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AutoPower:
A First for Gulfstream G150

Full-time autothrottle system is the first available in a midsize business jet.

BY J. MAC McCLELLAN
PHOTOS BY GULFSTREAM & SAFE FLIGHT

THE GULFSTREAM G150 is the fastest and longest-range midsize-cabin business jet, and now it is the first in the category to offer the safety and improved efficiency of a full-time autothrottle system (ATS). Gulfstream also recently earned full certification for the infrared enhanced vision system (EVS) with the same resolution and definition as the system offered on its large-cabin airplanes.

Gulfstream was the first business jet to offer an ATS when it introduced the G-III more than 30 years ago. Since then an ATS has been the norm in the large-cabin Gulfstreams. An ATS has also been available in the super midsize cabin G200. And now the AutoPower system in the G150 makes ATS available across the entire Gulfstream line, a strategy that is in keeping with offering the Plane-View cockpit and EVS in each model.

The most important reason Gulfstream offers an ATS is increased safety. The AutoPower system will hold the target approach speed within a knot or two even in gusty and bumpy conditions, and arriving over the runway at the VREF target is the best protection against an overrun, which is one of the most common types of accidents in business jet flying.

While it holds approach speed perfectly, the AutoPower also constantly monitors angle of attack and will simply not allow the G150 to get close to a stall. This is important, obviously, during landing approach

but is also a safety edge if the crew were ever to become distracted and allow the airspeed to decay in any phase of flight. And the crew workload reduction AutoPower adds safety potential, a fact recognized in major airlines and large-cabin business jets for decades.

There are several ways an ATS can be designed and integrated into the autopilot system, and I think the AutoPower in the G150 is one of the most intuitive and pilot-friendly. There really isn't much of anything to learn to use the system, and no button-pushing or other actions are required from takeoff to touchdown. The human pilot can take command of the throttles at any time by simply moving the levers, which offer only slight resistance through clutches that engage the ATS.

The visible parts of the AutoPower system are mode status displays located just outboard of each pilot's PFD, and engagement buttons on the throttle knobs. The guts of the system are Safe Flight's very sophisticated servo motors (inside the throttle quadrant) that actually position the levers, and a computer that is mounted inside the pedestal. AutoPower is available for all existing G150s, as well as on new airplanes, so the compactness of the system, and its small number of components, will make retrofitting a very straightforward and brief trip to a Gulfstream service center.

To see AutoPower in action, Gulfstream experimental test pilot Scott Martin, who headed up the development and certification of the system, and I taxied out just after sunset at Gulfstream's home in Savannah, Georgia. We had spent time discussing how AutoPower works and the various steps in the development program, but nothing like what I would call "training" was necessary to feel comfortable with the system.

Pilots can choose to use the engagement buttons on the throttle knobs to tell AutoPower to set takeoff thrust as they would in the larger models, but a more natural way is to simply move the levers forward themselves. At about 75 percent power, AutoPower takes over and sets takeoff N1 engine speed and shows you that takeoff power is selected on the mode annunciator. That's all there is to it. The system maintains takeoff thrust until transitioning to recommended climb power, which it adjusts automatically as the altitude and air temperatures change on climb.

A more real-world scenario is that you will have a fairly low initial assigned altitude that you will set into the PlaneView automatic flight control system using the normal altitude select knob. When the autopilot — or flight director if you are hand-flying — captures the assigned altitude, AutoPower transitions into speed mode and will move the throttles to maintain whatever airspeed you have selected automatically with no additional pilot inputs.

There is no way to appreciate how much an ATS reduces pilot workload until you fly with an ATS that performs as smoothly and precisely as AutoPower.

>>> There are autothrottle engage/disengage buttons on each throttle so the G150 system operates the same as in the large-cabin Gulfstreams. The mode annunciator (left) shows takeoff mode is engaged.

The pilot workload reduction, particularly in a busy ATC environment, is dramatic. You don't realize how much attention it takes to adjust power to maintain a desired airspeed even though the autopilot is flying pitch and roll to stay on the desired course and altitude. But with an ATS, the workload drops to near zero with the autopilot engaged, and I estimate it is cut by at least half when hand-flying. There is no way to appreciate how much an ATS reduces pilot workload from the mundane chores and allows attention to the rapidly changing situation around the airplane until you fly with an ATS that performs as smoothly and precisely as AutoPower.

During climb, AutoPower transitions from airspeed to Mach hold automatically. When level, it changes to a cruise mode where the gains in the system are tailored to smooth operation, so it doesn't change power for very little variation in speed. The system holds Mach within one or two one-hundredths but does it very smoothly, unlike some earlier systems that would saw away on the throttles chasing every little variation. Gulfstream has been able to measure an improvement in efficiency because of the smoothness and precision of AutoPower and says G150 pilots will see increased range thanks to the system.

The interaction between AutoPower and the PlaneView autopilot system is much more complicated than, say, cruise control in a car. As any pilot who has advanced beyond the most basic training knows, pitch sometimes controls airspeed, but sometimes it is power that sets speed, and most often both pitch and power inputs are needed. The pitch-power relationship is probably most complex during descent.

When you start down, AutoPower transitions into descent mode automatically, and depending on what profile you have asked the autopilot to fly, it behaves differently. A common way to descend is in airspeed hold mode (flight level change), and in that case the autopilot will adjust pitch to hold the desired speed while AutoPower brings the throttles back to near idle. But, if you tell the autopilot to descend at a selected vertical speed, then the ATS must adjust power in concert with the autopilot to hold both target airspeed and selected vertical speed. If you ask for too much of both, the ATS and

>>> Safe Flight engineers used protractor markings on the G150 throttle quadrant to precisely measure throttle lever angle during development.

autopilot work together to retard the throttles and pitch the nose up to prevent exceeding the airplane's speed limits.

Back in the terminal area, AutoPower shifts to speed mode and holds the selected airspeed within a knot or two with smooth, but aggressive, movements of the throttles. Unlike we human pilots, the ATS computer is never distracted for even a millisecond, so its focus on airspeed control is uninterrupted. Because it spots a change in the airspeed trend instantly, it can make a quicker, and thus smaller, throttle movement than would be necessary for the human pilot who needs to spot the change, process the required throttle action and then move the levers. AutoPower makes almost continuous changes, particularly in turbulence, but they are so small that they are usually imperceptible unless you are watching the levers move.

It was an unusual weather evening in Savannah, with the wind at 1,500 feet blowing 32 or more knots, while the wind was only six knots at the surface. It wasn't really turbulent, but the air was, as you can imagine, stirred up. It was a good test of the system as we maneuvered for the approach with flaps and gear coming out, and AutoPower transitioned to each new configuration target airspeed perfectly. VREF target approach speed was 117 knots, so we selected 123 for the approach given the possibility of at least a little wind shear with the difference in wind velocity close to the ground.

The FAA doesn't have specific certification performance requirements for ATS, so Scott and the other pilots at Gulfstream decided the system had to fly as well as the best human pilot standard, which is minus-zero knots and a maximum of plus-five knots over VREF on approach. The FAA agreed, and that's what the system does.

Because of some vectoring oddities — it was a perfectly clear evening and we were now flying VFR — the G150 intercepted the glideslope from above. The Collins Pro Line PlaneView system is perfectly capable of that maneuver, but it, and human pilots for that matter, are better adapted to intercepting the glideslope from below. The autopilot was a little too aggressive in nosing over to follow the glideslope down, realized its error quickly and pulled back up pretty hard to stay on the path. Even though AutoPower had no idea that a noticeable pitch-up change was coming, it shoved the throttles forward instantly, and the airspeed sagged less than two knots below the target. Even more impressive is that it pulled the throttles

back quickly enough so the airspeed went less than three knots over target before again stabilizing right on.

AutoPower maintained our target airspeed perfectly, and when the radio altimeter measured and announced 100 feet above the runway, the word *Retard* appeared on the mode display indicating the system was preparing for landing. At 50 feet above the runway, AutoPower began smoothly reducing power to idle. Gulfstream and Safe Flight tailored the rate of power reduction so that the G150 enters the landing flare right at VREF airspeed with no action from the pilot.

Even after the system has gone into its landing mode, go-around power is instantly and automatically available even for a brief period after touchdown in case there is the need to make a balked landing. The autopilot in the G150 is not capable of making a coupled go-around, so after you hit the go-around button, you get takeoff power automatically but must rotate the nose up into the flight director command bars manually. You can then reach up and engage the autopilot and everything is again automatic.

I'm not sure exactly why this is true, but the AutoPower system makes the G150 feel like a bigger airplane, both to pilots and passengers. It's probably the unmatched smoothness the ATS delivers all of the time that makes the airplane feel like it's moving around less. Or maybe it's the engine sounds that change more smoothly and usually over a smaller range than the human pilot can achieve. Whatever all of the reasons are, passengers will, I'm convinced, notice and appreciate the precision and smoothness of the system.

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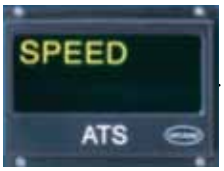
Gulfstream G150 AutoPower Description

CLIMB – DEEC
(Climb Position)
Select AFCS flight level change climb. ATS controls thrust levers to *N1 CLB*.

TAKEOFF – DEEC
(Takeoff Position)
Advance thrust levers. When both engines reach approx. 75 percent N1, the ATS will engage. *N1 TO* displayed on MSD.



CRUISE
Select desired Mach target with AFC speed reference. *Speed* will be displayed on MSD, and ATS will track the AFCS speed reference.

DESCENT
Select AFCS flight level change descent. *Descent* will be displayed on the MSD, and ATS will retard thrust levers for 10 degrees and cease servo command until flight director mode change.

APPROACH
ATS can be used with APPR, NAV, VS, pitch, or no AFCS modes. ATS will be in *Speed* and controlled by AFCS speed reference. *Speed* will be displayed on the MSD.

LANDING
Speed message will flash when aircraft descends through 100 feet. At 50 feet ATS will retard levers. *Retard* will be displayed on MSD.

GO-AROUND – DEEC
(Go-Around Position)
N1 GA will be displayed on MSD.

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