Piper PA-28RT Turbo Arrow

Turbos in light singles are, by and large, not a terribly happy combination; the Turbo Arrow is no exception.

Editorial Staff March 6, 2001 0

Saddled with a battered image, handicapped by a powerplant with a nasty reputation, the Turbo Arrow should be approached with caution. But various upgrades and a kind of Darwin effect may have weeded out many of the real clunkers by now.

When Piper hung a 200-HP turbocharged Continental onto the basic Arrow airframe in 1977, the combination looked like one made in heaven, rather than Vero Beach.

It was a perfect match: the worlds premier economy retractable single and a K-Mart kind of powerplant that promised high-tech performance at low-tech prices.

Alas, the engine was finicky, tricky to operate and prone to self destruction. Things got so bad that the National Transportation Safety Board in 1985 called for an airworthiness design review of the engine, citing a litany of component failures. (Then FAA chief Donald Engen rejected the request. More about this later.)

History

After a decade as the pinnacle of the Cherokee line, powered by the Lycoming IO-360, the Arrow was slotted for an upward move to turbo status in 1977. The steady four-cylinder Lycoming, though not famous for its silky smoothness, was replaced by a six-cylinder Continental TSIO-360-F.

It seemed a safe, sensible move. After all, the same basic turbo powerplant had transformed the Piper Seneca from a dog to a twin of high pedigree that was breaking sales records right and left. The new turbo model was also given a jazzier nose cowl.

Sure enough, sales of the new so-called Turbo Arrow III took off, and the normally aspirated model was relegated to almost a production afterthought.

After a couple of years, in 1979, the styling engineers decreed the Turbo Arrow should have a T-tail. The new tail was a joke, aerodynamically, but it looked good. The engineers got into the act too, though, since the Turbo Arrow IV also received a new version of the TSIO-360 (using an -FB suffix) with a beefier crankshaft and a much-needed extra 400 hours of TBO-now up from a paltry 1,400 to a rather decent 1,800 hours.

The Turbo Arrow IV, despite its idiosyncrasies, sold well enough to remain in production during the regular Arrows hiatus in the mid-1980s. When the conventional Arrow was brought back in 1988, it was given a conventional tail, while the turbo kept its T-tail. The turbo Arrow was discontinued after the 1990 model year.

Performance

Cruise speeds are nothing to rave about. Owners quoted speeds at altitude of slightly better than 160 knots in Turbo Arrows in only a few rare instances-usually at 19,000 or higher. One even listed 183 knots at 18,000 feet pulling 75 percent power. But it had an aftermarket intercooler and a Merlyn automatic waste gate.

Owners are further handicapped in calculating power settings at any altitude by an owners manual thats quite casual about engine operating physics. For example, the Turbo Arrow book shows constant manifold pressure settings yielding the same power output for a given RPM at any altitude from sea level to Angels 20. Whatever happened to exhaust back pressure and compressor discharge temperature, which vary with altitude and affect power output?

It should be noted that, for the same basic engine, Mooneys power charts show up to three inches in MP variation for constant power at various altitudes. Similar variations are listed in Pipers own charts for the Seneca III, which has just about the same engine as the Turbo Arrow.

So when the Turbo Arrow owner sets what he believes to be a 75 percent power at 14,000 feet, according to the book, he actually is pulling closer to 83 percent power.

But it must be conceded that the turbos on the Arrow will yield a decent climb into double-digit altitudes. And owners happily tell of getting climb rates of 800 to 1,000 fpm all the way up to 10,000 feet, with loads under gross weight.

I love being able to climb from 11,000 to 13,000 as easily as a non-turboed plane going from 3,000 to 5,000 feet, one owner told us. He added, This means that if for some reason I want to descend and then later climb back, I dont feel that I am giving up hard-earned altitude gained at 55% power.

With its 72 gallons of usable fuel, range of the Turbo Arrow is quite good. One owner calculated that, cruising at 65% power, he burned 11.8 GPH (liftoff to touchdown), which gave him 6:06 until fuel exhaustion. At 156 knots at 12,000 feet, that gave him a no-reserve range of better than 900 nm.

Incidentally, we noted that Pipers handbook figures for the 1978 Turbo Arrow III and the 1979 IV model showed a dramatically big takeoff performance margin in favor of the latter. The book suggested that, for example, at a 7,000-foot field elevation and 20C, the T-Arrow IV would clear a 50-foot obstacle at only 3,400 feet, vs. about 5,700 feet for the T-Arrow III. Since there was no difference in power output or airframe, how could this be so?

It turns out that Pipers engineers admitted there is no actual performance difference between the two airplanes. Apparently they simply changed procedures for measuring and extrapolating takeoff data. So which ones should the pilot trust? Who knows? Moral: dont cut the handbook takeoff margins too closely.

Loading, comfort

Equipped useful loads on the Turbo Arrow range from 937 to about 1,000 pounds according to pilots providing feedback. That means with a full 72 gallons of fuel aboard, a 505 to 568-pound payload can be carried. That, of course, works out to about three (170-pound) people and no baggage to speak of. With four 170-pounders aboard, figure on about four hours of flight at 75 percent power with no reserve.

The Turbo Arrows 1,208-pound max useful load is a bit better than the Mooney 231s and not quite as good as the Turbo Skylanes-about average for this class of aircraft.

Owners report no problems with loading balance on the Turbo Arrow, unless it has air conditioning, since the 60-pound rear compressor limits rear-seat and baggage loading somewhat. On one Turbo Arrow with good IFR equipment we flew for an editorial evaluation, we calculated it could have the fuel tanks topped off and a full 200 pounds dumped in the baggage compartment, while still carrying two 170-pounders in the front seats and a 123-pounder in the rear seat, without exceeding limits.

The Turbo Arrow has a decent-sized cabin-a bit roomier than the Mooney, a bit cozier than the Turbo Skylane. Legroom in the rear is pleasant, thanks to a fuselage stretch provided the entire Cherokee line back in 1972. Everyone piles in and out through the single door on the right front side of the aircraft. You want two doors and turbocharging? Check out the Turbo Skylane and Turbo Trinidad and A/B36TC Bonanza, and expect to pay quite a few bucks more for the privilege (and performance).

Handling

In a nutshell, quite benign as are all other PA-28s. However, owners of the T-tailed IV model note that the aircraft tends to over-rotate on takeoff. Since the pitch control is up out of the propwash, it gets a good bite on the wind a bit later on the takeoff roll. The transitioning pilot may therefore tend to yank back a bit too much.

Since the T-tail is located out of the propwash, it also does not have as good pitch authority at low speeds. In addition, a pilot who has flown both model Arrows told us the low-tail version reacts to flap lowering by pitching up, while the T-tail drops its nose.

Though were no fans of the T-tail, we feel that at least part of its poor handling rep is due to pilots assuming they fly it the same way as other PA-28s. But its pitch characteristics are different due to the stabilators placement.

Powerplant problems

The TSIO-360 engine in the Turbo Arrow (and other aircraft like the Turbo Dakota, Piper Seneca and Mooney 231) has been the focus of concern in the past. Our research when these aircraft were in production showed that problems with this engine were not merely causing maintenance hardship, but were knocking airplanes out of the sky with catastrophic inflight engine failures.

A five-year printout of FAA Accident and Incident Reports for the above aircraft from that time disclosed no fewer than 54 instances of powerplant failure in those aircraft. Furthermore, the engine stoppages werent the result of typical pilot errors such as fuel mismanagement, fuel exhaustion, etc. They occurred from failing connecting rods or rod bolts, broken crankshafts and damaged pistons.

The NTSB requested an airworthiness design review of the TSIO-360-FB engine, in Board Safety Recommendation A-85-58. When the FAA turned it down, NTSB chief Jim Burnett responded by saying: These engines have experienced, in addition to the connecting rod problems, frequent piston, cylinder, cylinder head and crankshaft failures. Because these engines operate at higher temperatures and pressures than other similar engines, the Safety Board is concerned that the effective design safety margins may not be as great as in other engines. An airworthiness design review is needed to determine if turbocharging is having a detrimental effect on these engines.

To see how things shook out, some years later we checked the records and talked to a sampling of major engine overhaul shops. The shops we interviewed told us they believed they had been confronted with fewer problems in the TSIO-360 engines.

But the accidents/incidents along with the SDR figures are not exactly reassuring. Engine failures, stoppages and malfunctions from one cause or another were blamed for by far the greatest number of accidents in the later period we examined: 41. The next nearest cause: inadvertent gear-up landings, with 16 reported.

By the same token, Service Difficulty Reports on engine and turbocharger together totaled 46, a whisker under the 48 reports logged by what is traditionally the leading SDR generator: landing gear problems.

In terms of deep, nasty mischief involving internal engine mechanics, not including turbo grief, we tallied 24 reports. And here were talking about things like cylinders cracked or broken or head separated (eight), broken connecting rods (five), broken rocker arm shaft/stud/nut (four), piston scuffing, failed counterweight, broken valve, etc.

Magneto arcing

Another problem was magneto arcing or missing at high altitudes where the thin air has less of an insulating effect. It wasnt until 1983 that Piper begin installing pressurized mags and offering retrofit kits to owners in the field.

Misfiring mags, incidentally, were considered to be one possible contributor to connecting rod failure by subjecting them to overstressing over a period of time. This time around we uncovered 14 reports of mag problems, but none involving misfiring, so presumably pressurization has mostly eliminated this problem.

Cylinder, piston and valve problems had also been the focus of considerable attention in our last report because of running too hot at high boost levels. Thats partly because the economy fixed-wastegate design keeps the turbocharger whirling away whether its needed or not. This tends to stress the engine and raises inlet air temperatures. Combined with poor engine cooling, it can cause considerable engine upper-end distress.

As noted above, we tallied eight reports of cylinder grief this time; and we counted another 10 miscellaneous problems involving valves, rocker arms/shafts, pistons and rings. These seem to be scattered through the study period right up to the present time with no apparent letup.

Turbo problems

Turbocharger cracking was the subject of AD 82-27-03, which required inspections every 200 hours unless a new type housing was installed. Make sure the new housing has been installed, to eliminate repetitive inspections, not to mention extra expense and possible engine damage from escaping hot gases.

We counted 11 reports of turbocharger problems in our latest SDR search. These included cracked and leaking housings, impeller damage and leaking seals. The AD permits cracks of certain lengths to remain in certain sections of the housing, but buyers naturally would be wise not to accept them. SDR submission dates suggest that turbo problems of various sorts continue unabated, though not in great abundance.

Cooling

A cooling kit was offered as an option by Piper (kit No. 764-152V), and potential buyers should make sure this has been installed. Earlier, owners had reported cylinder head temperatures running at the redline in warm weather, and were forced to use special procedures to avoid overheating the engine. The aircraft has no cowl flaps-like the fixed wastegate design decision, it was a presumably a misguided effort to keep prices down. Ironically, pilots flying with extra-rich mixtures were spending more money on fuel as a coolant.

Fliers who responded to our latest call for feedback did not dwell on overtemping problems, since many had installed the new cooling kit and/or intercoolers. One told us that where oil temperatures ran close to redline on hot days or at high altitudes before installing the cooling kit, the oil temp dropped at least one-and-a-half needle widths afterward, and he has no CHT concerns now, either. The cooling kit, which was made standard equipment in 1983, provides new baffles and extra louvers at the bottom of the cowling. With the kit installed, however, Turbo Arrow pilots now must make extra effort to avoid overcooling during descents.

Operating idiosyncrasies

Since getting the TSIO-360 started on cold mornings can pose a problem, we have two recommendations. First, try to get an airplane that has the electric priming system installed. One owner described it as worth its weight in gold. Second, consider replacing the aluminum electrical cables from the battery with copper ones. Power settings are, frankly, a pain, and its not hard to overboost. The takeoff is especially awkward. Just when the pilot should be directing most of his attention on the runway in front of him, with the Turbo Arrow he has to monitor the manifold pressure closely and work the throttle to keep from advancing too far on takeoff.

So the pilot is told to ease in only about 30 inches of MP as he starts out, then advance the throttle to the full whopping 41 inches as he goes bouncing along on takeoff. Since the MP needle tends to surge in a slippery fashion with throttle movement, the pilot tends to spend too much time nailing down throttle position.

Safety

The worst killer of Turbo Arrow pilots and passengers is that old bugaboo that has nothing to do with intrinsic aircraft safety: weather-pilots stumbling into weather conditions they couldnt handle. The biggest cause of nonfatal accidents in Turbo Arrows is engine failure/stoppage for one reason or another. Right up near the top is the perennial nemesis of gear problems-often with pilots inadvertently landing gear-up or maybe yanking the gear up too fast on takeoff.

A telling comparison is with the accident roster for the normally aspirated Piper Arrow. For that aircraft gear-up errors by far dominated the list, with engine stoppages making up the second major accident cause. In fact, on the normally aspirated Arrow gear-related accidents outnumbered engine-related accidents by 114 percent.

On the other hand, on the Turbo Arrow, engine-related accidents outnumbered gear-related accidents by 24 percent. Clearly, the turbo engine has to be viewed as an extra liability. Call it a safety liability or an economic one, as you will, since the greatest accident toll is in bent metal, not lives. We tallied only one fatal accident attributed to engine failure in the Turbo Arrow-for undetermined reasons.

An interesting sidelight to all the inadvertent gear-up accidents in both aircraft is that the automatic gear-lowering system time and again either fails to do its job or is outwitted by pilots disarming it for one reason or another.

Arrow pilots constantly inform us that their dislike for the system knows no bounds, especially since the gear can stay down too long on takeoff, or perhaps extend when they dont want it to in a steep climb if improperly calibrated.

Maintenance

The turbo system obviously imposes an extra maintenance burden on the Arrow, either by component cracking or failing or from scorching turbo gases escaping from fissures in the system and various components with unpleasant results. Engine mounts, firewalls, hoses and wires all were reported victims of unwanted heat dousing.

One SDR submitter suggested that a 0.025 stainless steel plate would help prevent incineration of the galvanized steel firewall, which is very close to turbo assembly and exhaust stack. Another pilot told us his mechanic installed several stainless steel heat shields under the cowl to protect these elements. And theres no escaping big bills required when upper-end engine parts like cylinders or valves fail. A number of owners cited repairs to these, although a couple of others moaned more about the money they laid out more than once to replace failed alternators.

Make sure the gear drive flexible coupling, Continental Part 635796, is checked whenever you pull the alternator, as it may be the source of failure, warned one owner. In general, pilots described maintenance to us costs as high, or manageable.

Although there are not a lot of Airworthiness Directives exclusively against the Turbo Arrow as opposed to the entire Cherokee line, one (86-17-01) calls for a new ammeter kit to prevent possible shorting and fire. Several SDRs called out problems with ammeters.

Incidentally, when the FAA summarily rejected the NTSBs request for an airworthiness review of the TSIO-360 engine, it made the statement that, in effect, when designing and certifying an engine, the manufacturer sets limits that must be observed by operators. And the FAA cant prevent operators from exceeding the published limits. Of course this cavalier reply completely ignores the possibility that the engine is so quirky and failure prone that problems with ordinary pilots who are not trained astronauts may have problems.

Modifications

A couple of significant mods have been fashioned to overcome the engine problems on the Turbo Arrow. Among these are intercoolers from Turboplus and Airflow Systems. and an automatic wastegate. Owners say they get a higher critical altitude with the intercoolers and lower operating temperatures. But critics increasingly complain that pilots too often make power settings incorrectly with them and subject the engine to excessive stresses.

In an effort to get rid of the onus of the fixed wastegate on the Turbo Arrow and other aircraft with the TSIO-360 engine, Merlyn Products has taken an even more dramatic step and come up with an automatic wastegate that looks like the answer to a prayer for Turbo Arrow owners. It increases the critical altitude by 5,500 feet as well as boosting cruise climb and speed slightly and lowering CHT and oil temperatures significantly.

The ostensibly nifty benefits of this system are much lower turbo speeds, lower engine RPM settings at all altitudes and in generally allowing lower engine operating temperatures.

One operator who had it installed described it to us as a wondrous gadget that allows him to fly all altitudes at 2300 RPM and 35 in. MP, keep TIT below 1400 and CHTs around 300 with fuel flow at 13 GPH, and offer much improved IAS at altitude. The device also had lowered throttle sensitivity, he reported. An extra benefit of lowered engine RPMs was greatly reduced interior noise-enough so that we have loosened the vise-like grip of the David Clarks, he said.

Various aerodynamic mods are also available from the usual sources.

Owner Comments

As owner of a 1977 Turbo Arrow since 1985, Ive found it to be very dependable business transportation. It allows me to fly relatively high (6,000 to 15,000 feet) and relatively fast (142-162 knots), all at a fuel burn of less than 12 GPH. With operating expenses (fuel, maintenance, annual, insurance, hangar, engine reserve, etc.) of less than $90/hour, its economical transportation, as well.

Power management is a bit tricky on the Turbo Arrow with its fixed wastegate. Just getting the airplane to stabilize in level flight can be a bit of a challenge because of the effect of ram air on the turbocharger. Its easy to overboost, and failure to allow a cool down of the turbo an lead to premature replacement. I wouldnt consider owning an airplane that had been rented out to multiple pilots. The biggest problem Ive had is with premature failure of the vacuum gyros.

Im happy with this airplane. If it were only available with de-ice capability….

-Bill Tucker
Moline, Ill.

I bought a 1978 Turbo Arrow III in 1979 and flew it until 1985, when I traded it in on a 1984 Turbo Arrow IV. Both had been demos.

I dont like the T-tail very much. When I got the new plane, I was operating out of a 2,300 foot field, and the short-field performance was not as good as the conventional tail (lack of elevator authority at low speed). The structure is heavier, and the added weight is at the back (aft CG is a usually a problem, not forward), and its harder to clean off snow and ice.

The III had a 1,400-hour engine, and I replaced it with a 1,800-hour factory reman from Continental at 1,483 hours. The original III engine did not have pressurized mags, and it misfired badly at high altitude, until I replaced the mags. The IV has pressurized mags, and I recommend them to anyone wanting to fly over 13,000feet.

I have started the III and IV in temps as low as 16F without preheat and without auxiliary battery help. I follow the electric primer chart, and it works like a charm. I once tried to start about 1 a.m. one December night at -4F without preheat, but it was no go (the battery quickly gave up).

The Continental runs rough at low speeds, especially for a six. (The four-cylinder Lycoming 320 in my old Warrior was smoother at low speeds.)

A couple of times I took the III up to FL 190 and FL 210. (Air traffic controllers couldnt believe it, all saying say aircraft type!) It trued at 171 knots at FL 210. At FL190, it was 167 knots at 65% (30”/2,400 RPM at 10.5 GPH on the fuel flow gauge) at -26C. I havent taken the IV above 16,000 feet or so.

In accordance with the Continental manual (the Piper manual doesnt address it), I let the turbo spool down by idling two or three minutes before shutdown (unless Ive taxied at 1,000RPM for 5 minutes).

Total maintenance (engine, airframe, avionics, 50-hr oil changes, 100-hr inspections and annuals) on the IV is now at a rate of $17.66 per tach hour (averaging 190 tach hours/year).

Tiedown at Manassas, Va. is $70/month, insurance is now $1,725/year ($90,000 hull/$1 million liability).

I had to replace the #4 cylinder on the IV at 826 tach hours, but the III had had no major engine work when it was replaced at 1,483 hours.

The automatic gear system is a pain, and I keep it on override and have disconnected the orange warning light. The defroster is a joke-plenty of air, but it isnt even warm, much less hot. The old Warrior put out lots of hot air, and still didnt melt the windshield. I also cant understand why Piper put the heat control over the defroster control-poor human factors engineering. Also, the copilot side heat is much hotter than the pilot side, and this is also true in the back seat.

The access door in the cowling is far too small. Its impossible to check and/or add oil without banging knuckles and spilling oil all over. The manifold pressure gauge is too hard to read, especially in the 29-33″ range used for cruise. The floor ventilation system is very effective, but not the overhead vents. The electric fan isnt worth the 8-lb. weight (or the $360 original cost).

The baggage compartment carpet always gets wet after a rain. The mechanic re-sealed all of the windows, but that didnt help the baggage area leak. The baggage door seal has been replaced, but that didnt help, either. The battery needs replacement about every three or four years, and airplane alternators are not nearly as reliable as those on cars, even though they seem to be the same units. I have had alternator failures with each plane-two or three on the Warrior, the same on the III, and one on the IV so far.

-Donald M. Schwentker
Alexandria, Va.

Weve flown our 1977 Turbo Arrow 800 hours since 1984. It has not yet let us down (literally speaking). Only twice have we had enroute problems. Once the alternator came loose and leaked oil. Next time a 40-cent alternator wire broke.

Three added features have made a helluva difference:

The factory cooling kit. With this we saw a slight drop in TIT. It also eliminated a couple of hot spots under the cowling.

The Knots 2U mods-all of them, including the flap/fuselage and stabilator seals. These give us the wonderful choice of faster or less fuel. We almost always use 75% power. Block-to-block fuel consumption dropped to just under 11 GPH. Speeds increased five to 10 knots (at 19,000 feet we get about 182 knots).

Also, climb rates are terrific. No sweat to get 1,000 fpm at 100 knots, except when fully loaded in high temperatures. In January, coming back from Florida at 17,000 feet, we asked for 19,000. The controller asked if we could get there in less than four minutes. Made it in three.

The Merlyn Black Magic Wastegate Controller is a wondrous gadget that was easy to install. The factory people were very helpful with a couple of minor problems regarding hookup to the pressurized mags.

Were delighted with the aircraft. Great fun, utility and comfort.

-Nate A. Newkirk
Elkins Park, Pa.

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