EVOLUTION *owner's*

newsletter

December 2012

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Information for the Evolution Owner and Builder

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Un-Commanded gear unlock during towing operations

There have been two incidents of nose gear collapse during towing due to the actuator becoming "unlocked". There is also anecdotal suggestion of at least one main gear "sag" during movement during construction.

Lancair engineering has completed an intensive in depth study of the gear actuation system, safeguards and possible failure modes. This process consisted of a thorough design review, an inspection of an incident involved actuator by the manufacturer and Lancair, and twelve hours of static operational testing. We had only one of the two incident actuators available to us otherwise we would have looked at both.

Our conclusion is that the cause of the collapse is contamination of the hydraulic system which exceeds the allowable size for normal operation and wear. The design review found no component design issues and a failure mode analysis found only one failure mode, which is contamination effecting the hydraulic fluid flow. We base this conclusion first on the fact that there have been only two reported instances of this condition in what must be thousands of opportunities, the inference being that if there was a component or system design problem the fault would be more common and repetitive, and further that the "incident" actuator that was inspected had metallic contamination in it large enough to scar the internal surface of the actuator. In addition, there was evidence of other "silt type" contamination having been in the system. We believe that the fault point was not the actuator per se, but in the porting to the solenoids contained in the hydraulic manifold. The exact fault pressure flow path that can lead to the pressure differential required to unlock the actuator during towing has been identified (this will be available in the full engineering report). We believe the contamination in the actuator is evidence of contamination in the entire aircraft hydraulic system (which we have not been able to inspect in the subject aircraft), not evidence that there is a problem with the actuator.

To avoid this condition we are urging all builders and users to use extreme attention to cleanliness during the fabrication and assembly of their hydraulic system during the construction phase, to clean and flush the system at the first 100 hr inspection and to clean and flush the system bi-annually thereafter.

Regarding safeguards to preclude an un-commanded unlock during towing, we suggest two.

- Momentarily or continually power up the system during the towing operation.

or...

- Open the emergency gear "dump" valve and leave

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Un-Commanded gear unlock: cont'd

it open during manually moving the aircraft. There is no danger of collapse if the valve is left in the open position for extended periods of parking or possible towing. This action "mimics" the normal down and locked function of the system and precludes the pressure imbalance that could cause the collapse.

There will be appropriate cautions and procedures issued in the Build Manual and Maintenance Plan documents in future kits.

Take it to the limit.....

Well that's what the song says, but what exactly IS the limit anyway? When it comes to operating the PT6 in your Evolution, there seems to be some question about that.

Many of us of a certain age or background are familiar with the term "Redline". Go beyond the redline and bad things are pretty likely to occur. Not only that, if you operate just under the redline, those same bad things are just about as likely. The problem with piston engines, with all their various parts zinging around and up and down is that the parts will eventually break or crash into each other. Turbine engines are different. In a turbine engine, the redline is a limit for a particular phase of flight. Operate below the limit, even just below, and you are in a safe zone for a specific amount of time. Operate above it, maybe just a little or for a specifically short time and you are still safe but the degree of safety changes with the amount of overage and time you spend there.

PT6 Limits

Let's talk about the PT6-135A. There are three basic limitations to safe operation of the engine; Temperature, Torque, and RPM's of the gas generator (Ng) and propeller (Np). Temperature, which is referred to as Inter-stage Turbine Temperature or ITT, is the temperature in centigrade of the gasses between the compressor drive turbine (CT) and the power turbine (that is connected to the propeller gearbox). Torque is the mechanical twisting force at the Prop flange measured in Pounds-Feet. Ng is the revolutions per minute of the gas generator turbine shaft expressed as a percentage of a reference rpm (101.6%). The percent is used because the actual rpm is a large number- 38,100 rpm. Each of these parameters has a maximum permitted value and each will reach its maximum at different times under different atmospheric conditions. For example, when the ambient air is cold more fuel can be burned at the same air/fuel ratio and the engine can then produce more torque. When applying power on a cold day climb or cruise you might reach the torque limit (2080 lb.ft.) before either of the others. As an example, on a +7C day at 3400 msl the engine reached the maximum 2080 lb.ft. torque at only 738C ITT and 99 %Ng. On a very hot day the ambient air is less dense and is already heated as much as 60C hotter than the cold day, and when applying climb power you may reach the temperature limit first. An example of this was a desert takeoff at +47C (117F) which caused a momentary 800C ITT at only 1300 lb. ft. torque. At other times, depending on barometer and temperature, and depending on the setup of your particular engine, you may reach the rpm limit (101.6%) first. You must always monitor your engine gauges when making power changes, especially large or rapid changes. For example, if you are used to operating in temperate or cold environments, you can easily exceed the temperature limit over temp or "Temp Out" on a very hot day if you use the same relative power lever movement at a very high OAT that you are not familiar with. Likewise you can over torque or "Torque Out"" on a very cold day if you apply power as you would have on a standard day.

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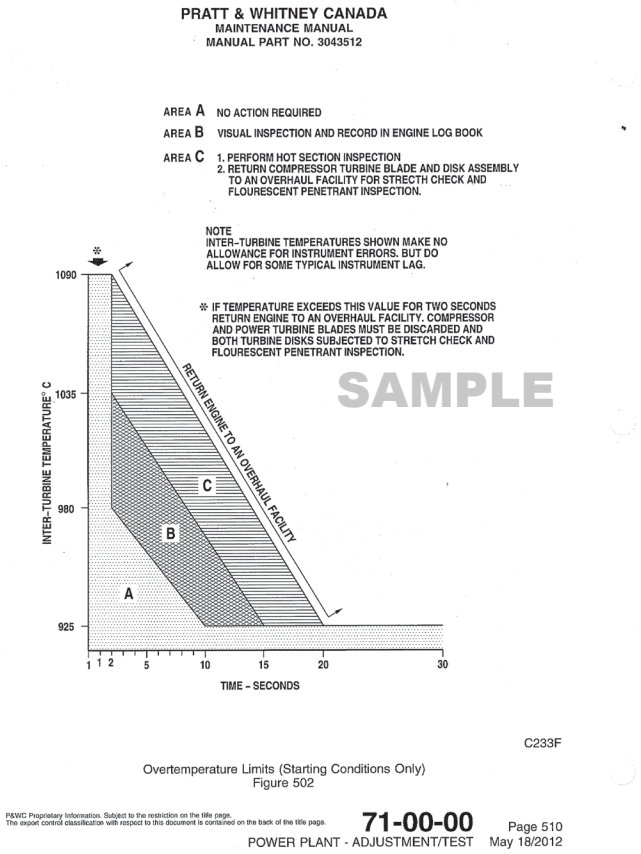
PT6 Limits (*cont'd*)

Temperature, torque and RPM limits are also subject to time limits. These can be found in your Pratt & Whitney maintenance manual (CD). On page 510 is a chart for Over-temperature Limits (Starting Conditions Only) which I have re-printed here. For example, this chart shows that a temperature of up to 1090C for no more than 2 seconds requires no action. A temperature of 925C for 10 (but not more than 15) seconds would require a logbook entry and a visual inspection, for 10 to 20 seconds, a hot section inspection and turbine disk overhaul would be required, and 925C for more than 20 seconds the entire engine would need to be sent to an overhaul facility. On page 513 is a torque limit chart which shows that 2400 lb.ft. for up to 20 seconds requires no action, and continuous running at the "limit" of 2080 is permitted up to 5 minutes with no action required. Exceeding the limits shown on the charts is clearly pretty hard to do and would require some sort of extreme situation, so despite the expensive nature of a severe over-limit episode, the charts are actually quite comforting. There is also a chart for "Inadvertent Cut-Off and Relight During Taxi". I recommend that you have a look all these charts.



Overtemperature Limits (Starting Conditions Only)
Figure 502

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Redlines and Yellow Lines

The G900x MFD in the Evolution is programmed to give a yellow warning bar when approaching a limit and a red warning bar when the limit is reached. The yellow bar is simply a visual warning that you have reached an arbitrary value that is less than, but approaching, the limit value. It is saying to you- "make changes carefully, or you may exceed the limit". The numerical value of the yellow bar has no particular significance other than to warn you that you could reach or exceed the limit if you are not careful with your power lever movement.

The most often asked question and probably the most

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Redlines and Yellow lines (*cont'd)*

discussed topic is essentially "If the max continuous ITT limit is 805C, can I fly continuously at 804C without damaging the engine?" The answer is yes you can, but you will shorten the life of your engine and of course you may inadvertently exceed the 805 deg limit. How much will you shorten it? Well now, there is the question. Wear is a function of load over time. Loads come in many forms, loads can be a temperature load, a mechanical load, an abrasive load, a bending load, etc. My father used to tell me "Hey, every time that engine goes around you're wearing it out." I have learned, as we all have, that he was right. So the amount of time your PT6 spends near the limit you're subjecting the parts to higher heat, for a longer time and therefore you will reach a point where some specific parts will degrade and reach their service limits sooner than if you were flying slower at lower power settings. In researching this topic I have found that literally no one can, or is willing to answer the natural question, which is "How much will the life before overhaul be shortened if I fly at Max Cruise Power?" The closest I have come is a candid answer from a very knowledgeable P&W Tech Rep, and his answer was "Maybe 10%". That being 350 hours on 3500, it's not such a terrible thing in an airplane like the Evolution that does not build a lot of hours per year. It certainly makes the point that it is up to you to decide how you wish to manage your engine and balance the speed/time/fuel/engine life parameters and be able to understand the concept of running "in the yellow".

Performance Charts

If you look in the operating handbook of a "traditional" PT6 powered aircraft like a TBM or Meridian you will find extensive charts that predict, based on temperature, pressure altitude, and aircraft weight what take off or cruise power torque should be. These serve to give you a target power setting for takeoff so that you do not exceed any of the essential limits, and for cruise, to allow you to plan for range and endurance based on fuel flows at various power settings. You probably have noticed (as have others with some degree of incredulity) that this has not been of as much a concern in the Evolution. This is because in any one of the traditional "heavy" aluminum designs it is expected that during any takeoff you will be using maximum available power and it is certainly essential to know what that should be before you move the power lever forward. Likewise with cruise flight, since on a hot day with a heavy load your engine or engines may not be able to provide the maximum performance and you will need to plan accordingly. Your Evolution is different since it has such a light empty weight and efficient design that takeoffs are performed at a recommended power level that in any but the most extreme conditions will not surpass any of the PT6 limits. The Evolution is very unique in the sense that you use more power in the climb than you do at takeoff. Your POH recommends a takeoff power setting of 1200 lb.ft., and this is approximately 60% of maximum available. Essentially your aircraft, even at gross weight, has such a favorable power to weight ratio that it will easily make field performance on a std. day at 60% power. Certainly if you are operating in extremely non-standard conditions you must closely monitor your limits but for all practical purposes your performance charts says " Takeoff Torque: 1200 lb.ft." . When setting climb and cruise power, monitor your limits and fuel flow for performance desired. You will soon have cruise numbers that you prefer based on the speed / fuel flow that fit your mission. Your Evolution will basically fly as fast as you desire up to maximum cruise limit for the day or as slow as you desire to conserve fuel. Having said all that, we have been doing extensive data collection and you will soon have a POH with more complete performance chart guidance that will indicate safe operations that will permit maximum engine life.

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Fly the Range Ring

The Garmin G900x provides the pilot with a graphic indication on your range based on the current groundspeed of your aircraft. On the MFD there is an "Out of Fuel Ring" that, based on the flight conditions at that moment , shows where you will be when the engine flames out. There is also a programmable "Reserve Fuel Range Ring", which shows where you will be (based on current ground speed and fuel flow conditions) when you reach a preset amount of TIME remaining in minutes. Generally we set this to 45 minutes in the MFD Aviation Menu. This one feature provides a very safe way to make tactical range decisions. If, during your flight you keep the Reserve Ring on your destination, you will ALWAYS land with at least 45 minutes of fuel on board. If during your progress you see the ring move "inside" your destination, you can simply reduce power (fuel flow) to move it back to the destination. If the ring moves "outside" your destination, you may opt to increase power to get there sooner. As you add power (and fuel flow) you will move the ring closer until it is again over the destination. You will, of course, burn more fuel, but again, you will always land with the 45 minutes on board. This method of range planning is simple allows for a continuously updated "how goes it" assessment of your available range adjusted for best speed.

Finally, Did You Know….

That under most circumstances in level flight (clean), the torque value in hundreds of pounds feet will yield an indicated airspeed equal to that 10% of that number plus 100. That is, 500 pounds = 150 KT Indicated, 600 pounds =160, 700 pounds = 170, 800 pounds =180. Just a coincidence, but a convenient one.

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PICTURE IT

Send us your photos

If you have any particularly good photos of your Evolution (especially in flight) we would like to add them to our web Gallery. Please email them to dougm@lancair.com. Doing so implies that we may reprint them publicly.

Fleet hours

We requested this in the last newsletter and had limited response, so I will ask again. It would help us a lot in our continuing analysis of any issues that may arise if we could get a fix on total fleet hours. Please send a simple email of your serial or N number and total hours to date.

Back Issues of these newsletters

If this is your first Evolution Newsletter or if you would just like to review the past issues, you can download them at: ***Click here***

Comments and responses please email:
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