

History of 500 Series Citation Line

During the mid 1960's, Cessna Aircraft Company decided to take a significant gamble and enter the light jet market. However, Cessna's entry into this market was to be somewhat different from the competition in many areas, such as cost, maintainability and performance. Cessna's new jet would be relatively inexpensive to purchase if you consider close to $\frac{3}{4}$ of a million 1972 dollars inexpensive. Construction technology would be conventional with perhaps the exception of the high bypass turbofan engines. Consequently, maintenance should be more Cessna-like instead of jet-like. And unfortunately, the yet to be named jet would be somewhat slower than the competition. The competition, by the way included names such as Sabreliner, Hawker, Jet Commander, Falcon and among others, the Lear Jet. These competitors were actually miniature airliners with nearly the performance, complexity and incremental expense associated with the larger commercial aircraft.

While Cessna's civilian experience was in the building of small personal use aircraft, we tend to forget that Cessna had experience building Jets for the Air Force, the T37 or Tweet as it came to be known. Cessna's strategy was to incorporate as much of their tried and proven light plane technology as possible into their small jet. The most obvious compromise was in performance, specifically speed and climb performance. The sacrifice in speed that Cessna accepted was partly the result of the wing they designed to be installed on this jet. This wing was a very aerodynamically sound wing with good slow flight characteristics, lots of room for fuel, but a straight wing, none the less. And straight, fat wings tend to be somewhat slower than the swept wing competition. These wings even had pneumatic boots, courtesy B. F. Goodrich for ice protection. However, with typical small jet missions of 300 to 500 miles, the speed penalty did not translate into the significant time penalties.

Other than the performance gamble, Cessna was also making a significant financial gamble. Depending on whose accounting you believe, the investment Cessna made in developing its small jet was somewhere in the range of 35% to 50% of the companies net worth. This was not a trivial financial risk. And in retrospect, it was a gamble that may well have carried the company through nearly 2 decades of selling no piston single or twin engine aircraft whatsoever. Keep in mind that the timeframe we are visiting is late 60's to early 70's.

Shortly after that period, Cessna's production of piston powered aircraft ground to a halt by the early 80's. Instead of building piston powered aircraft, the company was producing 50 to 80 light jets per year by the 1980's. The name of this small jet you are probably aware of by now. But the plane we affectionately call the Citation today was originally known as the Fanjet 500, a somewhat generic name designed to emphasize the fuel efficient engines to be used on the aircraft. However, marketing people at Cessna felt that the Fanjet 500 name could be improved upon. So a new name was sought and thanks to a Triple Crown winning racehorse of the era by the same name, the name Citation was chosen and the rest is history. What follows is a brief description of the evolution of the Citation line. We will limit our discussion to the 500 series Citations, those airplanes covered by the CE-500 Type Rating.

CE-500 & Citation I

The first Citation prototype flew in September of 1969. Approximately two years later, the FAA granted the Citation certification as a Transport Category aircraft. This infant jet was powered by two JT15D engines built by Pratt & Whitney producing 2200 pounds of static takeoff thrust each side on an ISA day at sea level. Cruise performance was around 330 knots, takeoff distance was in the low 2000 foot range and reference speeds (ref)

were in the low 100's. Handling was typical Cessna with no surprises.

Cessna has enjoyed a continuous backlog of orders for Citations ever since. Some of the noteworthy structural and systems changes are described below. These changes do not address all of the numerous "paper" changes made by Cessna or offered by aftermarket vendors that primarily increased maximum weights. Speaking of weight, typical early Citations weighed 6500 or so lightly equipped and empty. Since airplanes, like people tend to gain weight with age, a typical late Citation I today will weigh around 7200 pounds if equipped with Freon air conditioning and thrust reversers.

Maximum takeoff weight for nearly all small Citations today is 11850 pounds assuming they have not been modified by any aftermarket vendors.

In late 1972, beginning with Unit #41, Windshield Bleed Air anti-ice was introduced, replacing the electrically heated windshields used on the first 40 airplanes. At the same unit number, useable fuel capacity was increased slightly, by approximately 8 gallons.

In late 1974, beginning with Unit #214, the pressurization controller was replaced with a more capable unit that allowed the aircraft to be operated up to FL410, vs the FL350 previously authorized. At that same unit number, useable fuel was increased again, this time by approximately 20 gallons. This brought useable fuel to 3806 pounds, or 564 gallons. Fuel capacity remained at 3806 lbs through the remainder of the production run of the small Citation.

In late 1975, at Unit #275, numerous electrical system improvements were made. These included changes in inverter selection options and the addition of a system to protect the

airplane from damage during GPU starts. The SPZ- 500 Autopilot/Flight Director System first appeared on unit #275 and RCA avionics were replaced by Collins “Proline” equipment.

Early in 1977, the Citation I was introduced after a production run of 349 “straight” 500’s. The “I” had a wing slightly over 3 feet longer than the straight 500. The “I” was also available in Single Pilot version, designated the “I SP”, and was certificated to Normal Category standards. Approximately 70 units per year were delivered until 1978 when the CE-550, to be described next hit the market. Thereafter the CE-550 ramped up in volume while the CE-500 sales ramped down. The small Citation was essentially unchanged until in 1985 when production ceased at slightly fewer than 700 units. A steady shift of customers from the Citation I to the Citation II was underway, fueled by customer perception of the comparative value of the two models. Production numbers steadily declined to the point the assembly of the small Citation became uneconomical and production was terminated.

CE-550, Citation II, & CE-551, Citation IISP

In early 1978, the CE-550 or Citation II was introduced. The “II” was created by inserting a plug of over 3 ½ feet into the Citation I fuselage allowing the installation of 2 additional seats. Wingspan was increased by over 4 ½ feet. This allowed useable fuel capacity to be increased to 5000 pounds, or approximately 742 gallons. As a result, endurance was increased by well over an hour. Thrust was increased from 2200 to 2500 pounds per side by upgrading the engines to JT15D-4’s resulting in about a 30 knot increase in cruise speed to a typical 380 knots at light weights. Additional wing area and additional thrust allowed the aircraft to climb to FL430, a new higher maximum operating altitude. The SPZ-500 and Collins equipment were continued into the CE-550 line. All of this resulted in a heavier aircraft, 13,300 pounds vs 11,850 pounds maximum takeoff weight. Empty weight rose from a typical 7200

pounds for a Citation I to 8000 pounds for a typical Citation II. All systems remained essentially unchanged except that the Hamilton Standard Air Cycle Machine used on the entire 500 series aircraft was replaced by the Air Research or Garrett ACM on the first 480 some odd CE-550's.

A single pilot version of the Citation II, the CE-551 or IISP was also manufactured. It is essentially a "II" limited by its Normal Category certification to 12,700 pounds ramp and 12,500 pound takeoff weight. These aircraft typically weigh around 8000 pounds empty, carry 5000 pounds of fuel, have 9 or 10 seats and are limited to 12,500 pounds takeoff weight. So let's add this up. 8000 pounds empty plus 5000 pounds of fuel equals 13,000 pounds with no people or baggage in a 12,700 pound maximum ramp weight aircraft. Flown at legal weights, the IISP can never carry a full load of fuel. With a tiny 500 pound payload, a typical IISP can legally be loaded with 4200 pounds of fuel. A more typical 1000 pound payload limits the aircraft to 3700 pounds of fuel.

During 1983, the Garrett Air Cycle Machine being used at the time was replaced with the Hamilton Standard ACM, essentially the same unit installed on the 500 Series Citations. This change was effective with Unit # 482 and then # 485 and later. At Unit # 501 a minor change was made on the Oxygen Control Valve switch, located under the pilots left elbow, replacing two selectors with one.

Unit # 550 introduced a new style annunciator panel that differed significantly from the style used in the CE-500 and earlier CE-550 aircraft.

Production of the CE-550 was temporarily halted in 1984 and then resumed in 1989. This suspension coincided with manufacture of the CE-S550 to be described shortly. Cessna concluded there was still a demand for the CE-550 after the SII was replaced by the Citation V.

During 1989 with CE-550 Unit #627, many maximum weight limits were increased. Among others, maximum takeoff weight increased from 13,300 pounds to 14,300 pounds. Unit #626 and earlier can be modified to the heavier weights with minor changes. These “heavy” II’s have tremendous utility. With full fuel, these Citations can carry a full $\frac{3}{4}$ ton of payload over 1500 miles.

The Bravo was introduced with Unit # 801 in 1997. This CE-550 aircraft was equipped with new Pratt & Whitney Engines, the PW-530A’s. As a result, thrust was increased from 2500 to 2750 pounds and eventually 2887 pounds. Bypass ratio increased from 2.5 to 1 to 3.2 to 1. Specific fuel consumption of the later engine also improved. Trailing link main gear replaced the straight legged struts, requiring a larger gear well to retract into. This resulted in a slight reduction in useable fuel, down to 4860 pounds from 5000 pounds on the straight legged 550. However, due to the improved fuel specifics of the PW-530A’s, range actually improved. A new avionics suite by Honeywell and Allied Signal also appeared initially in the Bravo.

CE-S550, Citation SII

In 1984, Cessna introduced the CE-S550, commonly referred to as the “SII”. The SII fuselage is dimensionally unchanged from the II fuselage. The wing is completely new, a supercritical airfoil with less than a foot of increase in wingspan over the II. The pneumatic boots were replaced with a TKS weeping wing technology anti-ice system, reducing drag significantly. This aircraft carried 5800 pounds of fuel and cruised more than 20 knots faster than the CE-550. The SII therefore became the first Citation to break the 400 knot barrier. Additional fuel and speed resulted in almost an additional hour’s duration, significantly increased optimum range to 2000 miles on a good day and resulted in an increase in takeoff weight to 15,100 pounds. In addition to the cleaner wing, JT15D-4B engines with increased Maximum N1 limits were installed on

the SII though thrust remained the same at 2500 pounds per engine. Numerous additional aerodynamic improvements were incorporated to further reduce drag. Finally, hydraulic flaps, stick shaker and flap-trim interconnect made their first appearance on a Citation. The SII was produced until 1988 and 160 civilian units were manufactured. This aircraft would evolve into the Citation V to be described next.

CE-560, Citation V

In 1989, the Citation V appeared. The SII fuselage was stretched by a foot and a half improving legroom and JT15D-5A engines producing 2900 pounds of thrust were installed on the “V”. The additional thrust resulted in another 20 knots or so cruise speed and the ability to climb to FL450, eventually. The TKS weeping wing ice protection was replaced with boots by B. F. Goodrich. These boots were cleaner and lower in drag than the original Goodrich boots used on I’s and II’s. For its time, state of the art Electronic Flight Information System or EFIS was standard equipment as was the Sperry Flight Director/Autopilot and Collins avionics suite. Range did suffer but only slightly and takeoff weight increased to 15,900 pounds.

In 1994, beginning with Unit #260, an improved “V” known as the Ultra was produced. Modern large tube Honeywell glass was standard in the cockpit. JT15D-5D engines rated at 3045 pounds of thrust were installed resulting in another few knots.

The next evolution of the series began production in 2000 and is known as the Encore, also a “V”. The Encore began with Unit #539 of the 560 line. Maximum takeoff weight increased to 16,630 pounds, typical cruise increased slightly to of a bit over 420 kts and maximum operating altitude remained at FL 450. The Encore, however could actually climb to FL 450 in half an hour or so. Yet another engine upgrade to current technology PW535A engines

was performed providing 3400 pounds of thrust each side. These engines are from the same family as the PW530A's installed on the Bravo, offering the longevity, serviceability and specific fuel consumption advantages of the more modern engines. Wingspan increased by a bit over 2 feet and wing and engine ice protection are provided by bleed air. Main landing gear are trailing link in design requiring an increase in dimension of the wheel wells to house the retracted gear. This robs fuel tank volume much as in the Bravo. Therefore useable fuel capacity is reduced from 5800 pounds to 5440 pounds or 806 gallons. However as was the case in the Bravo, improved engine efficiency more than made up for the loss in fuel and range improved slightly over the V Ultra.

After 169 units were manufactured, the Encore was improved in 2007 to the Encore+, a very similar aircraft with electronically controlled engines and an updated avionics suite.

Currently, the Encore and the Bravo are the most refined versions of the CE-500 family in production. Total production to date of 500 series aircraft is over 2500 units. Significant improvements in range, speed, load carrying capability and maintainability have been made over the last 30 years. Purchase price has also gone up, by a factor of 10 in dollars not adjusted for inflation.

The Citation has been a tremendous success from the beginning in a very competitive marketplace and in times of an unstable world economy. The user-friendly straight wing has undergone refinement and thrust has increased to bring the Citation very close to many of its competitors in performance. And these performances improvements were made while maintaining the very forgiving flight characteristics the Citation has come to be known for. The aircraft is so manageable that the entire fleet can be flown single pilot if the proper paperwork is on board and specific single pilot training is accomplished and maintained. While many sneered at the "Slotation" or the "Nearjet", this family

of airplanes remains the most popular example of light jets since production began in the early 1970's.