough simulations of trips under a variety of payload and airport density-altitude conditions, with the goal of flying the longest distance at high-speed cruise. The payload lines, which are intended for gross simulation purposes only, are each generated from several points. Time and fuel burns, shown at the top of the chart, are plotted only for a four-passenger, 800-pound payload mission. Note: The takeoff distances are longer than those we published in the *1997 Planning & Purchasing Handbook* because of the recent 500-pound increase in MTOW. The original MTOW was 14,300 pounds. Now, it is 14,800 pounds, providing substantially it's a near-perfect model of human-centered design. If you opt to earn single-pilot certification in the Bravo, it should be a lot less challenging than checking out in a competitive turboprop.

Start procedures are simple. Press a start button on the engine start panel, wait for eight- to 10-percent N2 turbine rpm and advance the thrust lever into the idle detent. Repeat the process for the second engine, turn on the inverters, complete a few after-start checks and you're ready to taxi.

The Bravo's rudder pedal controlled, bungee actuated, nosewheel steering is fine for taxiway use. However, maneuvering in close quarters requires using a little differential brake and thrust, similar to other straight-wing Citations.

At ground idle, the PW530A engines produce enough thrust to require frequent use of the wheel brakes. Pilots may want to consider deploying one thrust reverser during prolonged taxi runs to avoid riding the brakes.

The Bravo has brisker acceleration during the takeoff roll than the Citation II because of its improved thrust-to-weight ratio, but not enough to alarm the passengers. What they will notice is its rapid climb rate and ability to top clouds and turbulence. Departing at a relatively light 12,000 pounds, we leveled off at FL 430 in 23 minutes, with a fuel burn of 400 pounds in the climb. (FL 450 is the aircraft's maximum certificated altitude and it's usable at typical operating weights.)

At a weight of 11,600 pounds, the Bravo settled into a 370 KTAS cruise on 730 pph at FL 430 in ISA+5°C conditions. That's about two percent better specific range than Cessna predicts for the Bravo.

At FL 330 in ISA+5°C conditions, the Bravo, at a weight of 11,000 pounds, nudged MMO at a speed of 405 KTAS. The book predicted a fuel flow of 1,208 pph. The actual fuel flow was 1,110 pph.

Subjectively, the Bravo's passenger cabin seemed quieter than the Citation II, but we did not measure interior sound levels. At high cruise speeds, the wind noise rush is more prominent than the low drone of the engine fans.

The Bravo, similar to the Citation II, has excellent high- and low-speed stability characteristics. Stalls are gentle, accompanied by moderate wing roll off, if you press the aircraft to the stall break. The aerodynamic pre-stall buffet and stick shaker provide such unmistakable warnings of the impending stall that if stall recovery is initiated promptly, there is virtually no altitude loss.

Flap and landing gear configuration changes produce generous pitching moments. Passengers will appreciate your slowing the aircraft well below the maximum extension speeds prior to making configuration changes. In addition, flap movement follows the movement of the flap lever. Moving the flap lever very slowly cause the flaps to reposition at the same rate, thereby easing the pitching moment and accompanying pitch trim change.

The Bravo requires more rudder pedal pressure during simulated one-engine-inoperative maneuvers than the Citation II because of its improved thrust-to-weight ratio and nearly identical airframe. The upside is substantially better one-engine-inoperative climb performance, especially when operating out of hot-and-high airports.

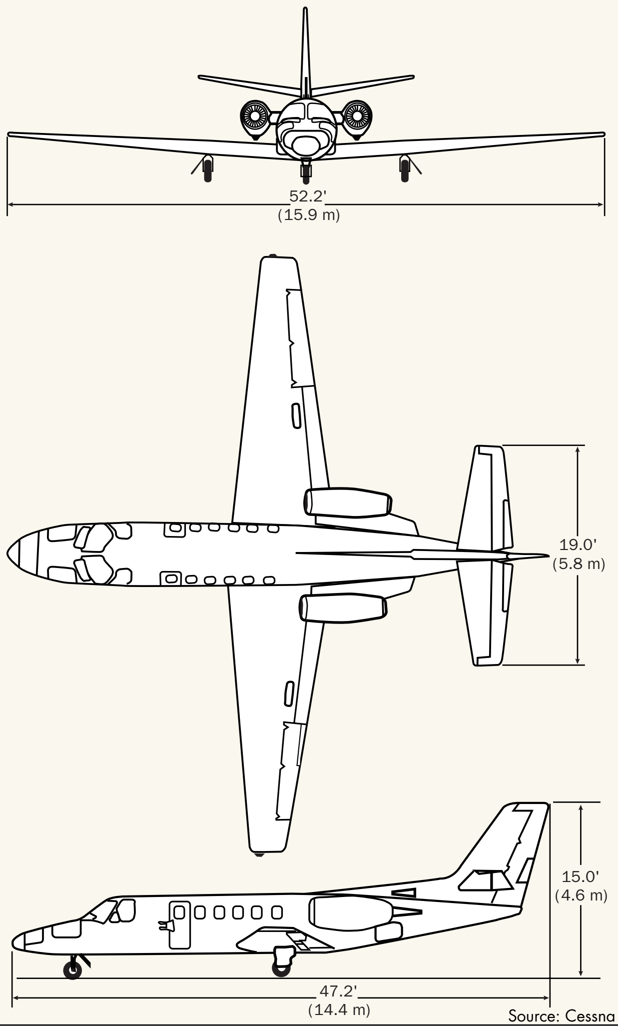
The trailing-link landing gear cushion the touchdown and make for a more comfortable ride over bumpy taxiways. In our opinion, however, pilots will still need to flare close to the runway and fly with finesse in order to achieve consistently smooth landings.

Brickbats? The AlliedSignal GNS-Xls essentially is a limited function, lateral navigator. There is no coupled vertical navigation capability and it's not capable of providing guidance for all ARINC 424 procedures. We'd prefer having a 3-D nav, GlobalStar 2100 or a Universal UNS-1K system offered as an option.

In addition, the GNS-Xls has no interface to the AlliedSignal CNI 5000 VHF nav and DME boxes for rho-theta navigation. As installed in the Bravo, it's a GPS-only nav system.

The Honeywell Primus 1000 system has a ram-air temperature readout on the EFIS, but no static air temperature display. If you need OAT or SAT, you have to use a ram rise conversion chart contained in the AFM.

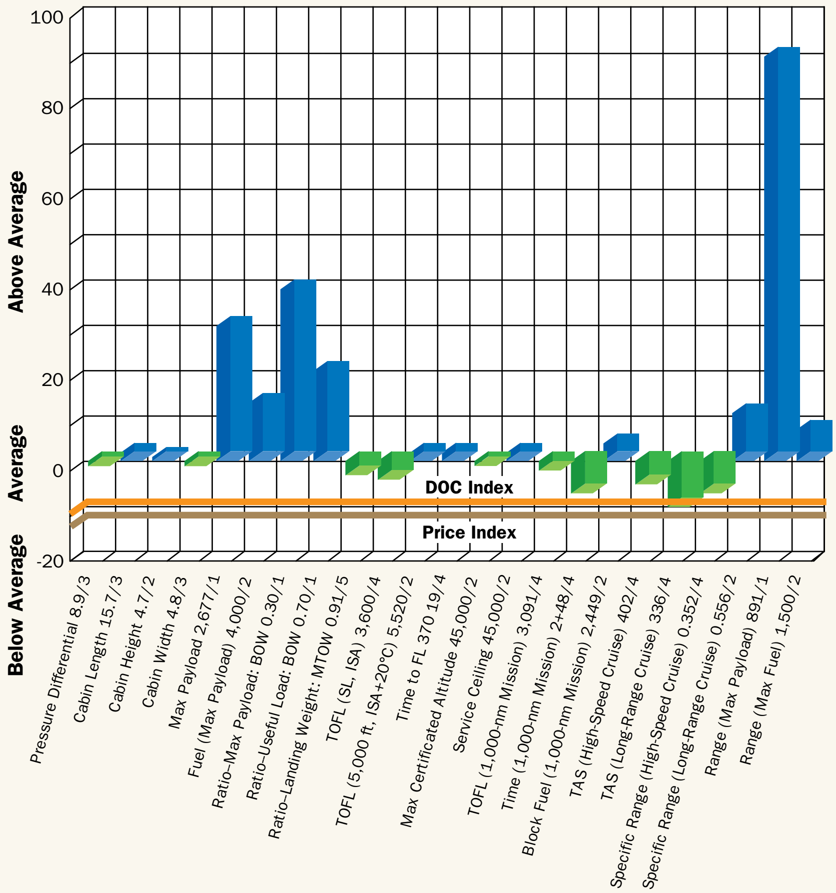
CESSNA CITATION BRAVO



PRICE AND PERFORMANCE

Escalate the 1992 price of the Citation II for five years of inflation and you'll find that, dollar-for-dollar, the Bravo is a close match to its predecessor. The Bravo's climb, cruise and altitude performance, however, is in a much higher league. Even more impressively, with its recent 500-pound weight increase, the Bravo has substantially

B/CA COMPARISON PROFILE®
(% Relative to Average)



Tradeoffs are a reality of aircraft design, although aeronautical engineers attempt to give each model exceptional capabilities in all areas at an affordable price. The laws of physics, however, do not allow one aircraft model to do all missions with equal efficiency.

B/CA compares the subject aircraft's performance and characteristics to the composite traits of the aircraft in its class. We do this to evaluate the strengths and compromises of the subject aircraft. We average parameters of interest for the aircraft that are likely to be considered as competitive with the subject of our analysis, and then compute the percent differences between the parameters of the subject aircraft and the composite numbers of the competitive group as a whole. The percent differences are presented in bar-graph form. We also include the absolute value of the parameter under consideration, along with its rank with respect to the composite.

For this Comparison Profile®, we present selected parameters of the Cessna Citation Bravo in relation to a composite group consisting of the Citation Ultra, CitationJet, Learjet 31A and Raytheon Beechjet 400A. The Comparison Profile® is meant to illustrate the relative strengths and compromises of the subject aircraft; it is not a means of comparing specific aircraft to each other.

Source: 1997 Planning & Purchasing Handbook

better range/payload flexibility than the Citation II, especially when operating from hot-and-high airports.

The Bravo, as shown by the Comparison Profile®, is competitive in most areas with other aircraft in its class, including time to climb and speed on typical business trips. However, its comparatively high max payload, weight-efficient structure and range with max payload make it a standout in the light jet class.

When measured against the price index line of the Comparison Profile®, the Bravo has a clear advantage compared to the light-jet class average. Only the CitationJet is priced lower. This is a tribute to Cessna's design-to-cost discipline for the Bravo.

Considering the Bravo's cabin dimensions, it's also a head-to-head competitor with the Raytheon King Air 200. Competitive turboprops maintain their long-time edge in fuel economy, but the Bravo's overall operating costs should rival those of the bestselling turboprop. However, the Bravo's acquisition cost is still about 20 percent higher than the King Air 200.

CITATION BRAVO SPECIFICATIONS

B/CA Equipped Price	$4,550,000
Characteristics	
Wing Loading	44.3
Power Loading	2.56
Noise (EPNdB)	73.2/90.7
Seating	2 + 7/11
Dimensions (ft/m)	
External	See Three Views
Internal	
Length	15.7/4.8
Height	4.7/1.4
Width	4.8/1.5
Power	
Engine	2 P&WC PW530A
Output	2,887 lb ea.
TBO	4,000 hrs
Weights (lb/kg)	
Max Ramp	15,000/6,804
Max Takeoff	14,800/6,713
Max Landing	13,500/6,124
ZFW	11,300/5,126
BOW	8,823/4,002
Max Payload	2,477/1,124
Useful Load	6,177/2,802
Executive Payload	1,400/635
Max Fuel	4,824/2,188
Payload—Max Fuel	1,353/614
Fuel—Max Payload	3,700/1,678
Fuel—Exec. Payload	4,777/2,167
Limits	
MMO	0.700
FL/VMO	FL 279/275
VFE (app.)	200
PSI	8.9
Climb	
Time to FL 370	19 min
FAR Part 25 OEI Rate (fpm/mpm)	998/304
FAR Part 25 OEI Gradient (fpm/mpm)	468/89
Ceilings (ft/m)	
Certificated	45,000/13,716
All-Engine Service	45,000/13,716
Engine-Out Service	27,750/8,458
Sea-Level Cabin	23,586/7,189
Certification	FAR Part 25, 1978/97

The 550-series aircraft have been Cessna's bestselling Citations. More than 850 units have been sold. They've racked up more than 3.9-million flight hours. The Comparison Profile® makes a compelling case for the Bravo's potential to increase that trend. According to a top management source, Cessna had sold 55 Bravos as of May, representing an 18-month backlog of orders.

In spite of its modest early sales figures, though, the price versus performance numbers in the Comparison Profile® are clear and convincing. The Bravo is a class winner. We expect it to widen its lead in the coming years. ■

By Fred George