# High Altitude Bonanza: Turbonormalizing and the 17,000-Foot Club

By Kevin Crozier

Turbonormalizing fundamentally changes the operating envelope of a Bonanza. With the addition of a properly designed and managed "TN" system, the aircraft becomes capable of efficient cruise in the flight levels with performance comparable to much more complex and expensive airframes. I've operated my turbonormalized A36 extensively between 14,000 and 17,000 feet, and while the performance is impressive, safe and effective operation at these altitudes requires disciplined engine management, oxygen planning, and a sound understanding of high-altitude operations.

## Turbonormalizing

A turbonormalizing system allows the engine to maintain sea level manifold pressure (29.6 inHg) as altitude increases. The Tornado Alley Turbo system used on my aircraft achieves this using a single turbocharger, automatic wastegate, and intercooler bolted onto the stock Continental IO-520/550 engine found in most Bonanzas. The system offered by Western Skyways is similar in its basic design. The goal is consistent power delivery while preserving the original compression ratio and engine characteristics.

## Climb and cruise

The first step operating in the high teens is the climb. At maximum gross weight (or above – many TN installations include a gross weight increase) and standard conditions, I use an initial climb speed of 120 KIAS, transitioning to 130 KIAS in the mid-teens to manage engine cooling and CHTs. My standard climb power is 30" (full throttle)/2500 RPM with fuel flows around 32–35 GPH rich of peak. CHTs are monitored closely, with target values below 380°F. Above 12,000 feet, climb rates taper from 800–1,000 FPM to 400–500 FPM near 17,000 feet.

At 17,000 feet my typical cruise configuration is as follows:

- IAS: 146–151 knots
- TAS: 185–205 knots
- Fuel Flow: 16.5–17.5 GPH
- Manifold Pressure: 29.4–29.6 inHg
- RPM: 2500
- Turbine Inlet Temperature (TIT): 1550–1575°F (70-80°F lean of peak TIT)
- CHT: 330–370°F

Operating at high altitudes reduces air density and, thus, the cooling mass flow through the cowling. Intercooler performance also degrades with altitude, increasing the risk of elevated engine temperatures if not actively managed. The considerations include:

- Maintaining higher climb speeds
- Cowl flaps cracked or open in cruise flight
- Multi-probe engine analyzer with alarms set for CHT (>400°F) and vigilantly monitoring fuel flow during climb.
- Use of the electric boost pump as required in the climb to maintain sufficient flow for engine cooling.

## Oxygen requirements and monitoring

FAR §91.211 mandates the pilot's use of supplemental oxygen above 12,500 feet for more than 30 minutes and above 14,000 feet for any amount of time, and requires oxygen availability for all occupants above 15,000 feet. In my aircraft, oxygen is supplied through a built-in Tornado Alley Turbo (TAT) oxygen system, plumbed to every seat for convenience and safety.

I utilize the Mountain High O2D2 pulse-demand oxygen delivery system, which offers significant advantages over traditional constant-flow systems. The O2D2 adapts oxygen delivery based on real-time breathing patterns, extending oxygen tank duration considerably. Unlike continuous flow systems, the pulse-demand design reduces oxygen wastage and minimizes the drying effect on nasal and sinus membranes, improving overall comfort during extended flights.

Another key feature of the O2D2 is its apnea monitoring capability. If the user's breathing stops or becomes irregular, the system alarms, letting everyone know that someone has stopped breathing (through their nose anyway), further enhancing safety.

As a standard operating practice, I activate the oxygen system anytime above 10,000 feet and continuously monitor all occupants with fingertip pulse oximeters. My targets are $SpO_2$ levels above 92 percent for the pilot and above 90 percent for passengers. Monitoring is key, especially at high altitudes, as $O_2$ saturation declines rapidly if the oxygen system fails or malfunctions, and corrective action must be taken immediately.

### Descent

When planning my descent, I start well in advance – typically 30 to 40 minutes or over 100 nautical miles from my destination. The goal is to ensure a smooth transition to lower altitudes while managing engine temperatures and maintaining situational awareness.

For the initial stage of descent, I push the nose over and descend 500 FPM. As airspeed approaches the yellow arc, I pull back the power to approximately 20 inches of manifold pressure to continue the descent, maintaining airspeed outside of the yellow arc.

This approach not only allows for an efficient descent, but also ensures that sufficient time is available to handle any adjustments for weather, ATC instructions, or traffic patterns near the destination. By starting the descent early, I minimize the likelihood of rapid altitude changes, which could otherwise lead to passenger discomfort or increased workload in the cockpit.

### Icing considerations

The ability to climb above weather is one of the major advantages of TN-equipped aircraft. However, it comes with risks:

- Freezing levels can be at or above MEA during winter, placing the aircraft in the icing zone during cruise or descent.
- Freezing levels may be encountered at any time of the year within the altitude capability of a turbonormalized Bonanza, even in summer.
- Turbocharging provides no anti-ice capability. If ice is encountered, your only tool is altitude and escape planning.
- My operating limits are no flight into known icing conditions, no climbs through visible moisture near freezing without a clear top, and no descents through visible moisture near freezing without above-freezing temperatures below.

The additional margin afforded by a TN system can allow a safe climb above icing altitudes as long as ice is not encountered or expected (unless your airplane has "known ice" certification), but the airplane must be fully configured and capable to escape if cloud tops aren't reached.

### Conclusion

A properly operated turbonormalized Bonanza offers excellent utility, performance, and flexibility. It can fly above most weather, cover long distances efficiently, and operate at altitudes that reduce pilot workload and turbulence.

But it is not a shortcut. High-altitude flight demands precise engine monitoring, oxygen discipline, and advanced planning. For Bonanza owners flying regularly above 12,500 feet, system knowledge and high-altitude proficiency are essential.

For those seeking additional insights into TN operations, the ABS Learning Center offers a webinar I presented. It provides detailed configuration guidance for each phase of flight and practical advice for managing turbo-specific emergencies.

*Kevin Crozier* is the caretaker of a turbonormalized 1981 A36. He's an ABS Recognized Instructor (CFI / CFII / MEI), and an FAA-designated software Designated Engineering Representative. Kevin is the owner of KTronics Aero Services, located near Austin, Texas.