"Land as soon as possible"

By John Morris

Or "Land as soon as practical". These two terms are included for certain emergency procedures for the PC12. They are not included in *that* many procedures for good reasons! But caution dictates. Without looking at Section 3, Emergency Procedures, can you think of which areas of the engine and any other system components might require use of the term "Land as soon as possible"? How about "Land as soon as practical"? The answer may surprise you. [I will list the "possible" procedures at end of article]

The definition for "possible", as published in all versions of the Pilot's Operating Handbooks is: **Land without delay at the nearest airport where a safe approach and landing is reasonably assured**.
And "practical": **Landing airport and duration of flight are at the discretion of the pilot. Extended flight beyond the nearest suitable airport is not recommended.**

Landing as soon as possible or practical is not always possible , due to variables. Hence the first paragraphs from EMERGENCY PROCEDURES:

"3.1 GENERAL

'The recommended actions to be taken in case of failure or in emergency situations are contained in this section. Some situations require rapid action, leaving little time to consult the emergency procedures. Prior knowledge of these procedures and a good understanding of the aircraft system is a prerequisite for safe aircraft handling.'

> **'KNOW YOUR AIRCRAFT AND BE THOROUGHLY FAMILIAR WITH IMPORTANT EMERGENCY PROCEDURES.'"**

By finding the emergency procedures that do include these two terms you could come away with idea that *at least* those procedures should be well understood, correct? Not completely but it's a good start.

While attending the New Orleans POPA convention one of the presentations was given by a current investigator from the NTSB Aviation Division. Towards the end of his discussion he referred to the Butte, Montana PC12 [March 2009] accident as an example of decision making and used specific systems references from the investigation. Unfortunately he made some statements regarding the accident that were not completely factual but more importantly to me was the amount of attendees to this presentation who seemed to not know much about this accident and the potential causes relating to the final outcome. Specific questions were asked that the presenter was unable to answer since he was just using this accident as a general reference to his presentation. This particular accident, as unfortunate as it ended, is a case study of the pilot's actions (a 10 year PC12 driver) as well as the fuel system and all of its related components. Even if flying an NG (the accident aircraft was a Series 10) any reader not familiar with this accident should download/review a copy of this 90 page report, #NTSB/AAR – 11/05, from the NTSB website.

At the end of this POPA presentation I felt I should re-address some parts of this 2009 accident. Coincidentally I had a client just returning from Europe in his NG that same weekend of the convention who experienced a similar fuel event that I will go over.

I have previously written two articles for the POPA magazine, winter and spring 2011, relating to the fuel system as a result of the Butte accident titled "Simply Serious" that might also be of interest for review.

The leading theory as to the beginning cause of the Butte accident was the lack of using a fuel ant-icing additive, a limitation requirement by Pilatus for all flights operating below 0° C ambient outside air temperature. The United States is the only country that refines/uses Jet A fuel while the majority of the remaining countries use Jet A-1. For this discussion I am referring to these two turbine fuel types for their published, by Pratt/Whitney, freeze points; -40°C Jet A and -47°C for Jet A-1.

Here is synopsis regarding the 2009 accident: The day before the accident, the PC12 had flown from Cabo San Lucas to the Los Angeles area. During the flight the aircraft exhibited, via recovered Central Advisory Computer (CAWS) data, both fuel boost pumps cycling without an annunciation for low fuel pressure (FUEL PRESS) on the CAWS panel indicating a possible fuel filter blockage. This was observed by pilot and owner on board (confirmed by owner at later time) and the only other time in the CAWS records for a similar event was two years before. No action or maintenance report was done for remainder of that flight or after. The next day the aircraft departed the LA area for a 2 hour northbound trip to pick up passengers and then proceed to Bozeman, Montana. At approximately 1:30 minutes into that leg the same occurrence began regarding the boost pumps and CAWS annunciations. During descent the left boost pump became full-time ON while right boost pump autoed OFF, indicating a possible auto fuel-balancing. The aircraft refueled at the 1st of two quick stops, observed refueling without anti-icing additive. As well, the FBO in LA area stated that top-off without additive was ordered the day before. The aircraft then proceeded on a direct flight to Bozeman at FL250. At approximately 1:15 into flight the same occurrence as previously noted occurred. The pilot chose to continue the flight, by-passing several airports instead of landing as soon as possible (or even reducing altitude). Also, actions were intermittently taken regarding the fuel "issues" but the left fuel boost pump apparently was inoperative causing a continuing-increasing fuel imbalance. The assumption is that the left fuel tank re-fueled eventually to full while the right fuel tank emptied at a higher than normal rate that finally caused the pilot to request a diversion to Butte. Another 1:15 after the initial indications into flight and after a high rate of descent towards the landing runway a go-around apparently was initiated causing loss of control. The final determination was that the fuel filter (and possibly the fuel boost pump) was affected by fuel icing, which caused the fuel filter to be blocked. A fuel imbalance ensued due to an inoperative left fuel boost pump. Please read the report for full details.

Of note: One outcome from this investigation was a recommendation for placarding that has since been implemented, to my knowledge, on all turbine aircraft operated in the United States - see below:

> "Amend aircraft certification fuel placarding requirements so that aircraft requiring fuel additives, including fuel system icing inhibitors, have a fuel filler placard that notes this limitation and refers to the airplane flight manual for specific information about the limitation. (A-11-77) Require all existing certificated aircraft (both newly manufactured and in-service aircraft) that require fuel additives, including fuel system icing inhibitors, to have a fuel filler placard that notes this limitation and refers to the airplane flight manual for specific information about the limitation. (A-11-78)"

One more note regarding the Butte accident: I was asked a series of questions from a non-federal investigator with one particular question discussed towards end of this article. The questions was: If crossing the North Atlantic and the event that happened at Butte occurred what would he be able to do and why was there not a cross-feed system in the aircraft? My answer was simply that; (1) During a water crossing in single engine aircraft you are never much beyond the gliding distance of the aircraft, in case of engine failure. With the fuel capacity on board, the PC12 can accomplish the leg safely, even though the aircraft will consume more fuel at a lower altitude. (2) I believe that cross-feeding is not necessary due to the actual simplicity of the fuel system. The system was made pilot proof because fuel mismanagement is one of the leading causes of engine failure.

What I wrote 7years ago concerning use of anti-icing additives was that freeze point meant the temperature for *water* separating at the molecular level and then freezing in the jet fuel. That was my personal definition of freeze point. However, there are currently conflicting definitions found on the internet regarding freeze point. One of the latest published definitions of freeze point is “At very low temperatures, aviation fuels will develop solid hydrocarbon [wax] crystals. The freezing point test for aviation fuels was developed to determine the temperature at which these crystals completely disappear.”

The NTSB report included the information that the recorded EIS (Engine Instrument System) OAT of 32°C was corrected to a value of 40°C to account for instrument errors. This seems to be implying that without an anti-icing additive the aircraft had reached the published freeze point without the NTSB directly stating what would happen to the water in the fuel at that point. Additionally I have found several technical papers suggesting water becomes *free* from suspension in Jet fuel at varying temps of -10°C to -35°C, depending on several additional variables including the rate of fuel flow and other particulates that can accelerate the free water to then crystalize. It then becomes a matter of the size of the droplets (amount of water freed) and like super-cooled droplets (SLD) against a wing, the metallic components of the fuel system can be an attractor for ice formation.

What is agreed upon is that jet fuel temperature, when fueling the aircraft, can affect the amount of water that the fuel can hold in suspension. The warmer the outside temperature at fueling, the more possible water present in a mixed form, that at a later time, and with an outside air temperature at/near the published freeze point, could separate to then quickly freeze. Prist, one of the available anti-icing additives states the following in their product literature:

“Prist Hi-Flash additive has limited solubility in jet fuel, but is completely soluble in water. When dissolved water separates from the fuel, some amount of Prist Hi-Flash additive quickly leaves the fuel and preferentially dissolves in the water. This depresses the water’s freezing point. As the fuel gets colder, and more water particles appear, more Prist Hi-Flash additive leaves the fuel and enters the water, and your aircraft’s fuel lines stay clear.”

No one has definitively stated that the anti-icing additive lowers the free water freezing point to a value at or colder than the published (hydrocarbon) freeze point for Jet A and Jet A-1.

But based on the above statement for Prist and other similar ant-icing additives it would seem that we should always have it in use, for PC12s and any other turbine aircraft that do not have inflight fuel tank heating, to protect against fuel icing.

This brings me to the subject of my client returning from Europe. During his North Atlantic crossing from Northern Scotland to Iceland, about a 3.5 hour cross country with headwinds, he encountered a CAS (Crew Alerting System) Fuel Low Pressure indication [NG's display this versus the CAWS Fuel Press]. Following emergency procedures both boost pumps were turned ON from AUTO. However, the "land as soon as possible" best/nearest airport was in Iceland. Murphy's Law caused this event to develop at the mid-point between the two islands! So the next best option was to request a lower altitude. This was granted. And other than a fuel imbalance beginning to appear prior to landing the trip was completed successfully. The remaining legs were also uneventful.

Questions:

- What fuel was in use? Jet A-1
- Did he use an anti-icing additive? No. Due to Jet A-1 freeze point
- What was the SAT indicated at his Flight Level? -30°C.
- Why did he have a fuel icing event?
- What about the fuel imbalance?

When we talked shortly after his arrival back in the United States I suggested that he take his NG to a service center for removal/inspection of the fuel filter. This should be done if any driver encounters the low fuel pressure caution.

Last note: The Low Pressure Engine Driven fuel pump (EDP) also has a bypass in case of failure and will cause the Low Fuel Pressure caution. How would you know the difference between the fuel filter blockage and the EDP failure? You will not. Take the plane for service after this kind of event!

The fuel filter is a series of metallic wafers, which more durable than paper and allow for cleaning and re-installation. Debris was present in the wafers even after about 9 more hours of flight. One can only suspect that there may have been contamination introduced via the fuel truck during one of his refuelings while in Europe. Then, possibly the last refueling was done when the air was warm outside, allowing for additional water to be suspended in the fuel, which then (again possibly) released as free water at the *warmer* SAT. With the contaminates already present it gave the water something to adhere to causing the water to crystalize sooner.

Landing as soon as possible, or landing as soon as practical are always up to the pilot in command to determine if the task is safe and able to be performed. Knowledge beyond just reading the procedure will always assist in making the correct, safe decision.

"A safe pilot is always learning"

John Morris

"Land as soon as possible"

All of these procedures conclude with the term assuming earlier checklist remedies were not successful in rectifying or reducing the occurrence

All PC12's:	Engine:	Oil Pressure, Torque, ITT, NG
		Propeller Overspeed (NP)
	Fuel System:	Low Fuel Pressure, Auto Fuel Balancing,
		Low Fuel QTY, Fuel Leak,
		Loss of Fuel QTY (NG-Analogue)
	Prop DeIce:	
Series 9/10	Electrical:	Essential Bus [If Battery Bus]
NG	Electrical:	Essential, AV 1, Bus Tie, Generators, Bat Hot
	Pitot 1 or 2,	Static