



2002 Cessna Citation X

More tanks-full payload, shorter takeoff distances,
better hot-and-high climb performance, nicer handling qualities

By Fred George

Six years ago, the 0.92 Mach Citation X, Cessna Chairman Russ Meyer's riposte to decades of "slow-tation" jokes, started streaking past every other business jet at speeds of 500-plus knots. With 3,000-mile range, it could beat the next fastest midsize business jet between New York and Los Angeles by 30 minutes against 95-percent probability winter headwinds and burn 2,500 pounds less fuel in the process, much to the delight of new owners.

Then, Citation X pilots started racing heavy-iron jets across the North Atlantic. In spite of having to make a 20-minute pit stop in Canada or Iceland for fuel, the Citation X could best most large-cabin jets flying nonstop between Europe and the United States by up to one hour. If you wanted to top the X, you had to buy a Gulfstream V or a Global Express at two and one-half times the price.

But the Citation X potentially had its share of Achilles' heels. Typically equipped, it could carry only four or five passengers with full fuel. A series of weight increases had sapped its takeoff field and climb performance. On warm days, for example, the X needed more than 6,000 feet of runway for takeoff. Weight limit-

Photos courtesy of Cessna

ed, one-engine-inoperative climb performance cut up to 350 miles off its four-passenger range when departing from hot-and-high airports, a shortcoming fully exploited by archrival Dassault Falcon Jet with its trijet Falcon 50. In addition, the Citation X's climb performance with anti-ice on was anemic.

Moreover, roll control authority and roll feel left plenty to be desired, especially when landing with a strong crosswind.

Enter the 2002 Citation X. Starting at serial number 173, the Citation X received a 400-pound weight increase, plus a 5-percent takeoff thrust increase. The combo gives the Citation X a slightly better takeoff thrust-to-weight ratio than a Gulfstream IV-SP. Now it can carry six to seven passengers with full fuel and it needs less runway at its 36,100-pound MTOW than the old aircraft required at its 35,700-pound MTOW. (See accompanying "Range/Payload Profile" chart.)

The new Citation X also has more climb thrust, enabling it to reach cruise altitude sooner, which gives it slightly more range. The climb improvement is especially apparent with bleed air anti-ice on. Time to climb to FL 290 with anti-ice on, for instance, is 15 minutes for the new Citation X. The old version needed 26 minutes. The result? The new Citation X spends considerably less time in icing and turbulence during the climb.

The aileron control linkage has been re-gear. This doubles aileron deflection with the same degree of yoke rotation, up to maximum deflection. Roll spoiler gearing remains unchanged. The result is crisper initial roll response and softer initial roll-control feel.

Standard equipment now includes TCAS II, EGPWS and a CVR, along with a 76-cubic-foot oxygen bottle, lighted approach plate holders and logo lights. A deluxe interior, including high-gloss wood veneer cabinets, also comes standard.

The Honeywell Primus 2000 avionics package also has been upgraded. High-speed yaw damping is more robust. Vertical path guidance is available for non-precision approaches. And the EICAS now spells out the causes for a "No Takeoff" message, enabling the crew to take immediate corrective action.

How well does the 2002 Citation X measure up to expectations? Here's what we found during a recent demonstration flight.

Performance Boost

The 2002 Citation X's Rolls-Royce AE3007C1 turbofan engines have been upgraded from the AE3007C configuration with improved hot section parts that



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allow a 19°C boost in maximum ITT for takeoff and a six-degree higher temperature for climb and cruise. This allows a 5-percent increase in takeoff thrust with no loss of flat rating and only a \$4 increase in each engine reserve.

Five percent more takeoff thrust may not seem like much, but it produces virtually the same reduction in takeoff field length distances. The improvement is even more apparent when departing hot-and-high airports. The Citation X still is weight limited under such conditions, but there is less range penalty. Departing Reno-Stead, elevation 5,046 feet, on an ISA+20°C day, for example, the Citation X can fly four passengers 3,003 miles, only 138 miles less than the range when departing San Francisco on a standard day. The old Citation X, in contrast, had a 2,738-mile range with an 800-pound payload.

With seven passengers on board, the 2002 Citation X has about the same range advantage in such hot-and-high conditions. The new model can fly a 1,400-pound payload 2,778 miles, while older models were limited to a 2,514-mile range mission with seven passengers, assuming the same airport conditions.

Between 5,000 feet and 8,000 feet, though, the increase in takeoff thrust tapers back to the original rating. However, the aircraft can depart Aspen with six passengers on a 31°C day, fly to White Plains, N.Y., and land with NBAA IFR reserves. And that's with no tailwind.

Greater thrust also slightly reduces climb times to initial cruising altitude. But the new aircraft's greater weight puts it at a slight disadvantage regarding initial cruise altitude on warm days. Crossing the

North Atlantic, for example, the new aircraft cannot climb directly to FL 410 at MTOW in ISA+10°C conditions. Plan on a 52-minute climb with an intermediate level-off at FL 390. At ISA+20°C, FL 370 is the initial cruise altitude and that takes a 67-minute climb. It can step-climb from FL 370 to FL 390 after 37 minutes, and then climb from FL 390 to FL 410 after just over two hours.

Rule of thumb? After level-off, if the aircraft can climb 500 fpm or more at 0.80 Mach, then it can make a 2,000-foot step climb to a more-efficient cruising altitude. Each 2,000-foot step climb nets a 200-pph reduction in fuel flow. At FL 410, for example, total fuel flow is about 2,200 pph. But at FL 470, fuel burn drops to 1,600 pph.

On long trips, few operators throttle back to 0.82 Mach to stretch the range. They climb at 285 to 300 KIAS to 0.80 or 0.83 Mach until reaching initial cruise altitude. Crossing the North Atlantic, for instance, they get enough head start to climb to FL 410 prior to reaching oceanic airspace, if ambient temperature permits. Once level, they let the speed build up to 0.86 or 0.88 Mach and then request a higher cruise altitude, usually FL 430 to FL 450. This technique essentially allows them to cruise at 490 to 500 KTAS, except for the step climbs.

The 2002 model has improved yaw damping, enabling operators to descend at 0.90 Mach with rock-solid comfort for passengers, based upon our observations. Using a 0.90 Mach/340 KIAS descent speed schedule to 10,000 feet, operators plan on a 3,000-fpm average descent rate and an altitude-to-distance ratio of about 2.5:1. For example, a descent from FL 470

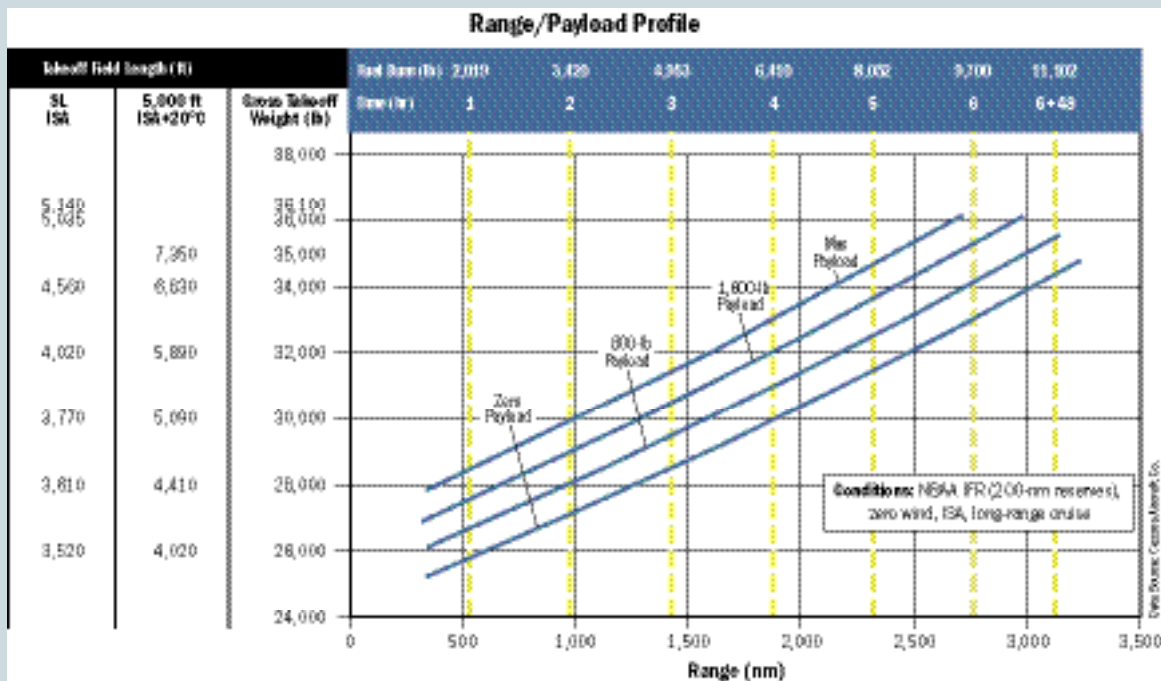
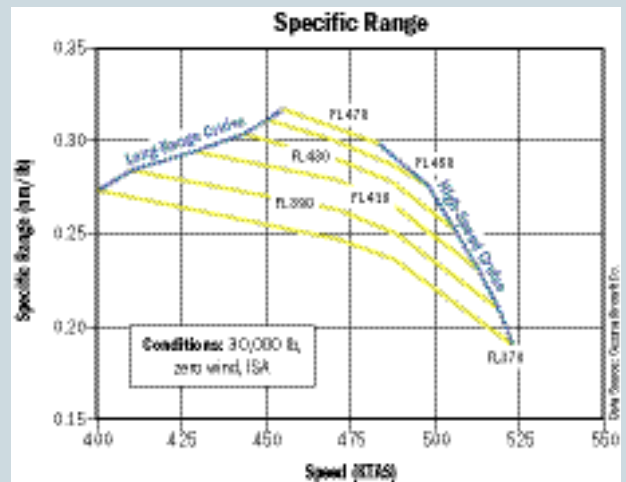
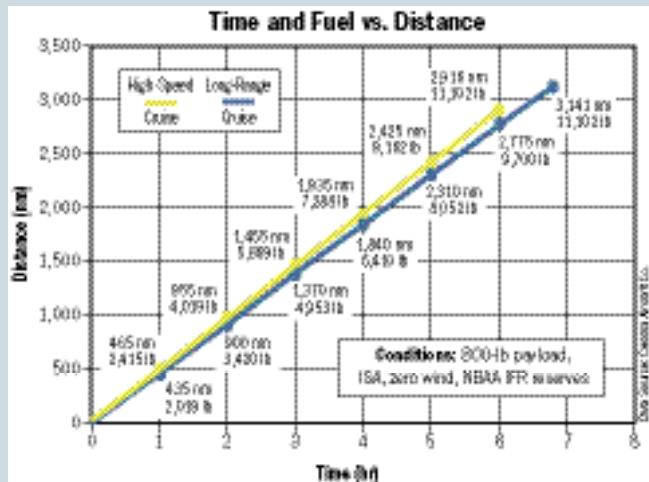
Cessna Citation X

These three graphs are designed to be used together to provide a broad preliminary view of the Citation X's performance. These data are subject to change prior to type certification. The 2002 Citation X Preliminary Flight Planning Guide, available from Cessna Aircraft, contains additional runway, climb, cruise and descent data.

Time and Fuel Versus Distance — This graph shows the performance of the Citation X long-range cruise and high-speed cruise. The numbers at the hour lines indicate the miles flown and the fuel burned for each of the two cruise profiles. Each of the data points is based upon specific mission data supplied by Cessna Aircraft.

Specific Range — The specific range of Citation X, the ratio of miles flown to pounds of fuel burned (nm/lb), is a measure of fuel efficiency. The sharp slope of the lines between the long-range and high-speed cruise end points, as well as the peak at FL 470, indicate that the Citation X's highest cruise speeds are available in the mid-30s, but fuel consumption increases by nearly 50 percent. Flying in the high-40s drops cruise speed by 25 to 35 knots, but cruise speed still nudges 500 KTAS.

Range/Payload Profile — The purpose of this graph is to provide simulations of various 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 are plotted from individual mission profiles with several data points, ending at the maximum range for each payload. The time and fuel burn dashed lines are based upon the long-range cruise profile shown on the Time and Fuel Versus Distance chart. The runway distances are significantly improved compared with the data published in *B/CA's* December 1995 report.



to sea level requires 117 miles and takes about 16 and one-half minutes.

Passenger Accommodations

Optimists describe the Citation X as being a super-midsize business aircraft. While that's true in exterior dimensions, the cabin measures 5.7 feet high and 5.6 feet wide, resulting in the smallest cross section of any midsize aircraft, except for the Gulfstream G100 (née Galaxy 1125 SPX).

The 23.5-foot cabin length, however, enables operators to configure the interior in a variety of ways. Most buyers, though, have chosen an eight-seat, double-club arrangement, so Cessna standardized that configuration in the 2002 model and made other layouts optional.

Each of the seats has pitch, lateral track, swivel and rake adjustments. Pairs of seats can be configured as fully reclined berths for overnight flights. However, if left and right adjacent seats are tracked inboard or swiveled, aisle access is restricted. Folks in the forward cabin can't walk aft to the lav if adjoining rear seats are tracked inboard.

Cessna interior engineers, however, have made good use of the available interior space. The factory demonstrator we flew, for example, has double-club seating, with forward galley and storage cabinets, plus an aft lav with luggage and equipment storage bays. The cabinets feature high-gloss finish, walnut burl veneer, with satin-finish gold-plated hardware. The seats are covered in cappuccino-color leather, complemented by a buff color overhead fabric and ivory color side-wall material.

Up front, there are generously sized left and right navigation chart storage compartments, a left-side entertainment center with dual DVD players, a convertible closet with hanging bag rod and a cabin entertainment display screen. On the right, the forward galley features two heated liquid containers, a microwave oven, bottled and canned beverage storage, and ice drawer, plus room for catering, stores, dinnerware and napkins. A 117-VAC 60-Hz AC outlet is available for accessories.

Between facing pairs of seats, the aircraft has fold-out worktables covered in leather and framed with high-gloss walnut burl. There are cabin entertainment display screens for each seat and four AC outlets for laptops.

The aft lavatory has solid pocket doors for privacy and an externally serviced flush-potty. Some operators believe the potty's five-gallon capacity and re-circulating fluid design are inadequate for long-range missions. The lav also features a wash basin with warm water. The fresh water reservoir, though, must be removed for refilling.



Most Citation buyers have chosen an eight-seat double-club configuration.

The 2002 model comes with a long list of standard features, including Teledyne Controls' MagnaStar C-2000 (using the GTE network), most avionics items that were former options, plus pulse and logo lights. Most customers also order a second HF radio and extended-range, two-bottle, 125-cubic-foot capacity oxygen system, among other options that add about 80 pounds to the aircraft. Less than one-third of the customers are ordering the \$127,000, 49-pound Aero-I satcom system.

As a result, it's unlikely that the BOW will exceed 22,100 to 22,200 pounds. This preserves the aircraft's six- to seven-seat, tanks-full payload capability.

Flying Impressions

B/CA's basic test profile doesn't provide the best test of the Citation X's capabilities, so factory demonstration pilots John Esping and Anthony Merck planned a roundtrip in serial number 750-0173 from San Diego Brown Field to Reno Tahoe International Airport.

We wanted to look at aircraft performance at high weight, so we loaded the aircraft with all 13,000 pounds of fuel. This resulted in a ramp weight of 35,292 pounds and a takeoff weight of 35,000 pounds, 97 percent of MTOW.

For the first leg, Merck took the right seat and guided me through procedures. Flying a Citation X, he noted, is much more like piloting a current-generation, large-cabin business aircraft than a midsize jet. Systems are automated and the Honeywell Primus 2000 avionics suite is completely integrated, including full performance computations available through the FMS. This shortens the checklists and decreases pilot workload. Moreover, the

Citation X retains much of the "simple Citation" design philosophy incorporated into the original Citation 500 we first flew three decades ago.

The split-bus electrical system, for instance, is automatically tied together prior to engine start and automatically split with both engine-driven generators in operation. APU fire detection checks and the start sequence are automated. Citation X retains the original aircraft's rotary test switch, green-colored ice protection switches and automated start sequence.

During start, APU bleed air is automatically re-routed from the packs to the air turbine starter. FADECs handle all the start chores and the engine-driven generators automatically come on line at the appropriate point. Once the start is complete, APU bleed air is redirected to the packs.

The Citation X's Honeywell LASEREF IV IRSes take six minutes to align, so the aircraft must be frozen in position until the warning lights extinguish. Merck initialized the NZ-2000 FMSes with position, aircraft weight loads, runway choice and wind vector. Merck overrode the FMSes' default climb speed schedule of 300 KIAS/0.80 Mach and entered 285 KIAS/0.83 Mach for a faster block speed to Reno. The FMSes automatically computed a required runway distance of 5,280 feet and posted V speeds of 128 KIAS for V₁, 131 KIAS for rotation, 136 KIAS for V₂ and 190 KIAS for en route climb on both PFD airspeed scales. Some heavy-iron business aircraft are just now acquiring this capability.

Rolling out of the chocks, we noted that the Citation X's carbon brakes are quite

touchy when cold, prone to grabbing with no stabbing. In addition, the AE3007C1 engines produce plenty of idle thrust, so frequent use of the brakes is required to check taxi speed. We deployed the left thrust reverser to avoid riding the brakes during the taxi.

And a quick deployment it was. Thrust reverser operation and geometry has been changed on late model Citation X aircraft. Now they pop out in one second flat, not three. And, the bottom half of the clamshell deploys more than the top, thereby preventing nose-up pitch up with full thrust reverse. The changes enabled Cessna to certify and take credit for thrust reverser use during rejected takeoff. Using one thrust reverser has little effect on accelerate/stop distance at heavy weights and on dry pavement, but on contaminated runways, especially at lighter takeoff weights, using a single thrust reverser considerably shortens the RTO distance.

During the taxi, Merck advised that the Citation X requires a healthy tug on the yoke to achieve the proper takeoff attitude, especially at high weights. This is because full fuel moves the c.g. close to the forward of just over 15 percent MAC. With no fuel and no passengers, the Citation X's c.g. pushes the aft side of the envelope.

Once cleared for takeoff, I pushed the thrust levers into the takeoff detent. Subjectively, the Citation X's acceleration felt similar to that of a Gulfstream IV-SP. Takeoff rotation, however, required considerably more effort, and I under-rotated initially.

The Citation X has fully powered flight controls in all three axes with artificial feel. We noted that pitch force is appropriately substantial. In addition, it takes a while to get accustomed to the aircraft's on-center dead-band in fore/aft yoke movement.

The aircraft's new aileron gearing, though, makes it much more pleasant to hand fly. But, the Citation X's relatively high climb, cruise and descent speeds require lots of concentration when the aircraft is hand flown. The Primus 2000 autopilot slashes cockpit workload, and, of course, it flies the aircraft more precisely and smoother than most pilots, including ours.

Kudos to SOCAL approach and Los Angeles ARTCC. We had requested an unrestricted climb and both agencies obliged. We hand flew the aircraft to FL 430 in 26 minutes, very close to book predictions for the default climb schedule. Once level, the aircraft accelerated to 0.876 Mach in ISA conditions, resulting in a 503 KTAS cruise speed and 1,980-pph fuel burn. We then engaged the autopilot



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to reduce workload. The book predicted a 497 KTAS cruise speed and 1,934-pph fuel burn. Nine minutes later, cruise speed had increased to 0.878 Mach and 505 KTAS in ISA conditions.

During the descent into Reno, we leveled off for a moment at FL 350. The cruise speed was 520 KTAS, but the fuel burn increased to 2,920 pph. Continuing the descent for landing to the south, we requested a delay vector to burn down to the aircraft's 31,800-pound max landing weight.

The Citation X rides well through turbulence caused by mountain winds and thermals. It has moderate wing loading, but its wing structure is quite flexible, providing a soft ride in rough air. The wing also is unexpectedly strong. It was designed for 160-percent ultimate load and it's been tested to 198-percent load without failure.

The aircraft is slippery. It won't go down and slow down simultaneously. Slowing to 250 KIAS at 10,000 feet, we had to plan the arrival carefully to stay below maximum flap extension speeds. There is little pitch trim change with extended slats and flaps to five degrees. Pitch change is more pronounced, but not excessive, when the flaps are deployed to 15 degrees. Extending landing flaps produces noticeable drag.

Thrust response to throttle movement at low power settings is sensitive. Small movements result in large thrust changes. We found it useful to hawk the airspeed trend vector to avoid excessive airspeed deviations with throttle movement during final approach.

Our first landing was crude. Our approach speed was too fast and the Citation X likes to fly in ground effect. We floated excessively down the runway. After

touchdown, we extended the ground spoilers, resulting in a pronounced nose-up pitching moment.

Make a note: Push down on the yoke when extending the ground spoilers. And fly the nose down to touchdown prior to deploying the thrust reversers. The Citation X's powerful carbon brakes stopped the aircraft with no loss of composure. And during taxi to the ramp, they were warm enough to provide smoother braking action.

Total fuel burn for the 498-mile first leg was 3,270 pounds and the flight time was one hour, 12 minutes. Notably, without the ILS approach and with a typical fuel load for a short mission, the trip profile would have been more direct, quicker and more economical.

For the return leg, Merck and Esping swapped right and observer jump seats. Oakland ARTCC capped our cruise altitude at FL 330 because of arrival traffic into the Bay area. So, we just left the power up and watched the aircraft accelerate. The book predicted a maximum cruise speed of 525 KTAS while burning 3,057 pph. Our actual cruise speed was as fast as 0.907 Mach and 530 KTAS, with a fuel flow of 3,080 pph. The 488-nm trip required one hour, five minutes, including a non-precision, circling approach into Brown Field. Total fuel burn was 3,070 pounds, quite surprising considering our relatively low cruise altitude. Possible reasons were the lower takeoff weight and the head start on the climb provided by Reno's 4,412-foot elevation.

One-engine-inoperative takeoffs and landings are easier to fly with the Citation X's revised aileron gearing. Roll control feel is better harmonized with the aircraft's moderate rudder forces. Pitch force,

though, feels as substantial as in a traditional heavy-iron aircraft, in our opinion.

OEI landings are best done in the flaps 15 degree configuration. There's much less drag than with 35 degrees of flaps. Coupled with the throttle sensitivity, it was essential to watch the airspeed closely during the approach. It was easy to get fast on approach, and the aircraft didn't slow down well without using flight spoilers.

Stay on top of airspeed control and OEI approaches are not difficult at all, in our opinion. In accordance with the new flight manual, we used one thrust reverser to slow the aircraft after touching down during the OEI approach.

Conclusions? The 2002 Citation X is more pleasant to fly by hand than the original version, but its heavy-iron workload favors using all the automation, especially the autopilot. During landing approach, airspeed control can be challenging considering its sensitive throttle response and low aerodynamic drag. Pitch control after touchdown takes practice, in light of ground spoiler effect.

Citation X Continuous Improvement

Since the Citation X's introduction in 1996, Cessna has made numerous evolu-

tionary upgrades that improve its range-payload capabilities and shorten its runway requirements, reduce pilot workload and increase passenger comfort.

The peppier performance of the 2002 model, including the improved tanks-full payload, is one reason why Cessna plans to deliver 36 Citation X aircraft this year and why more than 185 units now have been delivered.

But the 2002 model is not the ultimate Citation X. Cessna always has viewed the Model 750 as a smaller, more-efficient stable mate to heavy-iron business aircraft. As a result, the firm is studying the feasibility of advanced features associated with large-cabin business aircraft, including enhanced vision sensors, auto-throttles, head-up displays and synthetic vision.

The 2002 model raises operators' expectations of what they want in a top-of-the-line Citation. However, the ultimate upgrade for the Citation X is a bigger cabin. Until Textron, Cessna's parent company, OK's development of a next-generation, 500-knot Citation with more room for passengers, the firm risks losing today's Citation X customers to business aircraft made in Bordeaux, Montreal and Savannah.



The 2002 model raises operators' expectations of what they want in a top-of-the-line Citation.

Core customers, though, love bragging about blowing off every other business aircraft priced under \$45 million on sprints up to 3,000 miles. Until someone launches the first supersonic business jet, the Citation X's niche at 0.92 Mach remains quite secure. B/CA