Hot summer, hot performance

By John Morris

It's been one of the hottest summers that I can recall. As a result it also has allowed first hand observation of the PT6A-67B (P) as it relates, in this case, to takeoff performance. Whether operating in high or low altitude airfields with high time (>3200 hrs) engines or low time (<400 hrs) engines, the high heat does have an effect on engine performance. What is the effect?

The effect is engine temperature, which can have an effect on our decision making as to takeoff/initial climb procedures. Pilots have been properly trained for PC12 operations, but need a refresher as to hot operations and engine performance.

Limitations prescribe how to operate the engine (powerplant) for takeoff**. The takeoff limits, for this article, are [Max]: SHP / 1200, Torque / 44.34 PSI, ITT 800°C (850°C-PC12/47E) ** time limited to 5 minutes.

From the POH, Normal Procedures 4.9 TAKEOFF, line 2 and 3 (line 1 and 2 PC12/47E), the pilot is directed via the first stated line - ECS or (ACS) … OFF (INHIBIT) with the following "(If the torque as per Static Takeoff Torque chart in Section 5 is below flat rating)". The second stated line directs that the - Power Control Lever …SET with the following "(Under certain hot and/or high airfield altitude the engine power is below the torque limiter setting and manual power setting is required according to Static Takeoff Torque chart in Section 5)". Following this line, all PC12 variants, is a Caution: THE TORQUE LIMITER ASSISTS THE PILOT IN SETTING THE ENGINE POWER. THE PILOT IS RESPONSIBLE TO RESPECT ALL ENGINE OPERATING LIMITS. Then a Note: Increasing airspeed might cause torque and ITT to increase.

Looks like we need to see if we are below the flat rating and the torque limiter setting using the Static Takeoff Torque chart from Section 5 (see fig 1 and 2). But before we check out the chart a quick review of flat rating and the torque limiter.

Flat rating is when a high ESHP (Estimated Shaft Horsepower) turbo-propeller engine is restricted to a lower ESHP rating. Why restrict? Letting the "beast" go to its maximum at takeoff would probably do structural damage unless the airframe/engine mounts were built to sustain over the

duration of the airframe/engine mount lifetime limits. Hence the 5 minute time limit at takeoff power, even at this SHP rating. Instead of full ESHP, reduce the ESHP, which allows for less structural strength/mass, which will allow for more useful load, and use the available additional compressible air, or thermodynamics, at higher/hotter altitudes while maintaining the limits set by the manufacturer. The PC12/NG (PT6A-67P) has a 15% increase in thermodynamics due to the higher operating temperatures associated with a higher true ESHP than the PT6A-67B. This additional "energy" is used primarily for longer-sustained climb and higher cruise speed but is also reflected for takeoff with the higher ITT limit.

Which brings us to the engine limiting. Pratt&Whitney uses a torque limiter to control the output limit of the engine. Torque limiting is accomplished by P3 bleed air being removed from the Fuel Control Unit when the PSI limit has been reached via the Reduction Gear Box sensing. Torque limitation for all PC12s is 44.34 psi, which is based on Sea Level, ISA Standard Day conditions. In the early days of the PC12 the torque limiter was sometimes being set to values near 50 psi! All of course done statically, on the ground, by maintenance. Happily, that changed to a factory standard torque setting of 43.0 psi, based on Sea Level, ISA Standard. This factory standard allows, in principle, for the operator to apply full power, at any altitude, and never exceed the torque limit for that altitude (i.e. the EIS blinking at an inappropriate time, rotation-distraction). However, due to operator requests, maintenance, etc, the factory settings may not exist anymore. In any case it is the pilot's responsibility to respect engine-operating limits.

Now, if you look at the Static Takeoff Torque chart, all of the horizontal flat lines represent the "flat rating" of the PT6A-67B/P for the respective altitudes/temperatures. Torque (limiter) settings are derived from the right side of the chart for the same altitudes and temperatures. So, if the torque limiters are set to 43.0 psi for takeoff [SL, ISA standard day] are we below "flat rating"? Should we then turn OFF (INHIBIT) the ECS (ACS)? Why are we turning Off/Inhibiting the ECS/ACS? Answers shortly.

What about the TAKEOFF line dealing with Power Control Lever …Set "(Under certain hot and/or high airfield altitude the engine power is below the torque limiter setting and manual power setting is required according to Static Takeoff Torque chart in Section 5)"? Are we setting a lower power or a higher power? Can we set a higher power? Not at *that* moment if we use

full power, unless our torque limiter has been adjusted. Why would we set a lower power? What are we protecting from?

Unless we do a full power, standing still static run-up, before every flight and with the Static Takeoff Torque chart in-hand, will we truly know if the engine is below flat rating, and that we may need to adjust the torque manually? Not likely. Instead we use knowledge and understanding of what we are really looking to protect against.

So what are the answers? Basically, all answers relate to engine TEMPERATURE. Look back at limitations. The SHP of 1200 is controlled via Torque Limit. The Torque Limit is ultimately controlled by the pilot but normally by the torque limiter. ITT is where it *is* the responsibility of the pilot to not exceed the takeoff limit (not max continuous or max continuous climb/cruise). Most of the features in the PC12 are automatic, but ITT is a function of atmospheric conditions and equipment being operated by and for the engine, including engine age.

Takeoff and initial climb are VERY important. Distractions of any kind need to be avoided, such as a blinking EIS or CAS message from an over temping engine. Or would you reduce power at takeoff to avoid a high temp?

Why turn OFF (INHIBIT) the ECS (ACS)? If we turn OFF (Inhibit) the ECS (ACS) the ITT will drop approximately 20°-25C at takeoff. Normally the P2.5 Bleed air taken from the engine is used for cabin temperature/pressurization. This in turn is removing pre-burning performance air from the engine, which causes the ITT to rise correspondingly.

The piece of equipment operated for the engine, as it relates to ITT would be the Inertial Separator. With the separator open for takeoff the ITT will increase approximately 20° to 25°C. Why? We are letting air bypass the engine inlet causing the compressor to work harder, which means more fuel (not much, but enough to increase ITT).

We are required by limitations to do a Preflight Function Test for takeoff (AKA Inertial Separator). That does not mean we have to keep the separator open <u>for</u> takeoff. Pilatus recommends use of the Inertial Separator-OPEN, as it pertains for takeoff, if operating on unprepared surfaces. Of course it is a good idea to have the separator open for FOD protection but unless the

runway is contaminated the engine will perform (ITT) better with it closed. Will you benefit by closing the separator *and* turning OFF (INHIBIT) the ECS (ACS)? No. Tried all combinations. PFM (Pure Factory Magic)!

What about Manual Power Setting? Obviously if we reduce power that reduces fuel flow which reduces the burn output/ITT (temperature).

Engine limitations: 5 minutes at takeoff torque/temp. If you have a choice between ECS (ACS) or power reduction (shouldn't matter where), which should/would you do?

So what am I trying to say? Check your engine numbers, quickly, prior to takeoff with the ECS (ACS) operating *and* the inertial separator –Closed. Or better would be a co-pilot noting the numbers for you, specifically torque and ITT (you should have the OAT before engine start). Check the numbers against the Static Takeoff Torque chart-later. Do you have to turn OFF (INHIBIT) the ECS (ACS)? Be aware of using the Inertial Separator for takeoff, if not required. Don't do reduced power takeoffs-period.

"A Safe Pilot is Always Learning"

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ACFT Services provides training ONLY for all PC12's, no other aircraft.