TBM 850
is even faster

More power up high gives the fastest personal turboprop an even bigger speed advantage.

BY J. MAC McCLELLAN
PHOTOGRAPHY BY PAUL BOWEN

There are two important measurements of turbine engine power output. The one published in basic specifications, and tossed around when pilots get together to talk, is the takeoff power rating. And that's important. But a more difficult to define, and equally important, measure of turbine engine

power is how much is available at useful cruise altitude. The new TBM 850 has the same takeoff power rating as the previous model, but delivers considerably more thrust at high cruise altitude to increase its effective cruise speed by 25 knots or more.

The actual cruise power increase in the new TBM 850 is variable when you consider altitude and air temperature for the comparison, but it is nominally 150 shaft horsepower (SHP), thus the name change from TBM 700 to 850. Because the extra fuel needed to generate the extra power up high is offset by the cruise speed increase, range remains about the same with no fuel capacity increase. And when boring into a strong headwind, the higher true airspeeds actually improve range because a smaller percentage of the true airspeed is lost to the wind.

The TBM 700 could bump up against 300 knots true airspeed at standard air temperature in the mid-20 altitudes, but when cruising at the more fuel-efficient altitudes near the airplane's 31,000-foot ceiling, the speed dropped down to about 250 to 260 knots. The new 850 can top 300 knots at any weight, hit 320 knots at optimum altitude and maximum weight, and can come close to 320 knots true at its ceiling at typical cruise weight.

The key to the speed increase is a new version of the Pratt & Whitney turboprop engine, and a different way of tapping bleed air for pressurization. The new 850 uses the PT6A-66D engine, which is capable of producing 1,825 shp at sea level. The engine is in the same family of PT6 engines used on the big Beech 1900 regional airliners and the new speedy Piaggio Avanti twin turboprop pusher. The PT6A-64 that powers the TBM 700 can generate 1,580 shp at sea level, so you can see the size of the potential power increase.

A turboprop engine, like any engine, is nothing more than an air pump. The greater mass of air that an engine can compress and burn, the more power it makes. As air density thins at altitude, the engine has less mass of air to work with and power output drops. That's why so many turbine engines are flat rated, meaning that they can make much more power at sea level than the airplane can use. But you need to start with a reserve of power potential to have the power you want left up high for cruise. And the new TBM 850 has a bigger flat rating margin than any other airplane I can think of. The 850 at sea level has more than double the power potential available than it will use for takeoff and initial climb.

But the engineers at Pratt and TBM worked even more magic to obtain additional power and efficiency at cruise by modifying the engine-bleed air system that pressurizes the cabin. As in many large jets, the new 850 has a dual-bleed air tap that provides a reliable and steady source of pressurization at all power settings at any altitude in the operating envelope.

To pressurize the cabin in a turbine-powered airplane, engineers tap high-pressure air from the engine compressor section before the air enters the combustion chamber. This is called "bleeding" air, and it's an accurate description because the high-pressure air that goes to the cabin doesn't go to the engine burner section, so less power is produced. The engine is literally bled of power.

The new Dash 66D engine in the 850 has four stages of axial compressors plus a final stage of centrifugal compression. Obviously, the pressure is increased by each stage of the process. When the engine is operating at cruise power, only a small portion of the compressed air must be bled to maintain the 6.2 psi cabin pressure and keep the TBM cabin pumped up. But, the rules require—and every pilot would want—that the cabin pressure must be maintained when the engine power is low. In other words, you must be able to chop the power at the certified ceiling without the cabin altitude climbing. To meet that requirement, the TBM 700 tapped bleed air from a higher pressure section of the compressor than was needed for normal cruise and descent and that used more engine power. The new 850 has two engine-bleed taps to satisfy normal cruise power pressurization and the low power high-altitude condition.

When the 850 is operating at any typical cruise power setting all the way up to the 31,000-foot ceiling, the new bleed air system taps a lower pressure section of the engine compressor, which robs less power from the engine. If the pilot wants to make a rapid descent from high altitude

The TBM 850 cockpit is unchanged from the previous model and contains all the equipment necessary for safe and comfortable operation in the flight levels, including electronic flight instruments and Garmin GNS 530s. The passenger cabin features club-style seating, with aft seats that fold down for access to the baggage compartment. Bose headsets are wired to all seats.

■ **The crew door has become a popular option, even though it adds $75,000 to the price. The main cabin door is extremely large and has an electrically powered system that pulls it closed, ready for latching. The cowling opens quickly for access to the PT6 turboprop engine. In the lower photo you can see two bleed air lines running along the engine, the only visible change under the cowling.**

and reduces power to at or near idle, a system of valves move and tap bleed air from a higher pressure section of the engine compressor and the cabin stays pumped up and nobody's ears pop. TBM pilots can select to use the high-pressure bleed air continuously and give up the extra power, but the automatic mode is the norm, and will be used except in abnormal conditions. As I said, this is a typical pressurization bleed system in many jets, but is a new level of sophistication in this class of airplane, and for the price of some additional plumbing and valves, increases high-altitude cruise for almost no more fuel burn.

Since the design objective for the 850 was to increase high-altitude cruise speed, and everybody was pretty happy with the TBM's takeoff and initial climb performance, the decision was made to keep takeoff and initial climb power at 700 shp. The 850 weighs the same as the 700, which can use runways of 3,000 feet, so the decision makes sense. The 850 also retains the 700's torque limiting system during takeoff and normal airport maneuvering, which protects the engine and reduces pilot workload.

The flap selector in the 850 has a new, fourth position. It retains the flaps up, takeoff, approach and landing positions of the 700, but when you move the selector to the new detent beyond flaps up, the torque limiting system is disengaged and the full power of the new engine is available for climb and cruise. In this mode the pilot must observe torque limits by restricting power lever movements, but this mode is the normal mode in nearly all other PT6-powered airplanes.

I had a chance to fly the first TBM 850 off the production line at the company's U.S. headquarters in North Hollywood, Florida. No matter how closely I looked, I couldn't spot an external difference between the 850 and 700s that were parked nearby. The reason is that there aren't any, except for the most subtle reshape of the exhaust stacks on the new engine. When you open the cowling you can see the second shiny bleed air pipe for the dual tap system, but that's about it for external differences. The 850 weighs about 20 pounds more empty than the 700C2 that it supersedes, and most of that weight is accounted for by the pipes and valves of the new bleed air system.

The new TBM 850, like the 700, is a very complete airplane as standard. The dual Garmin GNS 530 GPS/flight management systems are standard, as is the electronic flight instrument system (EFIS) from Bendix/King. Pilots can choose XM Weather or the Bendix/King system to deliver weather to the cockpit. Everything else you need, including the equipment for reduced vertical separation minimums (RVSM) to fly above 28,000 feet, is available. The one major airframe option is a crew door that allows the pilots to enter ahead of the wing after passengers have been loaded and the huge main cabin door closed. This has become a popular option, though if it were my airplane, I would leave it off. The TBM cabin is large enough to climb into the pilot seats from the main cabin without unusual gymnastic ability. The cockpit space and room to maneuver is certainly on par with existing light jets.

The TBM cockpit has a big airplane feel about it, as you would expect from a company whose parent is part of the group that builds the Airbus. The systems are of modern design, which means they have a high level of automation. There is little to system management in flight, except to make sure you have the necessary fuel onboard. The fuel selector is also automated and a big knob rotates from one tank to the other on its own, to maintain fuel balance.

The TBM is, obviously, a single-engine airplane and that means it must stall at 61 knots or less at maximum weight, and has demonstrated that after one turn with pro spin controls applied, the airplane recovers in less than an additional turn even at extremes of weight and CG location.

Since the TBM was designed from scratch to be a single-engine turboprop, engineers knew they would need the most effective wing flap possible to meet the stall requirements. The long span Fowler flap covers most of the trailing edge of the wing, leaving only a little room for ailerons. To augment the authority of the small ailerons, the TBM has roll spoilers that extend after the aileron travels several degrees up to initiate the bank. Spoiler augmentation of roll control is common on larger jets for many of the same reasons. But unlike most jets, the roll control system on the TBM is entirely mechanical, operating by cables, pushrods and bell cranks. The control system is extremely smooth and has very little friction.

In late 2002 the TBM engineers demonstrated to the FAA that new 20G crashworthy seats and other modifications delivered the equivalent level of safety as the 61-knot stall speed limit at a 65-knot stall at maximum takeoff weight. The FAA approved the new stall speed, which allowed an 816-pound takeoff weight increase in the 700C2 model that carries over to the new 850. As soon as fuel burns off, the TBM maximum stall speed will decrease and be below 61 knots for most of a typical flight, so the equivalent safety finding covers only a small worst-case corner of the envelope.

Another unusual design feature of the TBM is its very high single value VMO (velocity maximum operating) of 270 knots. VMO, unlike the red-line limit of VNE (velocity never exceed) in a piston airplane, accounts for the effects of Mach at higher altitudes as well as the structural loads that increase with indicated airspeed. Mach effects include change in flying qualities and loads on the airframe. Air flowing over the wings and tail can approach Mach 1, the speed of sound, when the airplane itself is moving through the air at far less than that speed. For example, the air must accelerate so abruptly to pass over and under a thick wing section that a Mach shockwave can be created and change the performance of the wing or tail when true Mach is quite low.

Mach effects change with air density, becoming more critical as atmospheric density decreases with altitude. For that reason, nearly all turbprop airplanes adjust VMO down as altitude increases, thus delivering a larger margin away from the detrimental effects of Mach as the airplane climbs. The creators of the TBM took a different tack and designed in enough airframe strength and flying qualities margin that the airplane exceeds all standards at 270 knots indicated airspeed at any altitude up to its 31,000-foot ceiling. The single red line VMO of the TBM reflects both exceptional airframe strength, and very predictable and benign flying qualities at all altitudes. While some turboprops are limited by their VMO at high altitude, the TBM never is. That is especially important on descent, where you can shove the nose over in the TBM on descent and gain back some of the time spent in climb by coming down at a very high true airspeed without a reduce red-line limitation.

Whenever I have flown the TBM I am always impressed by the low pilot workload on takeoff and initial climb. The engine has been so expertly positioned that there is very little of the torque effects to compensate for that you would expect in such a powerful single. There is a rudder trim rocker switch under your thumb on the control wheel that you use to set the trim in the takeoff "pie" on the indicator. With rudder trim properly set, directional control on takeoff is as easy as in other singles that have a fraction of the power.

You will, however, use your thumb on the rudder trim rocker switch several times during a TBM trip. Changes in power, attitude and airspeed all require rudder trim adjustments. It's just the nature of a single-engine airplane and quickly becomes second nature.

Another initial impression in the TBM is of a great reserve of power, much like a jet. When you haul the nose up on rotation there is no need to reduce deck angle after liftoff. The TBM just keeps going up, with 130 knots yielding the maximum rate of climb. Some pilots object to the limited view over the nose, but I always think that with a climb rate well over 2,000 fpm I'm not going to hit anybody

TBM 850

The airplane flown and photographed for this report was the first TBM 850 off the assembly line. As standard equipment the airplane had dual Garmin GNS 530s, Bendix/King EFIS and automatic flight control system. Options included traffic and terrain alerting, and all necessary equipment to fly in RVSM airspace. The major airframe option was the forward pilot's door. All performance data comes from the pilot's operating handbook and represents standard day conditions unless noted.

Price	**$2,576,930**
Engine	**P&W PT6A-66D, 850 shp**
TBO	**3,000 hrs (3,500 hrs mature)**
Propeller	**4-blade Hartzell, 91-in dia**
Seats	**6**
Cabin length	**13.3 ft**
Cabin height	**4.0 ft**
Cabin width	**4.0 ft**
Overall length	**34.9 ft**
Overall height	**14.3 ft**
Wingspan	**41.6 ft**
Wing area	**194 sq ft**
Wing aspect ratio	**8.2**
Maximum ramp weight	**7,430 lbs**
Maximum takeoff weight	**7,394 lbs**
Typical empty weight	**4,670 lbs**
Maximum zero fuel weight	**6,032 lbs**
Maximum payload	**1,378 lbs**
Maximum fuel	**1,887 lbs**
Payload, maximum fuel	**873 lbs**
Maximum landing weight	**7,024 lbs**
Wing loading	**38 lbs/sq ft**
Power loading	**8.7**
Ceiling (certified)	**31,000 ft**
Pressurization	**6.2 psi**
8,000 foot cabin @	**28,500 ft**
Takeoff runway	**2,840 ft**
Climb @ MTOW	**19 min to 30,000 ft**
Max cruise	**320 kts @ 30,000 ft**
Fuel flow, max cruise	**389 pph**
Long range cruise	**252 kts @ 31,000 ft**
Fuel flow, long range	**263 pph**
IFR range, high-speed cruise	**1,365 nm**
IFR range, long-range cruise	**1,519 nm**
Landing runway	**2,430 ft**
VMO	**270 kts**
Stalling speed, MTOW	**65 kts**

right under the nose, but need to be looking up where the airplane is aimed. The traffic advisory system also lets you know about traffic nearby.

With the flap selector moved to the new, high power detent, the PT6 was able to deliver full-rated power and, despite a brief level-off down low, the new 850 reached 28,000 feet in less than 18 minutes. At that level with maximum cruise power set, the true airspeed varied between 306 and 310 knots, though air temperature was almost 20° C above standard and we were at maximum weight. Fuel flow, which is displayed in gallons per hour, unusual for a turbine, was 58.5 gph. If temperature had been standard, the handbook shows a cruise speed of around 320 knots, or a little more as fuel burned off. Under standard conditions at mid-cruise weight, the 850 delivers 320-knot true airspeed at 26,000 feet, but slows only to 315 knots at the ceiling of 31,000 feet, so there is very little penalty to climb. Fuel flow, however, drops from 66.6 gph to 55.8 gph for those five knots of airspeed.

The new engine uses the previous version as a baseline since takeoff power is unchanged, so some engine gauge readings in climb and cruise are above 100 percent. Though the torque limiting protection is gone once high power mode is selected, a monitoring system will illuminate a red light when the torque limit is reached. That light does not mean the limit has been exceeded. If there is a true exceedance, the system automatically measures the amount and duration of the event. Maximum propeller rpm for all operations is 2,000 and you can cruise at that setting or, if you find it more comfortable, reduce rpm and increase torque to maintain the same cruise speed. Every pilot will probably find his own sweet spot for cruise propeller rpm.

Despite its high speed and high altitude capability, the TBM is a single-engine airplane that behaves the same, and places the same demands on its pilot, as, say, a Bonanza, in the terminal area. The approach flap and landing gear extension limits are a high 180 knots so speed control is easy. Final approach speed at a turbine standard of 1.3 times stalling speed is going to be about 80 knots or less depending on landing weight, so everything will feel normal to an experienced single-engine pilot.

The people at TBM don't know why, but the new engine is much easier to manage in the pattern and on short final. In most PT6 installations, the power lever becomes very sensitive at the lower power settings used around the airport. At low power the propeller is operating close to flat pitch and a small reduction in power drives the prop flatter, creating a lot of drag and a sinking spell if you are not careful. But the new engine in the 850 doesn't seem to have this power sensitivity band. Power response to movements of the throttle remain linear all the way to touchdown, and I found it very easy to gradually reduce power into the landing flare without any abrupt change that could cause the airplane to drop in. There is, however, a powerful visual illusion because the nose is so long that the TBM is pointed way nose down on approach, creating the temptation to flare too high. After a couple of landings you get the proper sight picture in mind and landings become easy and predictable.

An obvious question in view of the 850's typical $2.8 million price is: Why a turboprop single when light jets such as the Citation Mustang will cost nearly the same? The answer is because the TBM is not a jet, that's why. The new 850 delivers speed close to that of the proposed new light jets, and undoubtedly more range, with only a single engine. Insurance companies are comfortable with pilots moving into the TBM directly from piston singles. No type rating is required, and the TBM doesn't have the runway limitations imposed on jets. And at today's prices, fuel has become a cost issue in any airplane, and you can't beat the efficiency of a single.

The TBM is really a personal airplane designed for the owner pilot who wants to go fast over long distance while carrying few, if any, passengers. In this airplane the pilot and his companion are the payload. The cabin is plenty roomy and comfortable for two couples, though six fit fine for shorter trips, but this airplane is about owner pilots, not passengers.

Bottom line, nothing goes as fast and as far for the money as the TBM 850, and it is being delivered now, is well established in terms of maintenance and insurance, and is available to virtually any pilot with an instrument rating. The airplane hit its target out of the box as the ultimate personal airplane, and with the extra speed of the 850, it just keeps getting better.

Falling Fast

BY DICK KARL

I squirmed around in my seat to see the instantaneous vertical speed indicator declare 6,000 feet per minute. Down. Portions of the Florida landscape filled most of the windshield. Both the pilot and copilot remained calm. The center controller kept asking for us to say our altitude. "22,000," came the reply. About 30 seconds later the same controller made the same request. "17-five," came the response. The altimeter unwound like a dizzy clock in an old movie. Our rate of descent had paralyzed the center's computer. We were "coasting."

I was sitting in the sumptuous back-facing seats of a brand new TBM 850. In the front sat Mac McClellan of *Flying* and Alan Griffin, TBM's chief pilot. I was joining Mac on a visit to Socata in North Perry, near Fort Lauderdale. While I was falling out of the sky, I was falling for this machine, the new souped-up TBM.

We had started with some preflight explanations about the differences between the TBM 700 and the 850, most of which went over my head. Then four of us hopped into this speed demon for a test flight. Mac sat in the left seat. In the back I admired the opulent surroundings, noted the adequate headroom and thought of our Cheyenne, with its nice interior, turbine reliability, but 25-year-old systems. Though the TBM felt marginally smaller in the back, it was roomier up front. And it is impressively faster and more economical to operate.

I had long thought that a TBM would be the perfect airplane for me. Fast and efficient, it can easily carry four with luggage and go a very long way. With no business associates to transport, I don't need the size of a King Air. At more than 300 knots, a TBM is close to the projected speeds of most of the VLJs, burns less gas and has a greater range. Just what I need.

After we landed at Lakeland, Florida, I was offered a go at the left seat and I jumped at the chance. The feel on takeoff was different than our airplane. It had been a long time since I'd flown a single-engine airplane of any type and the TBM has a long snout with a lot of power in the front end of it. I squirreled down the runway and rotated at about 85 knots, got the yaw damper on, flaps up and inertial separator stowed just in time to see 1,500 feet go by on the altimeter.

We turned downwind. I say "we" because Alan was doing everything but the flying—and he was probably doing most of that, too. On base I deployed approach flaps and pointed the nose down as instructed. The view was alarming compared to the deck angle of our airplane. It looked like we were going straight down. Alan cautioned me not to flare too early and I rewarded his instruction by ignoring it. I just couldn't help leveling this multi-million dollar airplane approximately five feet off the ground, where I sat transfixed as I ran out of airspeed and ideas at the same instance. Whomp. Alan said something about TBM's certification process for testing the gear strength, but I didn't catch it as we were on the go again.

The next landing was marginally better. We followed that with a balked landing (easy, plenty of power and airspeed), then headed up to 17,500 feet for the VFR trip back to Fort Lauderdale. We climbed at 2,000 feet a minute, leveled off, and found ourselves devouring Florida farmland to the tune of 345 nautical miles per hour. The glass/electronics were superb and too soon we were started down with North Perry in sight. Though Runway 9R is only 3,000 feet long, we turned off easily on a taxiway before the end.

What to say about such an experience? I know of no other airplane with this combination of attributes and these are exactly the characteristics I long for. The interior is beautifully done, the airplane is fast-fast, and the fuel burn is amazing considering the performance. The easiest way to explain my feeling as I got out of the pilot door is to say this: I want one.