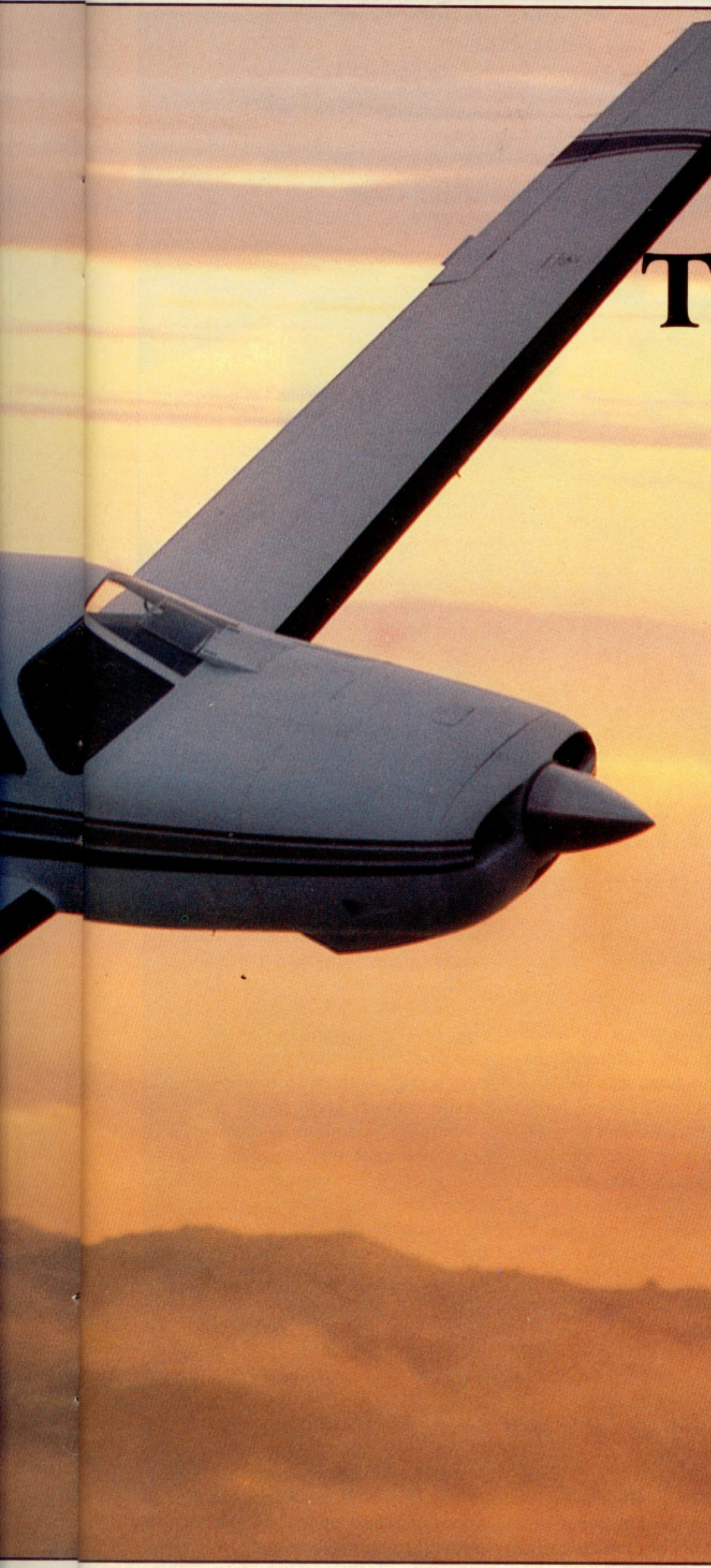


THE MALIBU MAKES IT

Flying the first of the future Pipers

BY EDWARD G. TRIPP

Is that the new Beech?" "No, it's the new Piper." "It doesn't look like a Piper." Within minutes of the time we parked at the fueling area in San Jose, California, at least six people made similar remarks. All the rest of the pilots who thronged to the new Malibu just admired, poked and asked questions such as, "What'll she do?"

N4319M is the fifth production Malibu. It already had been delivered to a retail customer, leased back to Piper and flown for 30 hours when *Pilot* creative director Art Davis and I flew to San Jose to make our first flight in Piper's stunning new single. What was supposed to have been a week with the PA-46-310P had to be compressed into one day due to aircraft scheduling problems and the very understandable desire of the purchaser to use his new machine.

All of us who had seen the prototype and read the specifications were impressed and anxious to see if the Malibu lived up to its very ambitious advance billing. The final word from the factory was that performance had been improved over the original claims. For instance, 75 percent cruise at 25,000 feet has increased from 208 to 215 knots. What Piper offi-

PHOTOGRAPHY BY ART DAVIS

cials are not happy to talk about is the failure to obtain known icing certification, something they had promised would be accomplished by the time retail deliveries commenced. (The first delivery was supposed to have been made in August, 1983; it did not occur until November.) The company announced during the Paris Air Show last year that all work on obtaining the certification was complete except for flights in natural icing conditions.

This is not necessarily a reflection on the characteristics of the aircraft. There is considerable speculation in the industry that the Federal Aviation Administration is changing its approach to icing approval, and that it may decide not to certificate aircraft for known icing flight in the future. One source speculated that the FAA merely may note that an aircraft is equipped with sufficient anti-ice and/or deice equipment. Several attempts have been made to verify the rumors, but we have yet to get confirmation or denial. The Malibu is the second Piper single slated to be certificated for known icing that has not been approved. More than two years ago Piper announced plans to obtain known icing certification for the

MALIBU

The cabin is light and airy. It lives up to twin aircraft standards.

Saratoga, but that has yet to occur.

Another significant difference between original and final specifications is weight. The goal was for an empty weight of 2,275 pounds and a maximum ramp weight of 3,867 pounds. These have increased to 2,606 and 4,116 pounds, respectively. Useful load is about 80 pounds below design goal.

The basic weight of N4319M is 2,772 pounds, which includes 165 pounds of optional equipment, including a 64-pound known icing package (all of which was disconnected), Sperry WeatherScout I color radar (17.4 pounds), air conditioning (59.9 pounds) and a Scott canister emergency oxygen system (8.5 pounds) that is based on one designed for McDonnell Douglas' DC-10. Payload with full fuel is 624 pounds, equal to that of several pressurized twin-engine aircraft of similiar performance. N4319M is a representative Malibu as equipped.

The many people who comment that the Malibu does not look like a Piper—at least not a Piper single—are correct. Rather than adapt an existing design to a new mission—the way the basic PA-28 Cherokee grew into retractables and twins, got a new wing and was stretched to six- and seven-place singles and twins—the company started from scratch with performance and occupant comfort goals. These included on-purpose operation at high altitude with attendant environmental, range and other performance considerations. Piper teamed with Teledyne Continental Motors to develop a piston engine that would work in the adverse conditions of high, thin air (see "Power for the Malibu: Run Lean Run High," p. 32). When the powerplant originally was announced, it was to have an initial time between overhauls (TBO) of 1,600 hours; that has been changed to 2,000 hours.

The end product is a large, handsome and truly untraditional Piper single. While the principal structure is conventional aluminum alloy, extensive use is made of flush riveting, and skins are butted end-to-end rather than lapped, to minimize aerodynamic drag. In this respect, it is cousin to the Aerostar (and shares the same production facility). Bonding has replaced rivets in much of the internal structure. According to the company, this provides a two-to-one advantage over rivets in terms of strength-to-weight, enables design shape to be held on the production line more closely, reduces vibration, improves fatigue characteristics and provides a smoother surface. It also results in manufacturing efficiencies. Computer-aided design has been applied in the development and refinement of the Malibu, and computer-aided manufacturing is employed on the production line (see "Tools of the Trade," p. 33).

The high aspect-ratio wings span 43 feet. Each contains a 61 gallon (60 usable) integral fuel cell. Each wing tank feeds into a collector sump; a two-stage electric boost pump is submerged in the sump that is activated when the pilot selects either left or right tank. Each wing-tank system also has an independent, non-icing vent system.

The ailerons and flaps are fairly wide span. The hydraulically controlled, mechanically actuated flaps extend both aft and down and help make the spread between stall and top speed at sea level 124 knots (59 and 183 knots, respectively, according to the most recent performance specifications; top speed at 23,000 feet is 234 knots). The ailerons and one-piece elevator are mass balanced. A single trim/anti-servo tab is mounted in the center of the elevator. All primary flight controls are cable-controlled; the rudder and ailerons are interconnected by a spring system.

The landing gear is actuated by an electrically driven, hydraulically actuated system. The nose gear rotates 90 degrees to lie flat in the nosewheel bay when retracted. The hydraulic uplocks will keep the gear retracted in the event of hydraulic system failure so long as the gear selector is up. The emergency extension system is free-fall; downlocks are mechanical. The gear and flap systems share the primary hydraulic system. A separate hydraulic system actuates the brakes.

The engine compartment is tight, to put it mildly. A large nose baggage compartment separates the pressure vessel from the powerplant and helps isolate the cabin from noise and vibration. It also permits more loading flexibility to maintain weight and balance within limits.

Quite a few pilots have reacted skeptically to Piper's claim that the Malibu is a cabin-class airplane. But once you step through the clamshell door you probably will agree with its claim. The door has automatically deploying and retracting steps on the lower half; both halves and their supports are beefy. The locking mechanism is one large handle, and there are sight gauges to ensure all the locking pins are engaged.

The cabin is light and airy. Club seating is standard. Leg room is quite good, and all the seats recline and are equipped with cup holders, reading lights and ventilation outlets. The fifth and sixth seats can be equipped with inertia reel harnesses (they should be standard), which are standard equipment for the crew seats. A 20-cubic-foot baggage compartment is located behind the last row of seats, within the

Opened up, the good access to baggage and people space is obvious. The forward baggage compartment helps isolate the pressure vessel from noise, heat and vibration. It helps pilots balance loads. The clam shell air stair door's steps deploy automatically.

pressure vessel.

There are stowage bins below the third and fourth seats. Cabin options include leather seats, a folding writing table, refreshment cabinets and a Wulfsberg Flitefone.

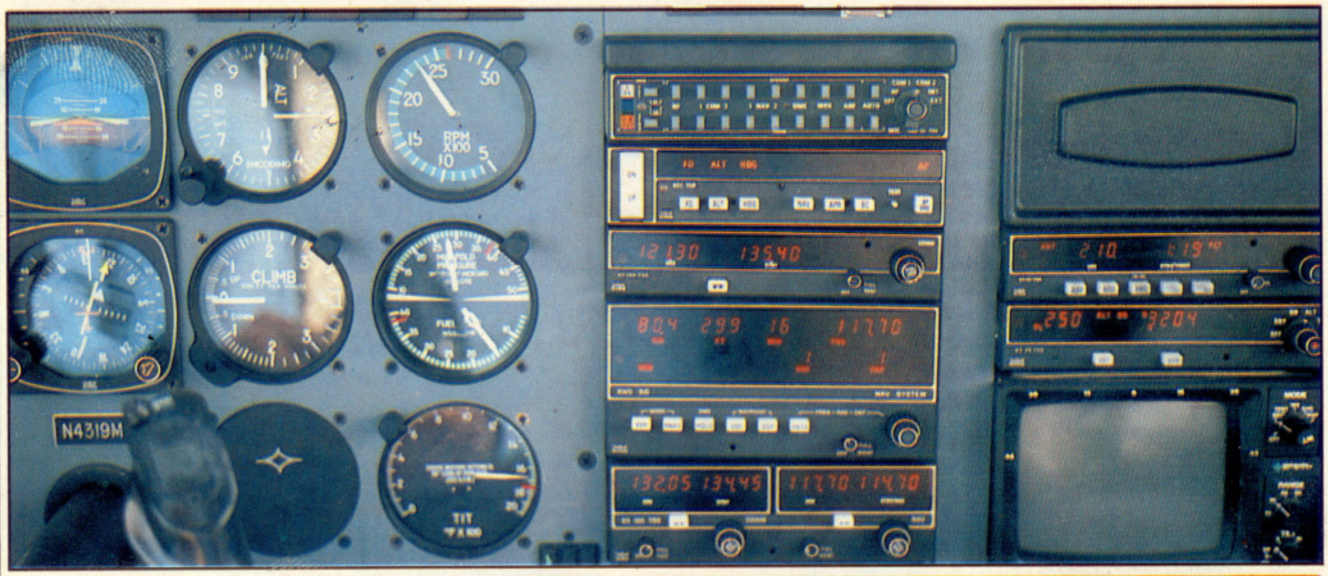
Access to the cockpit is fairly easy, and it is wide, comfortable and well organized. Even with the optional sets of basic copilot and radar flight instruments installed, there is a lot of room left over on the panel. Several built-in features add to pilot comfort, such as large map pockets in front of the arm rests on either cockpit side wall and individually controlled heated air outlets aimed at the crew's feet. Seats adjust fore and aft and recline. Vertically adjusting seats are an option, part of the so-called Executive Group ($2,130 and 17.4 pounds) that is not really an option. It includes an ELT as well as an external power source, true airspeed indicator, locking fuel caps and a polished spinner.

Organization and location of systems in the cockpit are good. The electrical system, which includes an emergency bus, has resettable circuit breakers throughout rather than the "push to reset when it pops only" type still found in so many aircraft. The biggest advantage is that systems can be isolated in the event of faults or electrical fires. Large rocker switches operate most systems, and they are grouped logically by function. Primary flight and navigation instruments are arranged in the standard pattern in front of the pilot, with engine gauges to the right and principal environmental controls to the left. A panel of 12 annunciator lights surmount the engine gauges. The power quadrant and trim controls are on a central console below the radio stack. The panel is finished in a businesslike gray paint; the absence of simulated wood grain plastic trim is welcome.

It is a utilitarian cockpit; easy to work in, easy to learn and comfortable for long flights at altitude. The only feature I found to fault during our time with the aircraft is that the main spar carry through intrudes on your backside when the seat is fully aft, fitting between the seat back and bottom cushion. Elbow and shoulder room is as good as that in many larger aircraft.

All in all, during our few hours in the Malibu at temperatures ranging from plus 20 degrees C to minus 26 degrees C, the cockpit and cabin were comfortable. Pressurization air is supplied by engine bleed air and is passed over a heat exchanger that can be fed by either ambient air or heated air from an exhaust shroud.

Davis and I flew with Joseph Ponte Jr., Piper's manager of press relations, who had been through the factory school and had flown this and other Malibus for several hours (Ponte also flew the platform airplane for the accompanying photographs). While a few hours in an airplane, particularly when compressed into a single day, with no time for reflection, variations in



MALIBU

Above, right: the panel has lots of open space on well-equipped models. Above: with the wind at your back at FL 250, true airspeeds are great. Right: Electric airplane.

atmospheric conditions and additional checking, does not constitute an evaluation, we sampled as great a variety of missions and situations as possible.

Preflight is simple and conventional. However, there are some cautions to be observed on refueling. The aircraft should be wings level to ensure that a balanced fuel load is maintained and to ensure that the system is filled to capacity. The Malibu probably is an aircraft for which special attention should be paid to temperature variations to preclude stress on the tanks and wings or, at the very least, expansion and loss of fuel through the vents. There always is mild positive pressure in the tanks, so care should be taken when opening the filler caps, particularly in high temperatures. There are only three fuel drains: one for each tank and a fuel filter sump drain low on the right side of the cowl.

Close attention should be paid to oil level, since the shallow sump has a maximum capacity of eight quarts; Continental recommends it be full for long flights.

Cockpit checks and prestart to takeoff procedures are not complicated for an aircraft of this category and capability, but the check lists should be followed methodically and meticulously. Starting procedures are straightforward. What struck me on the first start were the low noise level and relative absence of vibration.

Taxiing and ground handling were pleasant surprises. I had anticipated ponderous movement with the heavy engine slung way out front, poor visibility over the nose, high pedal pressures and lots of concern with the long wings. Only the latter proved true, and aside from the care needed to ensure clearance, ground handling is easy.

We flew the Malibu for just less than six hours that day. Operations included climb to and cruise at maximum operating altitude, cruise at middle and low altitude, emergency descents, a variety of approaches and landings, airwork, balked landings in a variety of configurations and missed approaches.

Weight at initial takeoff was just less than 4,000 pounds. Our first task was to climb as quickly as ATC would permit to 25,000 feet. We rotated at 77 knots, accelerated to best-rate-of-climb speed of 110 knots while the gear was coming up, then settled on a cruise climb of 130. The assumption about vision over the nose was proven wrong more definitely: visibility is good.

We did not get an unrestricted climb and were forced to level at intermediate altitudes twice. However, we averaged just less than 1,000 fpm to FL250. Passing through FL240, with indicated speed down to 105 knots with power set at 2,400 rpm and 32.2 inches of manifold pressure, the rate of climb was still 800 fpm. Cylinder head and oil temperatures were well in the green all the way up; average air temperatures were 10 degrees above standard.

We headed east toward Reno, Nevada, on a round robin that would terminate at Sacramento, California, to sample cruise performance and handling at altitude. We had hoped to find turbulence, but the best we could encounter was mild, continuous chop. I alternately hand flew and employed the flight control system, a King KFC 150 (King's KAP 150 autopilot is standard). Even maneuvers in the chop at altitude were good and solid.

Different cruise power settings, from 75 to 55 percent, were just about at book figures: 215 down to 186 knots. So was fuel burn. Above critical altitude (about 23,000 feet) leaning takes great care since the sloped controller for the turbocharger begins to act just like a fixed wastegate. Adjustment to any engine parameter—particularly mixture or manifold pressure—changes another, and the leaning process is a series of adjustments to throttle and mixture control. The engine is designed to be run at power settings of 75 percent and lower with the mixture leaned to 50 de-

grees on the lean side of peak turbine inlet temperature (TIT). Fortunately for nervous nellies like me, the TIT gauge is large; small incremental changes are easy to make—after a bit of practice.

Indicated cabin altitude at FL250 was maintained at a comfortable 8,600 feet. Airflow for ventilation was good, temperature control easy; conversation between the cockpit and the back of the cabin was easy too. And, during one leg at 65 percent power, true airspeed at 200 knots, the DME read out was touching 300 knots. ATC alternately was calling us a Cheyenne and asking what a Malibu was. It was great fun. Fuel burn at 55 percent power is 12 gph. With the wind at your back and more than a seven-hour endurance, you could cover a lot of country nonstop. In the right conditions, coast-to-coast flights with standard fuel are possible.

Westbound, we received clearance for an emergency descent to 12,000 feet. I extended the Malibu's landing gear, reduced manifold pressure to 20 inches (which will hold pressurization). In this configuration, you can go right up to 200 knots indicated in smooth air. I did not go above 185 knots, but the aircraft's vertical speed indicator was pegged at 4,000 fpm. At 170 knots, our

MALIBU

High aspect ratio wings designed for performance at altitude.

rate of descent was 3,500 fpm.

A brief 75-percent cruise check at 12,000 feet produced a true airspeed of 186 knots, quite good in the denser air.

For quite a while we orbited east of Sacramento doing stall series, steep turns, simulated missed approaches and slow flight in all configurations. The Malibu is solid and responsive throughout, down to minimum flying speed, although pitch sensitivity is a bit more pronounced at very slow speeds. There was a mild buffet preceding the stalls; in aggravated stalls and improper input the break and departure were more pronounced, but recovery was quick and straightforward.

During one simulated balked landing with gear and full flaps, I applied climb power without cleaning the airplane up; the Malibu's indicated rate of climb was still 700 fpm.

I made a few approaches at various airspeeds and settled on 120 as the most comfortable speed right down to final. My first impression is that it is a solid, stable instrument platform. Behavior in landing is unremarkable, that is to say, good.

During the photo mission, a type of flight where the pilot's attention is directed outside of the airplane, the Malibu again displayed its easy flying qualities.

Flying the Malibu is a pleasure; it makes few demands. The demands all should be satisfied before you fly, starting with specifying the optional extras. At base price, the airplane meets all requirements for basic IFR flight with the single exception of an ELT, and it includes a few things, such as an autopilot, that are not mandatory, yet are highly recommended. Anyone considering an aircraft of the Malibu's capabilities should recognize the hostile environment in which it is designed to operate.

Some of the options should be considered necessities. The 60 amp alternator is not sufficient to handle all the electrical loads in all types of flight, and there should be a dual system to provide back up. The same goes for the single vacuum system.

Icing encounters at altitude are prevalent in the summer and in warm climates. Even without known icing approval, the package should be installed. It is expensive ($20,160), but important. And, it includes dual alternator and vacuum systems.

Some method of weather avoidance should be included, also. Piper offers both the already mentioned Sperry radar and 3M's WX10 Stormscope.

One piece of equipment I could not find on the option list that should be standard on any aircraft that is built to fly at high altitude is a counter drum pointer altimeter. It is just too easy to misread the old-fashion double pointer altimeters, particularly if the pilot is distracted during climb or descent.

Corrosion protection and stainless control cables ($1,495 and $230) should be included.

The other advance work that should be undertaken by pilots moving up to any high-performance, high-altitude aircraft is pilot preparation. As easy as the Malibu is to fly, it is a systems airplane. Piper's school is up and running, and it provides the best way to learn the systems and related operational considerations and is the proper way to get checked-out.

For anyone who has not had it, the physiological training—including life in the altitude chamber—offered through the Chief of Physiological Training, AAC-143, FAA Aeronautical Center, Post Office Box 25082, Oklahoma City, Oklahoma 723125, should be essential. So should the Jet Transition course offered by FlightSafety International or its equivalent. While the Piper school treats the subjects covered in these programs, it cannot be as thorough.

The Malibu is a significant development. The appeal of a pressurized single already has been proven by Cessna. As best we can tell from our brief exposure, the Malibu is a large improvement.

There are a few considerations that are open questions. If known icing certification is not obtained, the operational utility of the Malibu will be restricted significantly. Only time will tell how successful Teledyne Continental's new engine development is. And there is a surprising number of operators who dislike Teledyne Continental products because of expensive operational problems. In our one-day flight of the Malibu, I heard from four of them who would not consider buying the aircraft because of the engine selection. Good operational results undoubtedly will make converts.

Piper decided to certificate the Malibu with fixed cowl flaps. My preference is for movable ones for several reasons, principally better engine temperature control in extreme cold and heat. Properly designed, they should add a bit to cruise speeds.

One of the operational proofs that will be determined by owner operation as opposed to factory-controlled testing is operation in high temperature. This is an area I have found to be a shortcoming with the P210 (although a new version, scheduled for introduction in April, includes aftercooling, which should offer improved performance).

Maintainablility is another quality that will have to be demonstrated in the real world. Some preventive maintenance program should be considered.

I would like to have had the chance to fly the Malibu in icing conditions, turbulence, high ambient temperatures and in heavy precipitation (the current static discharge system may not be adequate). To tell the truth, I would just plain like to fly it more. A lot more.

The market already has responded favorably to the aircraft. One dealer told *Pilot* senior editor Mark Lacagnina that he could sell five more immediately, and that Piper should double the production rate. According to the company, production is completely sold through this year.

The Malibu is a definite advance and has the systems, climb, cruise speed and descent performance to live in the high-altitude, long-distance world. You can bet it is the first of a new family of Piper aircraft. □

Sidebars contined overleaf

Piper PA-46-310P Malibu
Base price $275,000
Price as tested $332,739
AOPA Pilot Operations/Equipment Category*:
IFR $277,130 to $354,040**
**Price includes required equipment for all-weather flight if known icing certification is required.

Specifications

Powerplant	Teledyne Continental TSIO-520BE 310 hp 2,600 rpm
Recommended TBO 2,000 hr	
Propeller	Hartzell, two-blade, constant speed, 80 in dia
Length	28 ft 4 in
Height	11 ft 3 in
Wingspan	43 ft
Wing area	175 sq ft
Wing loading	22.3 lb/sq ft
Power loading	12.6 lb/hp
Seats	6
Cabin length	12 ft 4 in
Cabin width	49.5 in
Cabin height	47 in
Empty weight	2,606.9 lb
Empty weight, as tested	2,772 lb
Max ramp weight	4,116 lb
Useful load	1,509.1 lb
Useful load, as tested	1,344 lb
Payload w/full fuel	789.1 lb
Payload w/full fuel, as tested	624 lb
Max takeoff weight	4,100 lb
Max landing weight	3,900 lb
Fuel capacity, std	732 lb (720 lb usable)
Baggage capacity	
Forward	100 lb, 14 cu ft
Aft	100 lb, 20 cu ft

Performance

Takeoff distance, ground roll	1,750 ft
Takeoff distance over 50-ft obst	2,550 ft
Max demonstrated crosswind component	17 kt
Rate of climb, sea level	1,100 fpm
Max level speed	
Sea level	183 kt
23,000 ft	234 kt
Cruise speed/Range w/45-min rsv, std fuel (fuel consumption, ea engine)	
75% power, best economy	
25,000 ft	216 kt/1,296 nm (96 pph/16 gph)
10,000 ft	186 kt/1,116 nm (96 pph/16 gph)
65% power, best economy	
25,000 ft	206 kt/1,400 nm (84 pph/14 gph)
10,000 ft	173 kt/1,211 nm (84 pph/14 gph)
55% power, best economy	
25,000 ft	197 kt/1,428 nm (72 pph/12 gph)
10,000 ft	162 kt/1,336 nm (72 pph/12 gph)
Max operating altitude	25,000 ft
Max pressure differential	5.5 lb/sq in
Landing distance over 50-ft obst	1,780 ft
Landing distance, ground roll	1,175 ft

Limiting and Recommended Airspeeds

Vx (Best angle of climb)	90 KIAS
Vy (Best rate of climb)	110 KIAS
Va (Design maneuvering)	135 KIAS
Vfe (Max flap extended)	
10 degrees	170 KIAS
20 degrees	135 KIAS
36 degrees	120 KIAS
Vle (Max gear extended)	200 KIAS
Vlo (Max gear operating)	
Extend	170 KIAS
Retract	130 KIAS
Vno (Max structural cruising)	173 KIAS
Vne (Never exceed)	203 KIAS
Vr (Rotation)	77 KIAS
Vs[1] (Stall clean)	69 KIAS
Vso (Stall in landing configuration)	58 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 Categories are defined in June 1983 Pilot, p. 96. The prices reflect the costs for equipment recommended to operate in the listed categories.*

POWER FOR THE MALIBU: RUN LEAN, RUN HIGH

TSIO-520 is a familiar engine designation. It identifies a series of turbosuper-charged, fuel-injected, opposed, 520-cubic-inch displacement engines produced by Teledyne Continental Motors. In various forms, Teledyne's TSIO-520 engine powers a number of high-performance singles and light twins.

The engine in Piper Aircraft's new Malibu bears the same basic identification; but according to engineers at both Piper and Continental, the Malibu's engine is significantly different in the way it was designed and in the way it operates.

It is not uncommon for aircraft manufacturers to select a particular engine for a new or modified airframe. However, when Piper began designing the Malibu, it was not satisfied with existing products. So, the company furnished the expected size and performance specifications and asked the engine builders to propose designs that would meet the basic specifications.

Continental won the contract with its proposal for a brand-new 520-series engine, the TSIO-520BE. Continental officials are enthusiastic about the manner in which the project was conducted, and they are proud of the engine they came up with. "We were given enough latitude to build an engine to meet the requirements of the airplane," a Continental spokesman said. "It was the kind of design freedom that we do not see often." The company was so pleased with the results that it recommended a 2,000-hour time between major overhauls (TBO) for the new engine.

The Malibu's engine produces 310 horsepower at 2,600 rpm and 38 inches of manifold pressure. It includes a standard TSIO-520 counterweighted crankshaft and crankcase with heavier cylinders from Continental's geared engines, which produce 435 horsepower in some installations.

Total dry weight of the engine is 565.5 pounds. Bore (the diameter of each of the six cylinders) is 5.25 inches; stroke (piston travel within the cylinder) is four inches. Compression ratio is 7.5:1.

Continental engineer Bob Minnis, who directed the company's design efforts for the engine, said its most important features are the aftercoolers (intercoolers), tuned induction system, dual-stage fuel pump and oil sump.

The engine has two Garrett AiResearch turbosuperchargers, each with an aftercooler. An aftercooler basically is a radiator. As air is compressed by a turbocharger compressor, it becomes very hot. When the compressor discharge air is passed through the core of an aftercooler before entering the intake manifold, some of the heat is transferred to the aftercooler's cooling fins and is carried away by ram airflow.

Continental routinely tests its engines under conditions that will produce the hottest induction air. Some compressors in engines rated at or near 300 hp discharge air at a scalding 300 degrees F. However, the company said that, during tests of the Malibu's engine under the most severe conditions, the maximum induction air temperature reached was 130 degrees F.

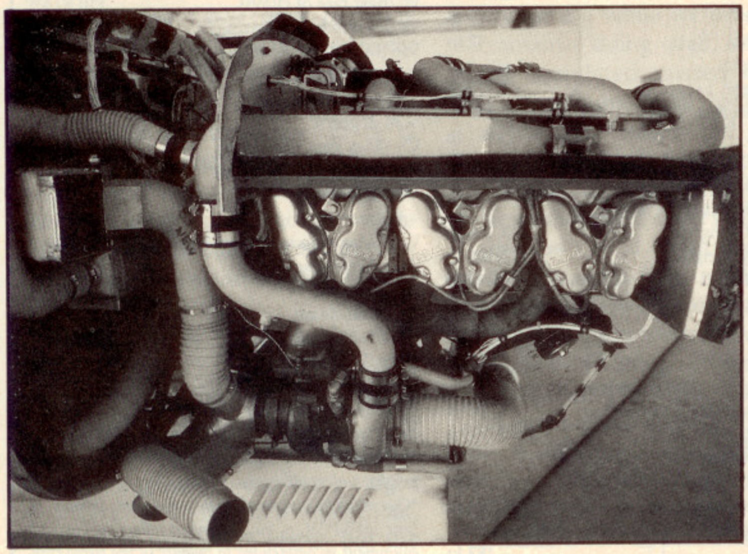
In addition to aftercoolers, the turbosupercharging system includes a sloped pressure controller, an overpressure relief valve, a variable wastegate assembly and sonic venturis. The sloped pressure controller is a fairly new system developed by Garrett. It incorporates a diaphragm, which adjusts intake pressure to compressor discharge pressure. During part throttle operation, deck pressure (pressure between the compressors and the intake manifold) is lower, resulting in cooler and more efficient engine operation. The sonic venturis, located on the outflow sides of the aftercoolers, channel air into the cabin pressurization system.

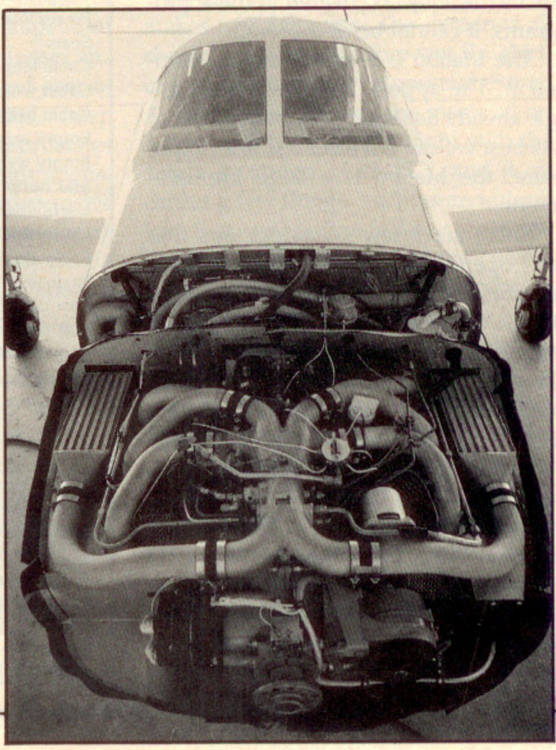
According to Continental, much of its design effort focused on tuning the induction system to provide an even distribution of air and fuel to each of the six cylinders for uniform combustion efficiencies.

Many turbosupercharged engines experienced fuel-flow fluctuations at high altitude due to negative pressures produced at their fuel pump inlets. To preclude this problem, Continental designed a two-stage fuel pump. The first-stage pump maintains a low, constant pressure on the second-stage pump, ensuring positive fuel flow. There is an electric fuel pump to back up the two-stage, engine-driven pump.

As installed in the Malibu, the TSIO-520BE engine is tightly cowled. Continental said extensive effort was devoted to the design of a shallow oil sump for the engine. The wet sump holds only eight quarts of oil, as compared with 10 to 12 quarts in other 520-series engines. However, Continental said almost all of the oil in the new sump is usable. The company noted that up to three quarts of oil are unusable in the deeper sumps of other high-performance engines.

The Malibu's engine is designed to be run at 50 degrees lean of peak turbine inlet temperature (TIT) when the airplane is





cruising at 80-percent power or less. (Leaning the fuel/air mixture is not approved during climb.) For some pilots used to flying other turbosupercharged airplanes, this procedure may appear questionable. However, a Malibu pilot who shies from following the approved leaning procedure may be doing his engine harm. The procedure is approved only when running at 80-percent power and below. But, setting the prescribed manifold pressure and rpm for 80-percent power and leaning slightly rich of peak will result in more than 80-percent power, thus causing internal temperatures to rise beyond the engine's tolerances.

Operating lean of peak TIT, however, requires some faith in the engine instruments. There are two temperature probes, one in each turbosupercharger turbine inlet. Readings from these probes are averaged and sent to the panel-mounted TIT gauge. Since there is room for error in the temperature-sensing system, it should be checked and calibrated regularly. One engineer recommended that the system be checked every 100 hours.

According to Continental, one of the most potentially harmful consequences of running lean of peak TIT is exhaust system corrosion because of extra heat and oxygen. To combat this potential problem, Continental fabricates portions of the exhaust systems with Inconel, an expensive chromium-iron alloy that can withstand higher temperatures and rejects corrosion.

When operated according to approved procedures, the engine has a specific fuel consumption of 0.395 pounds of fuel per horsepower per hour. The specific fuel consumption of similar engines typically is 0.42 pounds of fuel per horsepower per hour.

A few other items are worthy of mention. The engine has pressurized Slick Electro 6220 magnetos to ensure proper ignition at high altitude. In addition, the upper ring land in each piston has a steel insert that prevents the ring from fluttering at low-power settings and during steep descents. Continental also has improved the heat-treatment of exhaust and intake valves. According to the company, the new process provides harder and slightly stronger valves.

Continental said the TSIO-520BE engine is capable of producing much more than 310 horsepower and of operating much higher than the Malibu's 25,000-foot maximum certificated operating altitude. (Piper chose not to certify the Malibu for operations at higher altitudes since the regulations require more extensive—and expensive—structures and systems, such as double-pane windows.

One Continental spokesman noted that the TSIO-520BE actually should be loafing in the Malibu. Another spokesman said the engine is the first to get a recommended 2,000-hour TBO "right off the bat."

—Mark M. Lacagnina

TOOLS OF THE TRADE

When it came to designing the Malibu, Piper Aircraft decided to do a few things differently. Instead of building a scale model for wind-tunnel tests, the company built a full-size aerodynamic prototype with steel tubes, sheet metal and plywood and actually flew it. And instead of using labor-intensive manual drafting and numbers-crunching, Piper accomplished much of the design work and tool preparation by tapping into the computer mainframes at McDonnell Douglas Corporation.

Computer-aided design and computer-aided manufacture (CAD/CAM) are not yet household words, but nearly everyone has caught at least a glimpse of the technology. Television advertisements show butterflies and automobiles being created on computer screens. In a newspaper advertisement, one company claimed that its CAD/CAM system could create the perfect bat for Babe Ruth—one that would have allowed the slugger to knock even more baseballs out of the park.

The advertising hype gives an impression of CAD/CAM as an artificial superegghead that can create anything desired by a mere mortal. Putting imagination to wing, one could envision that, for the Malibu project, Piper's engineering staff was reduced to one dreamer who sat at a computer terminal and tapped a few keys. He asked the computer for an airplane with six seats, a cabin pressure differential of 5.5 psi, a cruise speed of 215 knots at 75-percent power at 25,000 feet with a specific fuel consumption of 0.395 pounds of fuel per horsepower per hour. The machine hummed, and then the Malibu appeared on its screen, ready for production.

Future shlock fantasy aside, however, there is nothing magic about CAD/CAM. It can create nothing. It merely is a sophisticated tool that can help people to create other tools and machines. The system did not free Piper's engineers from their drafting boards. They had to do a lot of design work on the Malibu before they ever sat down at their computer terminals.

As far as tools go, though, CAD/CAM is rather fantastic. During a brief demonstration of the system, I watched as a Piper engineer brought a complex drawing of the Malibu's fuselage structure onto a computer screen. He then selected a small section of the fuselage and used a mode controller and keyboard to request the values for all of the bend angles in the section. One by one, the numbers appeared—dozens of them. In seconds, the computer performed and presented calculations that would have required many hours to accomplish manually.

The engineer then asked the computer for the size and weight of the fuselage section. The computer responded with a question of its own. It wanted to know the locations of any holes in the structure. With an electronic wand, the engineer touched three large holes through which control cables are routed. (Since computer time costs money—lots of it—we did not bother with bolt holes and so forth during the demonstration.) The computer then presented the total volume and weight of the fuselage section and broke these values down into the volumes and weights of the various materials: aluminum, titanium, steel, magnesium and so forth.

The advantages of computer-aided design, according to Piper, are speed and accuracy. The Malibu's nose-landing-gear system, for example, was designed in about two weeks with the aid of computers. Without the computers, Piper's engineers would have spent several months at their drafting tables working out the nose-gear system.

Accuracy is derived from the computer's abilities to define a design to 16 decimal places and to coordinate various component designs through zero referencing. The latter provides a "homebase" for all design work. Every dimension is referenced automatically to a single point. "There is no tolerance build-up during design," said James E. Griswold, director of engineering at Piper's Vero Beach, Florida, facility. "This is most important when it comes to production," he said. "We can create tooling to very tight accuracies."

Once the design engineers have finished, the toolmakers go to work. To demonstrate computer-aided manufacture, a Piper engineer called up a wing-leading-edge section drawing on the computer screen. He then designed the form around which the wing section could be fabricated. The result during actual design of the Malibu was a computer-generated tape that is fed into a numerically controlled machine that stamps, cuts, drills and finishes the wing-leading-edge form according to the instructions on the tape.

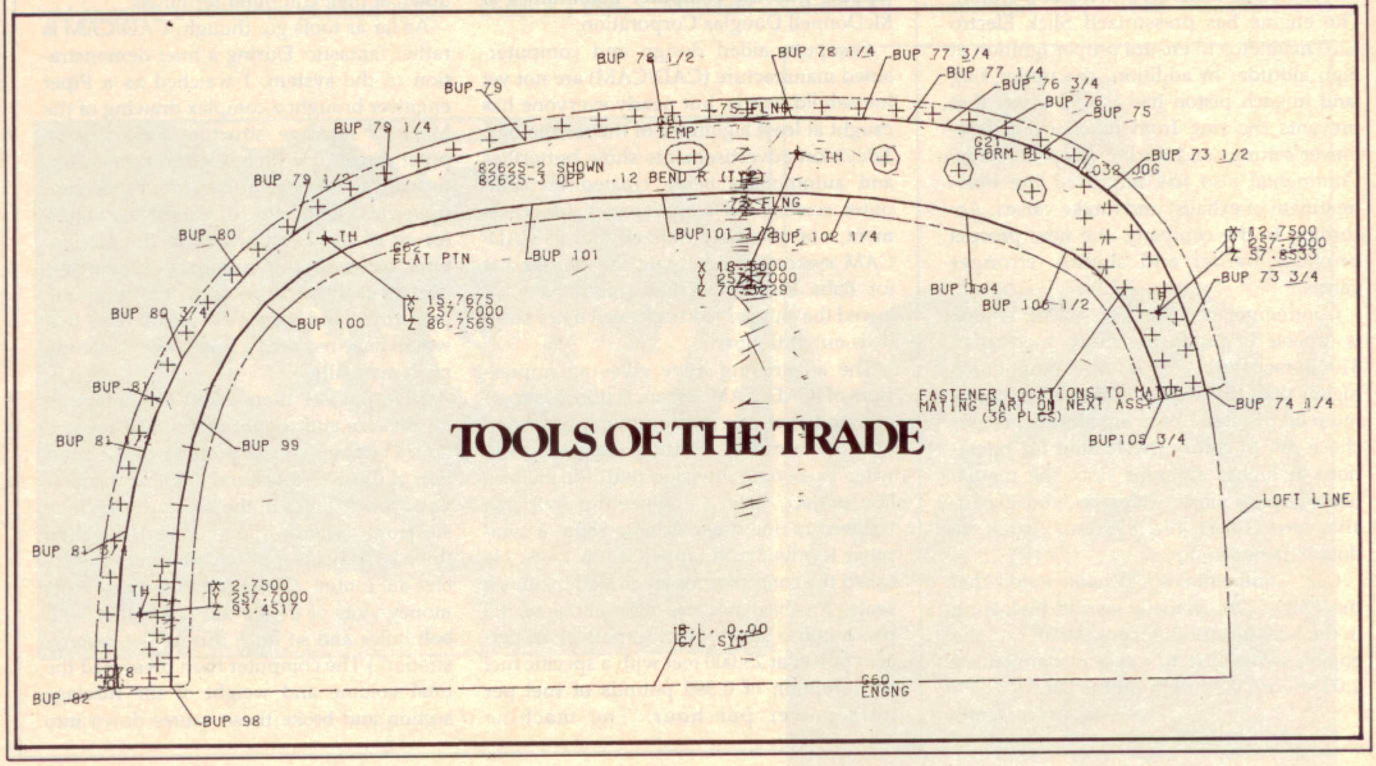
(Computer-aided manufacture should not be confused with robotics—the electromechanical and computer-driven machines used by many automobile manufacturers to mass-produce their products. Piper does not have a sufficient production volume to justify investment in robotics. The company uses CAM to produce tooling and certain sheet-metal sections for manual assembly of Malibus.)

CAD/CAM is fascinating technology, but what does it mean for the consumer? Griswold summed it up in one word: quality. "Just take a look at a Malibu and compare the fit and finish with another airplane," he said. "The fit of the sheet metal is tremendously influenced by CAD/CAM."

Marion J. Dees, vice president of engineering for Piper, believes that 90 percent of all new airplanes designed in the latter half of this decade will be designed with the aid of computers. Dees said the greatest advantage of CAD/CAM, from the standpoints of both the manufacturer and the consumer, is time. "We can get the same end product either way [with computers or with conventional design and drafting procedures]," he said. "With CAD/CAM, we get the end product faster."

Asked to speculate what the status of the Malibu project might be now if Piper had not used CAD/CAM, Dees replied, a bit hesitantly, "Well, I think we would still be waiting to go into production."

—Mark M. Lacagnina



TOOLS OF THE TRADE