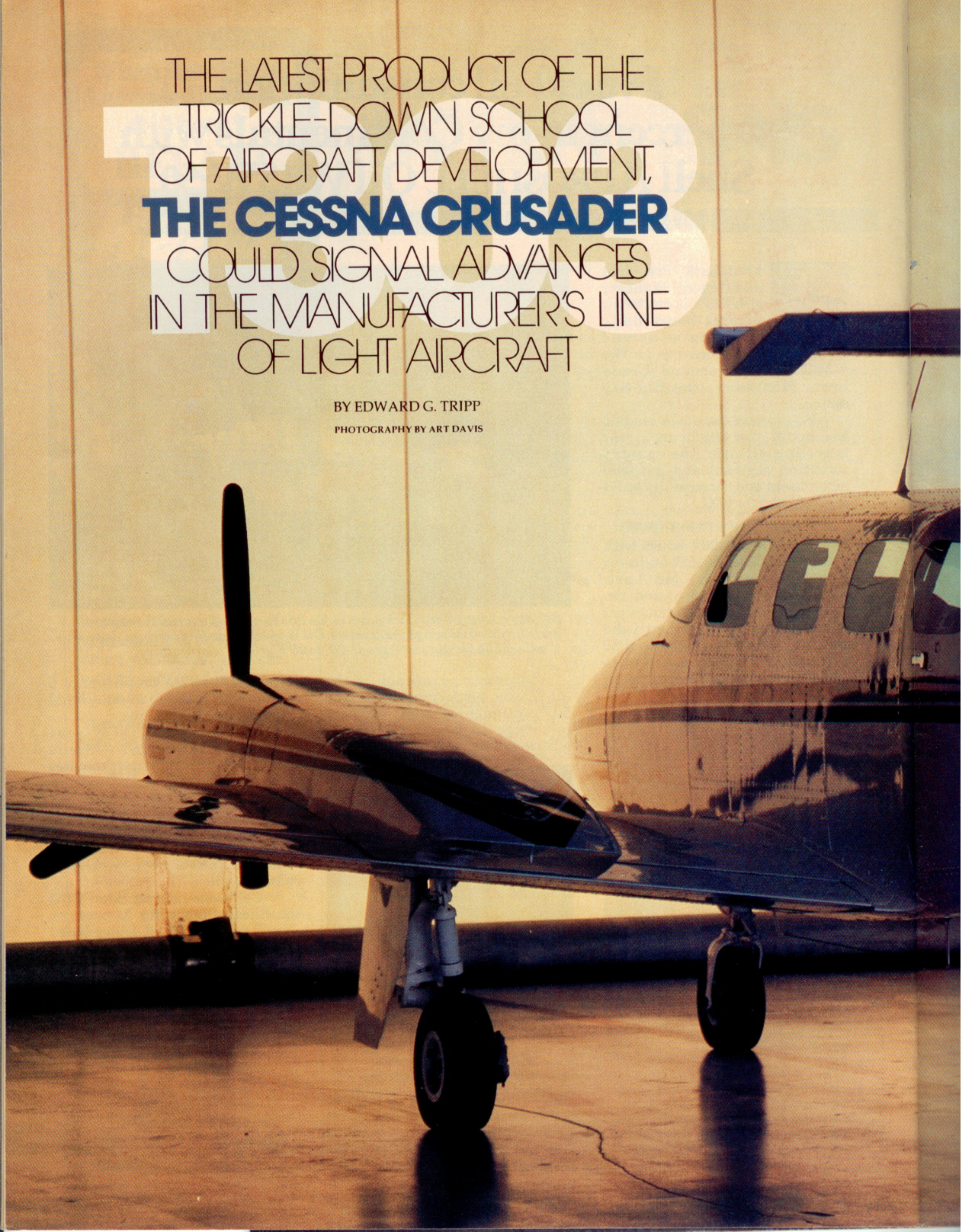
THE LATEST PRODUCT OF THE TRICKLE-DOWN SCHOOL OF AIRCRAFT DEVELOPMENT, THE CESSNA CRUSADER COULD SIGNAL ADVANCES IN THE MANUFACTURER'S LINE OF LIGHT AIRCRAFT

BY EDWARD G. TRIPP

PHOTOGRAPHY BY ART DAVIS



T303

The Cessna T303 is no longer news to most pilots. There have been quite a number of articles written already that spend a good bit of time talking about the transformation of the model designation from a Cougar/Duchess/Seminole category light twin to a cabin-class twin.

All we need to do here is salute Cessna for accurately reading the potential market, abandoning an idea to compete in a market that was limited almost before it began, and moving up the ante in a market segment where it and other major airframe manufacturing and marketing companies are more comfortable these days. All in all, it is a realistic approach to the operational needs of today.

The Crusader lands smack in the middle of the Piper Seneca and Navajo and the Beech Baron 58. It also replaces Cessna's 310 and T310 models, as was suggested in *Pilot* nearly two years ago. (See "Cessna Turbo 310R," May 1980 *Pilot*, p. 36.)

It should prove to be a tough move for the competition. Fully equipped for all-weather flight (certification for flight into known icing has not been obtained yet), the Crusader will list for less than the basic Navajo or Baron 58TC. It competes in performance and load-carrying with the Seneca, while it offers something closer to the Navajo interior arrangement.

It is a large-dollar game, one that is out of reach for most individuals. However, there are elements of the T303 that bear watching by all pilots and aircraft owners. It is the first new design from Cessna below the Citation and the Conquest since the Cardinal. Everything else that the company has dubbed new has been a derivative and largely a game of mix and match.

The Crusader was designed from scratch. Cessna established some ambitious goals for this airplane. The manufacturer has spent a great deal of time analyzing and developing handling characteristics, aerodynamics and systems as well as pilot analysis and criticism, which resulted in revisions. Engineering models spent a higher than normal amount of time in wind tunnel tests, and two prototype aircraft participated in a test program in which they were flown for more than 1,000 hours.

Cessna currently has five broad groups of aircraft: the 100, or light-single category; the 200, heavy single; the 300, light twin; the 400, medium twin (and now turboprop, with the addition of the 441 Conquest and 425 Corsair); and the 500 series jets.

To many pilots, the 500 series represents the best cockpit/systems design of any general aviation aircraft. When the 400 series twins were introduced, they were little different from the 310. Then they increasingly reflected the lessons learned from the Citation jet in terms of cockpit design and pilot work load. Then came the bonded wing, with integral fuel tanks and without the familiar tip tank. Externally and internally, the 400-series wing represents a big departure for Cessna's piston-engine aircraft. The turboprop Model 425 Corsair is the furthest advanced of the series.

The Crusader, or T303, is the first of the simpler series, and the first product built at the Pawnee Division, to reflect the operator-oriented design considerations that have been rolled out of the Wallace Division for several years. (The only 300 series aircraft built at Wallace, where the A- and T-37 military jets were built and where the 500—Citation—series and the 400 series twins are built, were the 310 series of twins, the ill-fated 335 and the originally troubled but continuing 340. The Skymaster and Super Skymasters

were built at Pawnee, where the 150 and 170 series were built, and where all the other 100 and 200 series continue to be built.)

Not only does the T303 not resemble any other 300 or lower series Cessna aircraft; except for the basic design of the wing, externally it resembles no other Cessna, period. In fact, superficially, it most closely resembles the unsuccessful Rockwell Commander 700.

The most immediately apparent differentness of the Crusader, compared to other Cessna twins, is the cruciform tail. The horizontal stabilizer is mounted approximately one third of the way up the vertical stabilizer. It is out of the disturbed air created by the propellers. Vibration is decreased, elevator effectiveness is improved and pitch changes with power or configuration changes are minimized. This also permits cruise operation at power settings as low as 2,100 rpm. The company claims that longitudinal stability is improved.

Airflow control devices are used just above the horizontal stabilizer (to maintain rudder effectiveness), near the wing-root/fuselage juncture and on both the inboard and outboard sides of the engine nacelles.

The wing airflow energizers resulted from an extensive program to analyze and control lift, drag and airflow separation during cruise, at high angles of attack and during stalls.

The point at which the wings and fuselage join is a tough design exercise with any aircraft. Both drag and stall characteristics are affected greatly by resolution of the problems of airflow, interference and related phenomena. It is even more critical on conventional twins because the inboard wing section concerns are compounded by the engine nacelles. This usually is handled by cuffs or extended shapes on the wing center section to control the flow.

Cessna began to evaluate the situation in the wind tunnel to develop the optimum cuff design in order to minimize drag and not degrade longitudinal stability. In flight tests, a slight buffet was felt in the elevators in landing configuration and attitudes. It was determined that the pattern of separation was creating a vortex of disturbed air that hit the elevators.

After a great deal of analysis and experimentation with various cuff shapes and vortex generators, David R. Ellis, supervisor of advanced design at the Pawnee Division, worked with Dr. William Wentz of Wichita State University on strakes, or flow energizers. The result was not only a resolution of the separated flow, but the leading-edge cuffs were done away with.

Another area of airflow interference that developed during flight tests was a high-frequency vibration with the flaps down. This turned out to be caused by disturbed airflow created by the long tail of the wing locker/nacelle. This was handled by another form of airflow energizers, perforated plates mounted on the flap's upper surface.

Gear actuation is electrically actuated hydraulic, similar to Cessna singles. This system has been troublesome, but the gear is designed to free fall to the down-and-locked position at airspeeds below 140 knots.

The wing is built using a good deal of bonding. There are no cowl flaps as such. In what is a type of updraft cooling arrangement, cooling air enters on either side of the spinner and exits out the top of each nacelle. The cowl-flap control actuates shutters inside of the exhaust louvers. This eliminates the drag connected with conventional cowl flaps and improves climb performance and hot, high-altitude cruise operations. During our series of flights in the second production T303, N9330T, the air temperature was quite high, but the engine temperatures were low, even during prolonged pattern work and single-engine operations. Nick Parrott, a pilot for Cessna's Air Transportation Division who flew with us, said that the cowl flaps are largely used to heat the engines, not to cool them.

This augurs well for the type of operation for which the T303 has been designed. In fact, it can be said that once the design objectives were set, the next step was to find the engines. They are from the familiar TSIO-520 family of Teledyne Continental, variations of which are used in quite a few Cessna aircraft. They are the first counterrotating engines on any Cessna twin and are described as lightweight; they are 65-pounds lighter than similar variants.

This should be a cause for concern, given the poor experience with other lightweight engines. They also have a higher-than-normal compression ratio for turbosupercharged engines: 8.5 to 1. This was done largely to obtain lower specific fuel consumption. The trade-off is a propensity to detonation, particularly since the engines are designed to be leaned to peak at up to 75-percent power settings.

The engines were being tested in a 1968 Model 310 six months before the prototype T303 flew. A hydraulic wastegate actuator and controller was selected to reduce system friction and related problems and to reduce pilot work load.

A maximum-power schedule was developed, as well. This is largely a manifold-pressure limitation and results in the inability to use 75-percent power at any altitude on a standard- or higher-temperature day.

This should indicate to operators that power schedules and settings must be selected and established carefully in order to avoid detonation and premature failure.

It is interesting to note that the engines have a recommended time between overhaul of 2,000 hours, high for turbosupercharged engines, and is covered by Continental's Gold Medallion—extended warranty—program. An engine-fire detection system, which provides both aural and visual warning, is included as standard equipment.

The electrical system has some large-aircraft features. It is a two-main bus system, and there is a dual avionics bus bar. This makes dealing with electrical problems much easier to manage without causing potential emergencies. Main power is supplied by dual 60-amp alternators (95-amp alternators are a $1,095, highly recommended option but are standard with the full de-ice system). All circuit breakers are the pull-off type so the pilot is able to isolate faults.

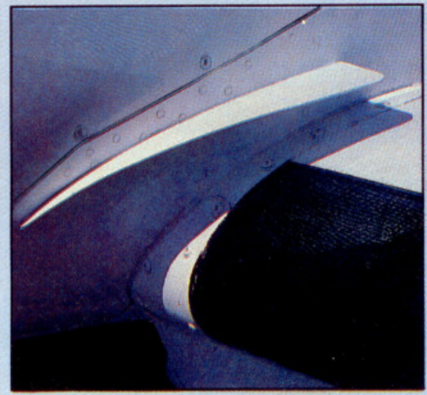
Another design goal for the Crusader is noteworthy: no down springs, bob weights or interconnects. It was achieved with little control-system friction and good aerodynamic balance. Trimming is provided for all three axes.

I hope that the Crusader reflects the shape and thought of things to come for the lower model series of Cessna products. The operational considerations and cockpit layout reflect a continuation of the design & engineering trickle down from the 500 to the 400 series. It is even less demanding to fly, in part because it is lighter, but also in part because that quality, or set of qualities, was designed into it. The Crusader also has a great deal of passenger appeal, particularly when compared to the 310.

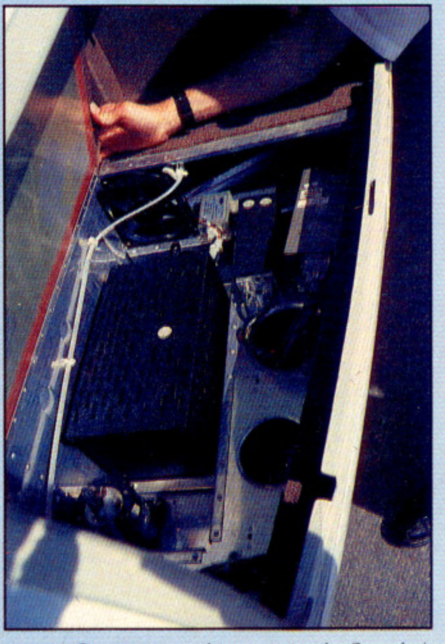
The T303 looks like a large airplane. More importantly, the cabin is fairly large for its power and weight. For instance, unlike the 310, the fifth and sixth seats are the most desirable (next to the first). Everyone enters through the airstair door, mounted on the end of the left side of the fuselage. The pilot's waddle and crawl through the cabin to the cockpit is no better and no worse than in any similar aircraft.

For the affluent family, for the busi-

A hatch next to the front passenger seat can be used for emergency exit or to ventilate the cabin during ground operations. Entry and exit normally are accomplished through an airstair door located behind the left wing.



Trailing-beam main gear makes landings simple and pleasant. Strakes mounted next to the wing roots (right) and on the engine nacelles improve airflow separation characteristics and smooth the flow of air over the elevator.



Cessna attempted to minimize the Crusader's operating costs by providing easy access for maintaining components. The cabin heater and several black boxes, for example, are located beneath the front baggage compartment.

ness with the desire or need to travel cabin class or for the air taxi operator, the Crusader has a lot of appeal. Unquestionably, the most popular seating arrangement will be club seating. The only drawback to this arrangement is that the third and forth seats should be mounted either further forward or on tracks to permit some adjustment; there is a great deal of space between the first and second rows of seats that should be used to provide at least the option of more legroom between the second and third rows.

The person who pays the bills (except in the owner-flown category) usually selects the right rear seat. The cabin dimensions are such that the elbow room here is as good as it is in the middle row of seats.

There is plenty of room behind the third row for baggage, with a 200-pound weight limit. There is also a nose baggage compartment, with a 150-pound limit for avionics and baggage, and the wing lockers in the extended engine nacelles on both wings with a maximum capacity of 120 pounds per side. If careful attention is given to mission length, fuel load, cab-

T303

in load and baggage requirements, the Crusader is an airplane that can be flown without any unwanted luggage competing with passengers for space.

In addition to the optional club-seating, the cabin can be fitted with writing tables, a refreshment cabinet with hot and cold storage and a stereo system. Though that status symbol of all, a john, is not available, a "universal" (male and female) relief tube is.

This may seem like a lot on the passengers' environment, but customer appeal has a lot to do with today's operating requirements. Walking up and through an airstair door and into a cabin puts the passenger in a better frame of mind than climbing over a wing and back through a tunnel-like cabin.

An operational concern, mixing it up with the big boys, was dealt with effectively, too. Approach flaps (10 degrees) can be selected at speeds up to 175 knots, also the maximum gear-extension speed. Twenty degrees of flap can be extended at 150 knots; full flaps at 125. The maximum gear retraction speed is 150 knots; with gear extended, the aircraft can be flown to the red line, 210 knots, a useful device for emergency descent. Extension and retraction time is much lower than other 300-series twins. The flaps are called semi-Fowler. When approach flaps are selected, they move aft as well as down.

The fuel-management system is simple and straightforward, and there is a single tank in each wing. Only two gallons of the maximum 155 gallons is unusable. There is also a lot of evidence that Cessna's engineers thought about maintainability and access to systems that need frequent attention.

The pilot is taken care of well. The organization of the cockpit and arrangement of systems and functions is excellent. The Crusader is set up for single-pilot operation, although engine instruments and avionics are located so that a well-briefed copilot can help without the interference mandated in some other twins, most notably the 310. It is a comfortable cockpit, too, which is an important consideration with respect to pilot performance. The cockpit is a major demonstration that the lessons originally learned in the Citation program are being applied lower down the line.

It will be a very easy twin to transition to, even if it is equipped with every flight and weather option available, thanks to the logical arrangement.

From our initial impressions, formed during about three hours of flight in broad daylight, Cessna has met its design objectives for flying qualities. From preflight to shut down, the Crusader is a simple airplane to operate. Ground handling and maneuverability are good. Visibility out of the cockpit is quite good as well.

The only trick to takeoff is nailing pitch attitude. A bit of back pressure is required for rotation, which must then be eased off quickly, but gently, to prevent pitch excursions. It is an easy characteristic to learn to anticipate; three or four departures should do it.

Climb performance is good enough for the relative power, weight and size of the airplane. Average climb rate through 12,000 feet at gross weight using cruise climb power settings of 2,400 rpm and 24 inches (also the maximum cruise power setting) and 120 knots is approximately 700 feet per minute. Maximum continuous power and best rate of climb speed will produce an average rate in excess of 1,300 feet per minute but will result in poor forward visibility and high noise and vibration levels.

Control harmony and response is very good, which is quite uncharacteristic for many Cessna products, particularly elevator forces versus aileron forces. The Crusader flies like a very light airplane, even at low airspeeds and during single-engine operations.

Roll response is very high, and the ailerons are effective even during full stall. During such maneuvers as engine cuts immediately after takeoff, balked landings and single-engine pattern work, there were no apparent vices.

The most difficult flight profile is after an engine cut after takeoff. Full rudder trim is not sufficient to fly the airplane; the pilot has to help with a foot. The pressures are not high, but a few minutes in single-engine climb can set the leg to trembling.

The other area where help is needed is the Dutch-roll tendency in turbulence, especially in approach configuration. I think that those people who do not order the yaw-damper system ($2,635 and 9.3 pounds) will be sorry.

Stall behavior is excellent. There is good aerodynamic warning, or buffet, then the Crusader stalls straight ahead. Full power stalls produce very high angles of attack yet straightforward stall breaks. It can be flown very slowly very comfortably, with plenty of control authority and a minimum of mushiness. Approaches and landings are simple and pleasant. Minor misjudgments are forgiven by the trailing-beam main gear. Even abusive operation, such as poor crosswind technique or crabbed touchdowns are covered up by the ability of the gear to absorb abuse and poor technique.

The Crusader is a pleasant airplane to fly and should be a confidence-builder for low-time pilots, and it is a low-work-load machine for everyone who flies it. It is one of the least demanding twins there is to fly and better behaved than quite a few singles.

Cessna claims that the Crusader is ready to fly IFR out the factory door. Its basic price includes a fairly complete avionics stack (you cannot buy it without ARC 400-series avionics, including an autopilot and slaved directional gyro).

There is still a fairly extensive options game to play, matching features to weight and cost. A typically equipped company version would cost about $290,000, add 270 pounds to the basic empty weight and reduce payload with full fuel to 680 pounds; an air taxi version probably would run about $12,000 less and add another 95 pounds in useful load.

The Crusader is an innovative aircraft that shows serious application of lessons learned and serious consideration to the operating concerns of potential customers. There are a lot of design elements that are applicable to other aircraft in the Cessna line, including the simplest singles.

It would be good for the company and even better for potential customers if the trickle-down theory of aircraft development were encouraged to flow through the entire Pawnee (light aircraft) Division.

Time and abuse in the hands of customers as opposed to factory pilots and engineers will be the true test of how well Cessna has met its commendable design objectives. But they have gotten off to a good start by designing and testing to meet operational objectives. □

T303

CESSNA T-303 CRUSADER

Base price $229,500
Price as tested $279,790
AOPA Pilot Operations/Equipment
Category: IFR*

Specifications

Powerplants	2 Teledyne Continental TSIO-520 AE/(counterrotating) LTSIO-520 AE 250 @ 2,400/32.5
	Recommended TBO 2,000 hr
Propellers	2 McCauley constant speed, full feathering, 3 blades, 74 in diameter
Wingspan	38 ft 10 in
Length	30 ft 5 in
Height	13 ft 4 in
Wing area	189.2 sq ft
Wing loading	27.2 lb/sq ft

Power loading	10.3 lb/hp
Seats	6
Cabin length	13 ft 7 in
Cabin width	47.75 in
Empty weight	47.5 in
Empty weight (as tested)	3,543 lb (est)
Useful load	1,870 lb
Useful load (as tested)	1,632 lb (est)
Payload w/full fuel (as tested)	714 lb
Max ramp weight	5,175 lb
Max takeoff weight	5,150 lb
Zero fuel weight	4,850 lb
Max landing weight	5,000 lb
w/heavy duty wheels & brakes	5,150 lb
Oil capacity, ea engine	9 qt
Baggage capacity	
Aft	200 lb
Forward	150 lb
Wing locker, ea	120 lb

Performance

Takeoff distance (ground roll)	1,275 ft
Takeoff over 50 ft obst	1,750 ft
Accelerate/stop distance	3,185 ft (est)
Rate of climb, sea level	1,480 fpm

Single-engine ROC, sea level	220 fpm
Max level speed, 18,000 ft	216 kt
Cruise speed, max recommended cruise power	
10,000 ft (72% power)	178 kt
20,000 ft (71% power)	193 kt
Fuel consumption, ea engine	81 pph/13.5 gph
Cruise speed, 65% power	
10,000 ft	170 kt
20,000 ft	184 kt
Fuel consumption, ea engine	73.5 pph/12.25 gph
Cruise speed, 55% power	
10,000 ft	155 kt
20,000 ft	166 kt
Fuel consumption, ea engine	62 pph/10.33 gph
Range @ max recommended cruise w/45-min rsv, std fuel, best economy	
10,000 ft (72%)	840 nm (est)
20,000 ft (71%)	890 nm (est)
Range @ 65% cruise w/45-min rsv, std fuel, best economy	
10,000 ft	920 nm (est)
20,000 ft	955 nm (est)
Range @ 55% cruise w/45-min rsv, std fuel, best economy	
10,000 ft	980 nm (est)
20,000 ft	1,000 nm (est)
Max operating altitude	25,000 ft
Single-engine service ceiling	13,000 ft
Landing distance ground roll	820 ft
Landing over 50 ft obst	1,450 ft

Limiting and Recommended Airspeeds

Vmca (Minimum control w/one engine inoperative)	65 KIAS
Vsse (Minimum intentional one-engine inoperative)	80 KIAS
Vx (Best angle of climb)	77 KIAS
Vy (Best rate of climb)	103 KIAS
Vxse (Best single-engine angle of climb)	93 KIAS
Vyse (Best single-engine rate of climb)	97 KIAS
Va (Design maneuvering)	148 KIAS
Vfe (Max flap extended)	
Approach 10°	175 KIAS
Full 20°	150 KIAS
Full 30°	125 KIAS
Vle (Max gear extended)	210 KIAS
Vlo (Max gear operating)	
Extend	175 KIAS
Retract	150 KIAS
Vno (Max structural cruising)	175 KIAS
Vne (Never exceed)	210 KIAS
Vs1 (Stall clean)	68 KIAS
Vso (Stall in landing configuration)	62 KIAS

All specifications are based on manufacturer's calculations. All performance figures are based on standard day, standard atmosphere, at sea level and gross weight, unless otherwise noted.

** Operations/Equipment Category for aircraft as tested, when known-icing package certificated; see June 1981* Pilot, *p. 103.*