Flying Piper's New M600 Turboprop

Business & Commercial Aviation
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Thu, 2016-08-25 04:00

Considerably more capable than the M500 Meridian

Piper Aircraft's new M600 combines the proven M500 Meridian fuselage, a clean-sheet wing with 600+ lb. more fuel capacity and an uprated Pratt & Whitney Canada PT6A engine with 16% more power to become the firm's best-ever performing single-engine turboprop. The M600, for instance, can fly a 200-lb. pilot, two 200 lb. passengers and 58 lb. of extra baggage more than 1,480 nm at long-range cruise and land with 100-nm NBAA IFR reserves. The M500, by contrast, can fly the same payload about 820 nm.

Depending upon winds, the M600 has sufficient range to fly between Seattle and St. Paul, Minnesota; Lompoc, California, and Lincoln, Nebraska; or Montreal and Miami. But at its 184 KTAS long-range cruise speed, such missions last more than 8 hr., stretching passenger endurance since it's without a lav. At its 257 KTAS normal cruise speed, though, the aircraft can fly more than 1,200 nm in just over 5 hr., enabling it to fly from most U.S. West Coast cities to most East Coast cities with a single mid-continent fuel stop.

With a *base price* of $2.853 million, the M600 is by far the lowest priced pressurized single-engine turboprop with such range. It's a design-to-cost model that provides the most improvements for the least price increase over the M500. Fitting the aircraft with a new wing was critical to accomplishing cost-effective performance improvements, as the M500 Meridian wing was adapted from the original PA-46 Malibu piston single. The M600's wing not only has more fuel capacity than that of the M500, it's also larger and beefier to handle heavier operating weights that improve tanks-full payload. And it allows Vmo redline to get bumped up to 250 KIAS, a 62-kt. increase that allows operators to fit in better with the flow of other turbine aircraft when descending into terminal areas.

The aircraft is easy to spot on the ramp, having an evenly tapered wing planform, a weather radar pod integrated into the right wing leading edge and stylized wingtips. Inside the aircraft, pilots will find a full-feature Garmin G3000 avionics package and passengers will nestle into upgraded seats in the four-chair club section. A sturdy worktable, covered with high-gloss wood veneer, folds out between the right facing passenger chairs. On the left side of the club section, there is a clamshell two-piece airstair door that opens for easy passenger access. When closed, its bottom step folds down to reveal two cylindrical recesses that hold beverage containers.

Other interior amenities include six USB charging ports, hard-wired Bose A20 active noise reduction headsets in the cockpit and all LED interior lights. The two USB charging ports in the cockpit make it possible to use dual redundant tablet computers for electronic charts. Put your manuals and other required documents on the tablets and you can leave all those tomes in your hangar.

There are design-to-cost tradeoffs, however. Piper elected to forego RVSM certification, limiting max operating altitude in the U.S. to 28,000 ft. The M600 also retains the M500's fixed geometry engine air inlet that lacks inertial separator diverter doors to seal off the plenum and increase ram recovery during cruise, thereby boosting engine efficiency. Developers also left off aileron trim, retained chemical emergency-use oxygen generators for the passengers and omitted detailed flight planning and performance tables from the POH.

Still, there's a long list of options to make the aircraft more comfortable, capable and convenient to fly. These include Sirius XM satellite radio that provides weather and entertainment services, an Iridium satcom phone, an engine fire detection system, DME, ADF, L-3 Stormscope lightning detector and a hybrid TCAS 1/ADS-B traffic advisory system, among others.

Structure and Systems

The M600's new semi-monocoque aluminum wing actually dates back to a 1979 airfoil designed by Robert J. McGhee and William D. Beasley at NASA's Langley Research Center. Their MS(1)-0313 (medium-speed, 13% thickness-to-chord ratio at 37.5% chord) airfoil blends the desirable high-lift characteristics of an earlier low-speed general aviation airfoil with some of the rooftop pressure distribution, turbulent boundary layer characteristics of low-drag high-speed airfoils. The result is an airfoil that has improved maximum lift coefficient and stall behavior characteristics with a relatively low drag rise up to Mach 0.72, well above the design speed of the M600. It's also comparatively immune to performance degradation caused by leading edge contamination.

For the M600, Piper modified the baseline airfoil to have 17% thickness at the root, tapering to 13% at the tip. The aspect ratio is 8.5:1, taper ratio is 0.4:1, geometric twist is 3 deg. and dihedral is 3 deg. Compared to the NACA 23000 series airfoils used for the Meridian, the M600's wing is thicker, but it has better lift-to-drag characteristics at cruise speed as well as even more benign stall characteristics. The increased thickness not only increases internal volume available for fuel, it also makes the spars and ribs taller and thinner, thereby reducing structural weight.

The wing has forward, main and rear spars. Many of the spar and rib components are single-piece machinings. Span-wise stringers are bonded to the wing skins to increase stiffness. Conventional mechanical fasteners, such as rivets and Hi-Lok fittings, are used to assemble the wing. Right and left wing halves are joined at the root and then the entire wing assembly is fastened to the fuselage with torque and shear fittings.

Most of the fuselage also is a conventional semi-monocoque, high-strength aluminum alloy structure, with the exception of the forward nose cowl shell made from aluminum and fiberglass. Skins are flush riveted in areas exposed to the slipstream. A steel tube assembly, forward of the pressure vessel, supports the engine and nose landing gear.

The nose cowl has dual engine air inlets at the 4 and 8 o'clock positions. The air plenum has an integral inertial separator that egests small debris and ice particles through fixed exhaust outlets on the bottom of the nacelle. The engine is a "medium size" two-shaft PT6A with a three-stage axial flow and single-stage centrifugal flow compressor, reverse flow annular combustor and single-stage high-pressure turbine in the gas generator (NG) section at the rear of the engine. Exhaust gases then drive a two-stage low-pressure turbine (NF) that powers the prop through a reduction gearbox. During flight, prop speed automatically is governed to a constant 2,000 rpm. Beta (zero thrust) and reverse pitch functions are available for ground operations.

The PT6A-42A engine essentially is the same as the -42 fitted to 1,200+ Beech B200 King Airs, among other turboprops, so it's been well proven since making its debut in the early 1980s. The -A designation means that the fuel control has a manual override (MOR) function similar to all other PT6A-powered singles. MOR provides a second means of engine control in the event that normal pneumatic servo functioning of the fuel control unit is lost or degraded, or if the power control lever linkage fails. MOR, however, doesn't provide overspeed, over-torque or over-temp limiting.

The thermodynamic horsepower rating of the -42A is more than 1,050 thp, providing fat flat-rating margins for the M600's maximum 600-shp takeoff rating. The benefits are strong hot-and-high airport performance and robust climb rates into the mid- to high 20s to escape low-altitude turbulence.

The 2.0-ft.-wide-by-3.8-ft.-tall main entry door is a two-piece, clamshell design with retractable airstair steps in the lower door and a window in the upper half. It provides access to the center of the passenger cabin. In addition, there's a plug-design, over the wing, emergency exit hatch on the right side of the fuselage.

The aircraft has a 20-cu.-foot internal baggage compartment aft of the club section. Each passenger seat has an eyeball outlet in the sidewall armrest, an audio jack and a cup holder. The interior is compact, but the seat backs of the copilot and forward right passenger chairs fold down to ease access to the cockpit for the pilot. While there's no lavatory, there is a relief tube.

Fit and finish of the interior furnishings puts the M600 in a class with more-expensive single-engine turboprops, including the Daher TBM 900/930 and [Pilatus](#) PC-12NG.

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There is a small pyramid cabinet between the copilot's seat and right forward passenger chair that contains an emergency oxygen tank and a single quick-donning mask for the pilot. Two chemical oxygen generators and six passenger oxygen masks supply other occupants in the event of loss of cabin pressurization. A fully charged oxygen tank can supply the pilot for 25 min. The dual chemical O_2 generators have 15 min. duration. While that's sufficient for an emergency descent in the event of sudden cabin pressure loss, a slow loss of cabin pressure due to engine failure potentially could be problematic if it's necessary to stretch the glide to reach a divert field. Glide time from 28,000 ft. to 12,500 ft. at best engine-out glide speed ranges from 16 to 19.5 min. depending upon aircraft weight, resulting in depletion of emergency passenger oxygen before reaching a safe cabin altitude.

All windows are Plexiglas with the exception of the pilot's windshield, which is glass faced and electrically heated for anti-ice protection. Other systems are simple, typical of first-generation pressurized single-engine turboprops. The primary flight controls are manually actuated with electric pitch and yaw trim but no aileron trim. Manual pitch trim also is provided. The three-position flaps are electrically actuated.

The landing gear are hydraulically actuated with pressure supplied by an electric pump. An emergency extension system drops the gear in the event of a hydraulic failure by releasing trapped hydraulic pressure in the landing gear actuators. Once the gear free fall, spring-loaded down-locks inside the gear actuators hold the gear fully extended. The wheel disc brakes are manually actuated. Nosewheel steering is provided by linkages to the rudder pedals.

The electrical system has a single 38-amp/hr. 24-volt lead-acid battery in the engine nacelle, plus an engine-driven 200-amp, 28-volt DC starter/generator and an engine-driven 135-amp, 28-volt DC standby alternator. These three sources power a single "tie bus" from which power is distributed through main, nonessential (systems) and nonessential avionics buses. Due to cooling limitations, the standby alternator may not be able to power all standard and optional equipment. Pilot-controlled load shedding may be required. A separate battery-powered emergency bus provides essential power to the pilot's PFD in reversion mode, AHRS 1, ADC 1, com/nav radios, Aspen integrated standby instrument system, left touchscreen control unit and cabin pressurization dump switch.

All fuel is contained in left and right main and header wet wing tanks. Each wing has a refueling port and anti-icing additive is required. Each tank has a heated fuel return line that automatically supplies surplus fuel warmed by the fuel/oil heat exchanger when necessary to prevent fuel gelling in cold air. Each tank also has an electric boost pump used for starting, for high-altitude vapor suppression and for backup to the engine-driven low-pressure boost pump. The engine draws fuel from both tanks simultaneously. But should an imbalance occur, the G3000 avionics system automatically turns on the boost pump in the heavy tank so that it feeds more fuel to the engine until the imbalance is corrected.

Engine compressor bleed air is used for cabin pressurization and heating. Bleed air is routed through a mass flow control valve that modulates the flow to a relatively constant level and partially mixes it with ambient air in a jet pump for cooling. The blended air then is split into warm and cool air channels. The cool air channel uses an ambient air heat exchanger to further reduce bleed air temperature. The G3000 system has an automatic cabin thermostat control feature that mixes warm and cool air to achieve the desired temperature. An engine-driven, vapor-cycle air-conditioner refrigerates cabin air for warm weather operations.

The G3000 also automatically controls cabin pressurization by venting air through dual electro-pneumatic outflow valves, using air data and landing field elevation as reference points. The 5.5-psi pressurization system provides a 9,600-ft. cabin altitude at FL 280 and 10,600-ft. cabin altitude at FL 300. An emergency bleed air system provides a redundant pressurization source for the cabin. Bleed air also is used to inflate deice boots on the wings and tail. Flight into known icing approval is expected later this year.

G3000 Avionics

This is the first Piper aircraft to be fitted with Garmin G3000 avionics. The installation features three, landscape configuration 12-in. displays with left and right PFDs and a central MFD. In addition, there are left and right touch-screen control units in the center console. The touch screens control most avionics and airframe systems functions, but a glareshield flight guidance control panel provides ready access to flight director and autopilot functions. As with most other G3000 and G5000 installations, the one in the M600 has loads of submenus lurking below most of the main touch-screen icons. The G3000 takes some practice to master the depth of its capabilities, in *BCA*'s opinion.

The display screens have exceptionally crisp resolution and a wealth of useful graphics. Color conventions on both the main displays and touch screens keep the pilot in the loop — magenta for computer-derived targets and values; cyan for pilot-entered data; green for active and white for standby.

The standard package is chock-full of features, including synthetic vision PFDs, 40-watt solid-state weather radar, digital autopilot, terrain and traffic awareness systems, dual SBAS GPS receivers, dual comm/nav radios, dual solid-state AHRS with GPS rate aiding, dual digital air data computers and an ADS-B OUT/IN-compliant Mode S transponder. Other features include an electronic stability function for the autopilot, automatic emergency descent mode, one-touch automatic level-off mode, hypoxia recognition system and under/overspeed protection, along with Garmin electronic flight charts, safe taxi system and an Aspen EFD1000 integrated standby instrument system. Notably, the autopilot has a coupled go-around feature, substantially reducing pilot workload during low-visibility instrument approaches. Just add power, retract the gear and the flaps and the system automatically will fly you to the missed approach holding fix.

Along with the Sirius/XM satellite weather and entertainment system and L-3 Stormscope sensor, options include Jeppesen ChartView electronic charts, Garmin Iridium satcom transceiver, Class B TAWS, Becker ADF receiver, Honeywell Bendix/King DME, second Mode S or Mode S diversity transponder, GTS 855 hybrid ADS-B/TCAS 1 traffic advisory system and engine fire detection system.

The XM satellite weather system is particularly useful for strategic weather avoidance, as a 978-MHz UAT radio capable of receiving FIS-B weather is not an option. Moreover, the 10-in. dish size of the pod-mounted weather radar results in 9-deg. beam width that makes it challenging to identify weather hazards at long range. But the radar has a very respectable 218 dB performance index and a max range of 285 nm.

Flying the M600

In late July during the Experimental Aircraft Association's AirVenture 2016 in Oshkosh, Wisconsin, we belted into the left seat of the third M600 at nearby Appleton International Airport (KATW) with Piper test pilot Craig Masters to sample its capabilities. The aircraft was used in flight test and still had residual wiring and fittings that added to its empty weight. Fitted with most popular options, though, it was only 28 lb. heavier than regular production aircraft.

Starting the aircraft is easy. Once the 600-shp engine was running, we performed a brief main generator and backup alternator check, switched on avionics, pressurization and air-conditioning and programmed the G3000 avionics using the touch-screen controllers. Our flight plan route was Appleton, BGOSH intersection, direct LKI VOR near Duluth, Minnesota, and return.

There's a wealth of information on the G3000's high-resolution display screens that span the width of the panel, but Garmin has used restraint with the graphics and features to prevent data overload.

The 85F (29.4C) OAT in Appleton taxed the capabilities of the engine-driven vapor-cycle air-conditioning system. We later discovered that it needed to be recharged with refrigerant. The aircraft lacks side vent windows that would allow some ambient cooling prior to engine start.

We taxied to Runway 30, stopping briefly near the end to perform a short prop overspeed governor check. There is no stand-alone prop control lever. Once the throttle is advanced for takeoff, prop rpm stabilizes at a constant 2,000 rpm for the duration of the flight. Once cleared for takeoff, I advanced the throttle carefully in an attempt to set 1,575 ft.-lb. of torque with precision. If you don't nail the torque value, you won't make the published runway numbers.

But as with many other PT6A installations, throttle response in the M600 is anything but linear. As gas generator rpm increases, throttle response becomes hypersensitive. It's all too easy to overshoot maximum torque or temperature settings because of frenetic throttle response. Fortunately, if you accidentally nudge torque or temp redlines, three warning bongs and red reverse video alerts on the EICAS clearly remind you to pull back on the throttle. But the aircraft won't make book takeoff, climb and cruise numbers unless you push up to redlines.

Some manufacturers lessen this problem by using throttle control linkage with non-linear movement. The first portion of throttle movement displaces the linkage more than the throttle is moved. The second portion of throttle movement displaces the linkage less than the throttle is moved. This results in more linear torque response to throttle movement.

At a takeoff weight of 5,800 lb., takeoff distance to 50 ft. was about 3,200 ft. on the warm summer day. We rotated at 85 KIAS. As soon as weight came off the gear, pitch response to yoke back-pressure increased. That's because the main gear are mounted well aft of the CG. With gear retracted, we accelerated to 100 KIAS and retracted the flaps. We settled into a 145 KIAS climb and checked in with Minneapolis Center.

Center vectored us off course, due north for our climb. Was it OK if we didn't go direct to Duluth, they asked? We explained that we just wanted some free airspace at FL 280 to check cruise performance. Once again, U.S. ATC proved that it's the most flexible, most accommodating air traffic management system on the planet.

Passing FL 200, we increased pitch attitude to slow the aircraft to the 122 KIAS recommended climb speed. During the climb, we had to spend plenty of head-down time making fine-tuned throttle adjustments to maintain maximum allowable climb power without exceeding torque and temp. Clearly, the PT6A is long overdue for a FADEC upgrade. And not just for the M600.

With a brief level-off at FL 230 for air traffic and while climbing mostly in ISA+13C to ISA+15C conditions, we reached FL 280 in 28 min. The POH predicted 31 min.

Once level, the aircraft accelerated to 258 KTAS while burning 250 lb./hr. in ISA+11C conditions, again slightly better than POH performance. However, we noted palpable 133-Hz vibration from the four-blade aluminum prop during high-power climb and cruise operations. According to Piper, an optional upgrade to a five-blade carbon-fiber Hartzell prop will be available in December 2016. The upgrade should eliminate much of the vibration, as well as potentially improving climb performance, based upon our experiences flying other single-engine turboprops with five-blade Hartzell carbon-fiber props.

After the high-speed cruise check at FL 280, we headed back toward Appleton, descending out of Class A airspace, canceling our instrument clearance and proceeding VFR at 13,500 ft. for airwork. During the descent, we took advantage of the M600's 250 KIAS Vmo redline (62 kt. higher than that of the M500 Meridian) to expedite the mission.

Down at 13,500 ft., we started our airwork drills with steep turns. Make a note. It's helpful to drill down through the G3000's submenus on the touch-screen controllers to disable the aircraft's automatic electronic stability and protection functions that help pilots recover from upsets. Otherwise, the autopilot roll servos engage to help return the aircraft to wings-level attitude.

Steep turns at 140 KIAS were a snap because of the green doughnut flight path vector symbol on the PFD that shows aircraft trajectory. Pin it on the horizon line and the altimeter seems to freeze.

Clean and dirty stall behavior is a strong suit of this aircraft. At a weight of 5,500 lb., the aircraft stalled clean at 71 KIAS and 60 KIAS with gear down and flaps fully extended. There was only the slightest tendency to roll off when we held the aircraft into the stall, but it was easily countered with minor roll control inputs. As the aircraft has very strong speed stability, stall recovery was immediate as soon as we released back pressure on the yoke. Engineers in Tarbes, France; Stans, Switzerland; and Wichita, please take note. This single-engine turboprop sets a very high bar for benign stall behavior.

Appleton Tower controllers had their hands full with arriving and departing World War II vintage warbirds, AirVenture visitors, regional jetliners and corporate aircraft. So, we diverted to Clintonville (KCLI), 23 mi. north-northwest of the airport for pattern work.

We circled overhead KCLI to alert airport employees who had a truck parked on Runway 32 and a riding lawnmower operating on the grass close to the intersection of Runways 32 and 22. We elected to line up for Runway 22.

While the aircraft is fairly easy to fly in the pattern, the non-linear throttle response makes precise speed control a challenge. Once we learned how to make very tiny throttle movements, it became easier to control thrust and speed.

Nearing the pavement, we reduced power to zero thrust at 30 ft. and settled onto the runway. Compared to the M500, the M600 has higher pressure tires that make for firmer touchdowns. Using moderate prop reverse and braking, we stopped the aircraft in about 2,000 ft.

After a couple of full-stop landings, we returned to Appleton and landed on Runway 21.

Price and Value

Glance please at the accompanying Comparison Profile chart. It puts the M600's capabilities into perspective with a broad spectrum of single-engine turboprops, including the M500, TBM 900/930 and PC-12NG. What emerges is a picture of a niche airplane, one that offers considerably more capability than the M500 Meridian but one that doesn't offer the speed, size, payload or range of $4 million to $5 million top-line models.

Value for dollar, as illustrated by the dashed price line, is what separates the M600 from most competitors. It's one of the few sub $3 million offerings in a field that's now dominated by far pricier French and Swiss models. The Cessna Denali, pegged at $4.8 million, will enter the mix later in the decade, thereby increasing pressure at the top end.

Piper has taken a different route, a more affordable entry into this class of aircraft. The firm has delivered more than 550 Meridians, not because of its unmatched performance but because of its unmatched price. That's almost as many units as the more capable and far more expensive TBM 700-series aircraft.

The M600 helps Piper bridge the gap between the M500 and TBM 900/930. Quite apparently, it doesn't offer the same speed, range or cabin size as the models from Daher. But it also doesn't have their $4 million+ price tags. This is an aircraft that targets operators who want 1,200-nm to 1,400-nm range, rock-bottom operating costs and top-notch avionics at a 30% savings.

As the value leader in the single-engine turboprop class, the M600 has potential to carve out a considerably larger share of this market segment for Piper.

This article appears in the September 2016 issue of Business & Commercial Aviation *with the title "Piper M600."*

Source URL: http://aviationweek.com/business-aviation/flying-piper-s-new-m600-turboprop