Engine Ops

By John Morris

I will be writing, initially, about maximum power operations, (again), this time focusing on the torque limiter / limitations. I will finish the article answering some lingering questions regarding the engine operating / limitations and procedures.

Why discuss max power operations since we know what the limits are? Because I *still* have observed some pilots who not want to use maximum power at takeoff. When asked why the reduced power, some have said that the engine indications for torque were exceeding limits, some are interpreting the Static Torque Performance chart incorrectly and a few do not wish to “push” the engine unnecessarily – for maintenance-cost purposes.

I hope we know what the answer to the “push” response is, at least how I DO respond – “What the #! $&, Over”!

The maximum torque with possible exceedence and proper understanding of the Static torque chart are more important towards best performance and safe operating practices.

Overtorque of the engine gearbox is not safe – period. Having an engine with a maximum thermal dynamic power much greater than the certified Shaft Horsepower (SHP) requires the pilot to maintain the certified limits. The torque limiter is used primarily, as I used to teach new PC12 drivers, as a means to “pilot-proof” us from exceeding the engine limitations since it is much simpler when starting the takeoff roll to be able to smoothly advance the Power Control Lever to the forward stop [with a verifying scan for rated torque / ITT limits] once at the stop versus advancing the Power Control Lever intermittently, monitoring the power / ITT so as to not exceed the defined Red Line(s), all while accelerating down the runway – Single pilot, what should we be looking at?

The torque limiter has been, generally, factory set for a maximum indicated torque of approximately 43.0 PSI (at rotation), sea level – standard day ISA. This setting usually will allow advancing the PCL to the stop with no adverse Torque / ITT indications since the engine is not arriving at the rated 44.3 PSI. This factory setting allows for operations throughout most high airfields with no changes to PCL movement except for high/hot ITT considerations.

To confirm how the torque limiter has been currently set we will use the Static Takeoff Torque Performance chart, POH - Section 5.

As the chart indicates, the aircraft must be static-not moving, in order to accurately determine the torque limiter setting. OAT must be noted (NG's – OAT not SAT), then while setting / holding brakes, advance PCL to stop and observe / note the Torque indication. Then check known OAT / field pressure altitude to confirm maximum torque using the Static Takeoff Torque chart. The horizontal line drawn through the OAT / field pressure intersection to the Engine Torque PSI is your "Flat Rating" torque. You would then confirm the noted torque from the static "test" versus the chart defined maximum torque. As noted in POH - Section 7, Torque Limiter " If the maximum torque is below flat rating (below torque limiter setting), the torque has to be set manually by the PCL". This means, if possible, you can advance the PCL to make up the difference. If the static test was a full power / full forward PCL, what additional torque is available? Of course if after the static test you confirm engine torque is greater than the chart maximum then the PCL setting would now be employed, statically, before takeoff roll begins. Either of theses scenarios requires maintenance of the Torque limiter. It now MUST be noted: The Static Takeoff Torque chart does NOT indicate what the maximum rated torque is when accelerating for takeoff / rotation as the aircraft is moving, applying additional ram air pressure to the compressor (more available torque) and/or if the inertial separator is open this will also effect compressor performance (less torque). It is not generally practical to sit at / near the end of a runway and perform this check but it should be performed periodically if any doubts regarding maximum takeoff torque. <u>Be aware of FOD when performing this check!</u>

Which brings up the torque exceedence indication with the PCL at or near the stop while accelerating down the runway. The question I ask, and/or observe for myself, is whether the exceedence continues or subsides back below maximum takeoff rating. If it subsides then the torque limiter is functioning (and is allowed by limitations), even though it should be noted / addressed with maintenance since as I have indicated earlier that if the factory setting is incorporated then these temporary indications should not occur. If the Torque indication is maintaining above maximum limits then definitely the torque limiter needs to be adjusted as you should not have to manually set power for each takeoff plus the potential, continuing harm to the gear box. Saving the "extra" power by

manually setting takeoff power is asking for problems / costs that are not worth the risk!

Questions / Answers

Is it possible to not exceed maximum takeoff torque but exceed maximum takeoff temperature?

Answer: Yes

Hot / High airfield operations. Observe use of ECS / ACS and / or Inertial Separator as loss of ram air / cooling bleed air will definitely effect compressor output pressure to burner section of engine.

Referencing POH – Section 2, Limitations Engine Operating Limits PC-12/41/45/47 and PC-12/47E (NG)

Why is Takeoff Power time limited to 5 Minutes?

Answer: From FAR Part 1. 1 General Definitions

"Rated takeoff power, with respect to reciprocating, turbopropeller, and turboshaft engine type certification, means the approved brake horsepower that is developed statically under standard sea level conditions, within the engine operating limitations established under Part 33, and limited in use to periods of not over 5 minutes for takeoff operation"
The FAA considers this time limit to be routine or normal takeoff operations (single-engine). For multi-engine the time can be increased up to a maximum of 10 minutes for an OEI (One-Engine Inoperative) abnormal operation.

Is Transient time – 20 seconds, meant for starts only?

Answer: No

Transient engine events involving Torque, ITT, Propeller (Np) or Oil Pressure are listed and no (maintenance) action is required if occurrence returns too normal within 20 seconds of the maximum permitted value listed. FAR Part 33 requires this parameter.

As discussed earlier if the Torque exceeds maximum Takeoff limits we should not overreact (at that moment), as we will have time to fly the airplane first!

Can you maintain the maximum continuous torque 44.3 PSI, during climb, in the –47E (NG)? The –41/45/47

Answer: Yes

For the –47E – as long as the Maximum Continuous / Climb ITT does not exceed 820°C. This torque setting also will maintain Shaft Horsepower (SHP) at the maximum certified 1200 during climb

Answer: No

For the –41/45/47 Maximum Continuous torque is 36.9 PSI due to the "innards". The compressor turbine experiences the greatest amount of heat energy, pre-ITT indication. The legacy PC-12's Maximum Continuous / Climb ITT of 760°C versus the NG's 820°C should help with explanation of different power outputs during climb between engines and their design differences.

Seems like the torque limiter is a great item to have installed. Is there a downside to this unit?

Answer: Not really

As long as the torque limiter is functioning correctly the gearbox will always be protected from exceeding its limits (maximum takeoff). However, as a result it becomes possible to overtemp the engine due to atmospheric conditions and internal design. Also a possible un-confirmed "downer" is the torque limiters effect on the fuel control unit (FCU) sensing bellows [for details ask your training provider about this, if not sure].

In summary, takeoff performance should always be by the "book" with Section 4 - Normal Procedures, Takeoff: Power Control Lever – Set not meaning as desired but only if an exceedence may occur, which should be corrected.

" A safe pilot is always learning"

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