Operational Efficiency:

Making the Most of Your Fuel Dollars

by Matthew McDaniel

Feeling the sting at the fuel pump? Don't give up hope; there *are* ways to operate more fuel efficiently. If there's one area where the airlines excel, it is operating fuel efficiently within the confines of the FARs and SOPs. I became acutely aware of this when I returned to airline flying in 2005. In the three-plus years I'd been away from airline operations, their commitment to fuel saving measures had expanded exponentially. As GA pilots, we can learn (or adapt) plenty from the airline industry's efficiency procedures. The all-too-common attitude among turbine pilots is that the higher they fly, the more efficiently they are operating. That is a far too simplistic viewpoint.

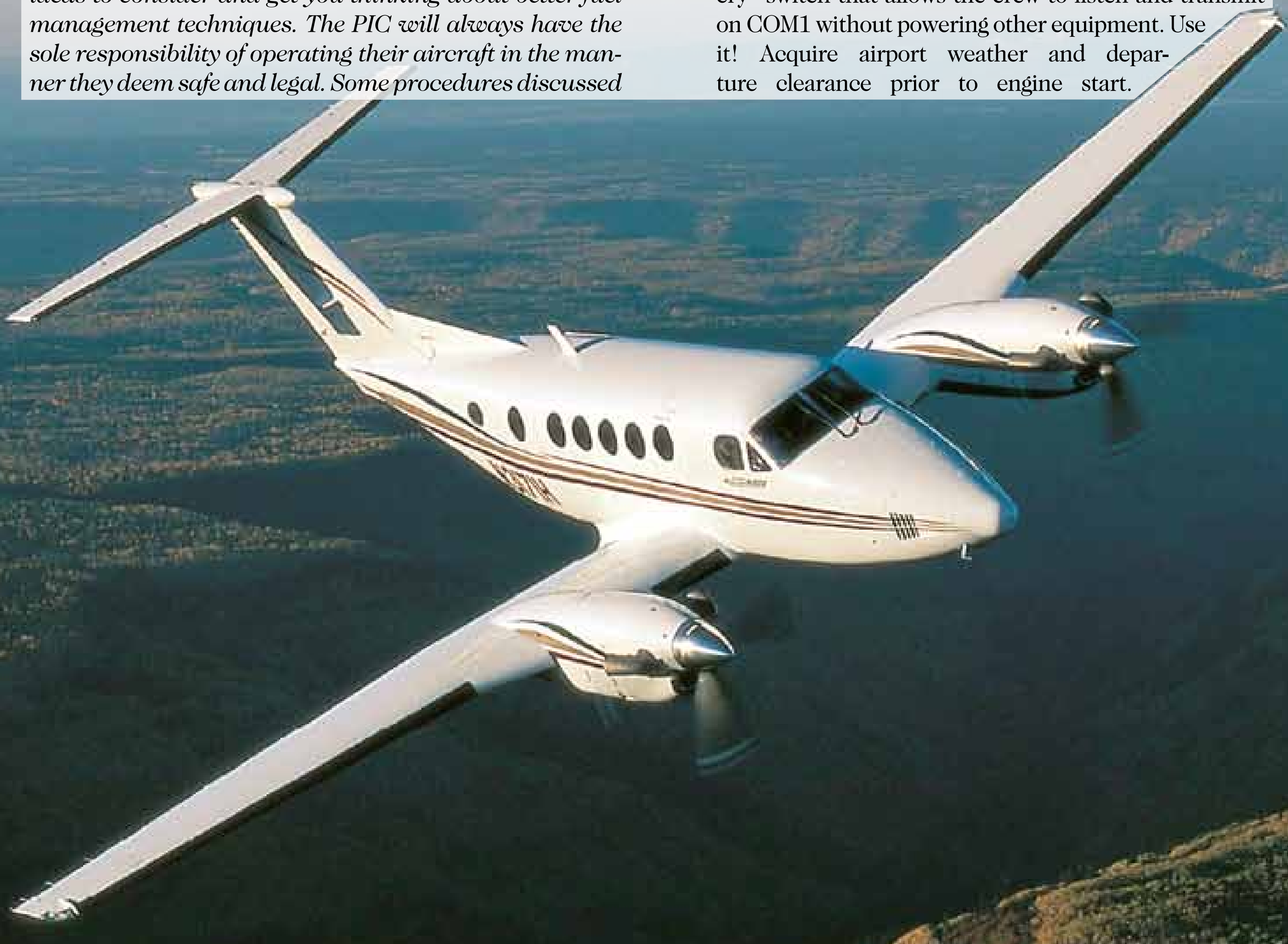
Author's Note: This article is intended only to present ideas to consider and get you thinking about better fuel management techniques. The PIC will always have the sole responsibility of operating their aircraft in the manner they deem safe and legal. Some procedures discussed may differ among King Air models, vintages and modifications. Always consult your POH for acceptable practices and procedures.

Pre-Flight

Fuel waste often starts before the aircraft ever moves. Consider these fuel saving tips.

Before engine start:

- During cold weather, pre-heat the engines (and cabin, if possible). This lessens the need to sit idling until the engine (and avionics) reach minimum temperatures.
- Get in, get situated and get everything in place.
- Many King Airs are equipped with a "Clearance Delivery" switch that allows the crew to listen and transmit on COM1 without powering other equipment. Use it! Acquire airport weather and departure clearance prior to engine start.



If your aircraft is equipped with a GPS or FMS that allows the saving of flight plans, you can power it up, insert your flight plan and save it into the flight plan catalog. This will allow you to quickly retrieve and activate your flight plan after engine start, saving the fuel normally burned while the Nav systems are being programmed.

Run-up and Taxi

You are ready to start the engines and should need minimum time before taxi and first flight checks. Remember, you saved your flight plan, so simply select and activate it from the Nav system's catalog.

- If you can do your system checks in your parking spot, do so. This prevents having to power up to leave the parking spot and then again to leave the run-up area.
- Apply just enough power to get the aircraft rolling, while using minimum power and minimal braking. Utilizing Beta thrust can be very effective in controlling taxi speed, lessening the need for braking. This saves fuel, reduces brake wear and keeps brakes cooler and more effective, should you need them for an aborted takeoff. Of course, avoid Beta+Power, as that will increase engine power and fuel burn.

Runway Choice and Initial Climb

At controlled fields, pilots generally accept a controller's runway assignment without question. At uncontrolled fields, they often choose the runway closest to them (wind permitting). The airlines teach: An airplane burns far less fuel taxiing to the most distant runway, than it would if required to takeoff and climb opposite the desired direction of flight, then make a large turn to get on course.

- Don't hesitate to query ATC about your desire to utilize a runway that would permit you to takeoff in the general direction of your destination. You could even do so before engine start.
- When choosing a runway, prioritize:
  1. Wind, terrain and traffic
  2. Which gets you on course the quickest
  3. Shortest taxi distance
- If taking off opposite of the desired direction of flight, climb steeply. This will prevent you from flying a greater distance in the wrong direction and, thus, lessen the required backtracking. It also can result in a quicker clearance to turn on course, as ATC often needs you to reach a specific altitude before they can turn you.

Cruise Climb

The general rules of thumb still apply here:

- If climbing into a headwind, use a faster IAS and a shallower climb. This allows the headwind to have less negative affect on your groundspeed (percentage of speed wise) and gets you further downrange, while keeping you lower, longer (presumably in lighter headwinds at lower altitudes).
- If climbing with a tailwind, use a slower IAS and a steeper climb. This allows the tailwind to have more positive affect on your groundspeed (percentage of speed wise) and gets you up into the presumably stronger tailwinds, quicker.

Cruise

Since cruise is generally the longest portion of any given flight, it is also the segment with the largest potential for fuel savings.

- Using all available resources, evaluate the winds aloft (reported and forecast). Careful wind planning is a commonly wasted opportunity to increase fuel efficiency. Use winds as one of your decision points for choosing cruising altitudes. Be aware of frontal boundaries, pressure systems and jet stream location. All can change wind direction/speed as you progress along your route. When passing through such areas, often it is advantageous to change altitude to stay in the most favorable winds. But, if a higher altitude is desired, you need to evaluate the gain versus the extra fuel burned while climbing and whether the additional altitude will actually decrease your TAS.
- Consider true airspeed. As a rule of thumb, you will gain 2 KTAS and for each 1,000 feet of climb. However, turbine engines are air-breathing engines in the same sense that non-turbocharged piston engines are. As the air gets thinner with altitude, available power will drop. The exception to this is for sharply derated turbine engines, which can maintain their *rated SHP* (or thrust rating) to a specified altitude. However, that altitude is rarely as high as typical cruise altitudes, so flying higher is usually more fuel efficient only to a point. Eventually, your available power will be low enough that you will no longer gain TAS as you climb. Generally speaking, you can count on faster TASs only into the FL200s for non-derated turboprops. Above that, close comparison of the conditions (winds, temps, etc.) and your performance charts is necessary to determine if anything is to be gained by climbing even higher.
- Your route is also a consideration. GPS Direct is the shortest distance in ground miles, but when you factor in wind, you can calculate air miles and sometimes discover GPS direct is *not* the shortest distance. A GPS Direct routing is not a straight line, but rather a great-circle route. That means the longer the route, the more your heading will change as you progress, potentially causing a wind-component change too. If that slows your GS along the way, you could actually end up flying more air-miles (miles flown through the airmass) than if you'd flown a similar, yet slightly longer, airway routing that kept you on a more consistent heading.

If this concept is a little confusing, let me give a realistic example to simplify it: *Assume a ~700 nm King Air flight, where an airway routing is 10 nm longer than a GPS Direct routing and the headwind difference is only 10 knots.*

A Nautical Air Mile (NAM) = [Nautical Ground Mile (NGM) x TAS] / GS

Example:

Direct Route (GPS Direct): 700 NGM, TAS=260 kts, GS=225 kts (35 kt headwind)

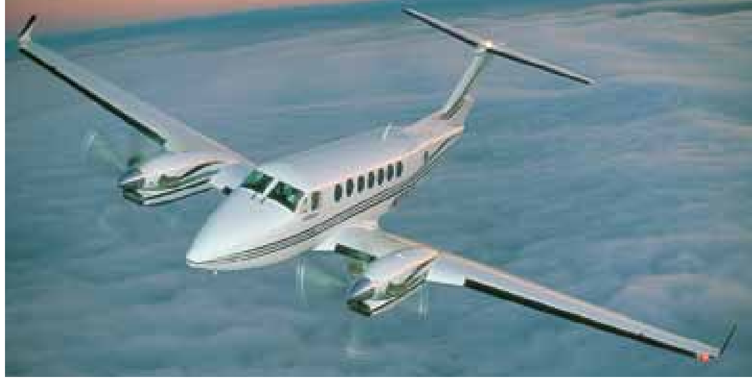
[700 x 260] / 225 = 808.9 NAM

Non-Direct Route (airways or fix-to-fix): 710 NGM, TAS=260 kts, GS=235 kts (25 kt headwind).

[710 x 260] / 235 = 785.5 NAM

Conclusion: By flying the slightly *longer* airway routing, with only a 10-knot wind difference, you'd actually fly 23.4 *less* air miles! The difference (fuel savings) is small, but small savings add up when applied consistently.

- If you have a headwind, it is more efficient to cruise a little faster. This results in a smaller percentage penalty from the headwind and gives the wind less time to work against you. The stronger the headwind, the faster you should push into it. Conversely, it's better to cruise slightly slower with a tailwind. This results in a larger percentage bonus from the tailwind and gives the wind more time to push you along. When I say fly "slower" or "faster," it's a relatively small airspeed range in King Air's (rarely more than +/-30kts from a "standard" cruise speed). If you aren't sure, experiment using your fuel computer, if you have one. Change power setting, allow fuel flow and TAS to stabilize and note the change in ETE, ETA and Fuel at the Destination. Any of the suggestions above can be validated, in flight, by quickly "running the numbers" through various combinations of your GPS/FMS equipment (for re-route distances and courses), an E6B, a calculator and/or any on-board fuel computer(s). Of course, the POH charts can be *very* helpful too! Or you could use the same formula (at left) to determine air miles versus ground miles.



When deciding cruising altitudes, careful wind planning is a commonly wasted opportunity to increase fuel efficiency.

Example 1: Assume you have a screaming tailwind on a 700 nm flight and want to extract the most advantage from it; so you decide to fly a slower TAS. Comparing your efficiency at typical cruise (250) versus a "slower for the tailwind" speed (say 225):

250 TAS: [700 NGM x 250 kts TAS] / 325 kts GS (75 kt tailwind) = 538.5 NAM (air miles) and 1.66 hours flight time. Fuel burn would be around 550 pph* (911.3 lbs.).

225 TAS: [700 NGM x 225 kts TAS] / 300 kts GS (75 kt tailwind) = 525.0 NAM (air miles) and 1.75 hours flight time. Fuel burn would be around 450 pph* (787.5 lbs.).

Conclusion: By slowing down 25 KTAS to take better advantage of the 75-knot tailwind, you will fly 13.5 *less* air miles, while arriving less than six minutes later and saving roughly 124 pounds of fuel.

Example 2: Assume you have a brutal headwind on the same 700 nm flight and want to minimize its damage to efficiency and arrival time; so, you decide to fly a faster TAS. Comparing your efficiency at a typical cruise speed (250) versus a "faster into a headwind" speed (285):

250 TAS: [700 NGM x 250 kts TAS] / 175 kts GS (75 kt headwind) = 1,000.0 NAM (air miles) and 5.7 hours flight time at 550 pph* = 3,142.8 lbs.

Flying at 285 TAS: [700 NGM x 285 kts TAS] / 210 kst GS (75 kt headwind) = 950.0 NAM (air miles) and 4.5 hours flight time at 650 pph* = 2,940.5 lbs.

Conclusion: By flying 35 KTAS faster to minimize the 75-knot headwind, you will fly 50 *less* air miles, arrive a whopping 1.2 hours earlier and burn 202.3 pounds less fuel!

**NOTE: I'm told the above performance figures represent a B200 with all Raisbeck modifications. I cannot account for their level of accuracy, but the principals are what matter here. While your mileage may vary, the principals will not.*

With today's rising fuel costs and uncertain economy, even little things to increase your fuel efficiency can add up and help with operating costs.

Descent

Economy descent principles are very similar to those discussed in the climb section.

- When cruising with a headwind, it's usually best to begin descent earlier and at a slower rate. The early descent allows you to come down out of the headwind sooner. Since you're descending a greater distance from the destination, you'll need to use a slower rate. This may mean you are not descending at the optimum idle power setting that is beaten into turbine pilot's psyche. But, if the winds are significantly less down lower, you will compensate by picking up groundspeed as you descend. Descending at only 1,000 fpm allows you to pick up a little speed in the descent and hold that speed increase for a longer period of time.
- When cruising with a tailwind, try to stay up in the strongest tailwind for as long as practical. Plan to delay the descent as long as possible (passenger comfort needs notwithstanding). It's usually my goal to stay high just long enough to allow a descent rate that is sufficient to give a good gravity-induced

speed boost (even at idle power), but not so steep that I'd potentially exceed any structural, turbulence or autopilot limits. If you achieve that goal, power changes in the descent are unnecessary.

- At some point you are going to reach an altitude where you'll need to make a power adjustment. If you plan it right, this should be as you're entering the VFR pattern or the initial segment of the IFR approach.
- Regardless of the descent strategy used, it can be made easier by utilizing the VNAV profile information in most modern GPS and FMS units. On the VNAV page, input your desired altitude at the desired distance from the airport (or other waypoint). Then input the desired vertical speed. As you approach the selected descent rate, request a descent from ATC and match the vertical profile required to achieve your descent parameters.

Instrument Approach and Landing

Because instrument approaches are so procedural and consistency is critical to safety, there are few opportunities to make major fuel-saving changes. But, there are things well within SOP to consider.

- Don't configure too early. It is important to configure for the final approach segment on-time, but doing so too early will only require you to carry more power for longer to compensate for flap/gear-drag. Plan to be fully configured, stabilized and on-speed no later than 1,000 feet AGL.
- Generally, approaches with vertical guidance are going to be the most fuel-efficient choices because they allow a consistent power setting throughout the entire final approach segment. A non-precision approach, however, may require multiple power changes for step-down fixes.

- As with departure, your choice of instrument approach and landing runway can be a fuel saver. ATC, wind and traffic flows permitting; choose the approach that allows the shortest transition from the en route to final approach course.
- Also consider the landing runway and where you will land versus where you need to taxi. The shorter distance, the better. However, it's still more fuel efficient to taxi a long way, than it is to overfly the airport, reverse course, and fly back.
- If you are only using the approach to "get down through the clouds" while the airport is technically VFR, consider a downwind approach and a circle-to-land maneuver (which is basically just a traffic pattern when the weather is VFR). If a downwind approach is closely aligned with your en route course, it can be used as an efficient transition from cruise flight to the VFR traffic pattern and often lends itself well to an appropriate VFR pattern entry.

VFR Traffic Pattern Entry

Fuel waste in this phase of flight is due, almost entirely, to not briefing the en route course versus the airport layout and/or expected pattern entry. Use all available information to become familiar with the airport layout and how to safely, legally and efficiently enter the traffic pattern. As a Check Airman, I often saw pilots ignore this simple task, become confused when they arrived at the field and being forced to circle, overfly, and make unnecessary turns to "get their bearings" before entering the pattern.

Landing and Rollout

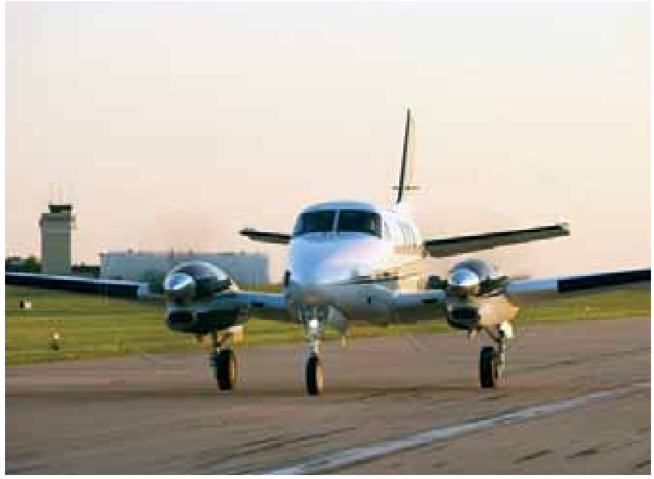
Avoid using Beta+Power reverse thrust unless runway length dictates otherwise. It's an effective tool when required, but when not required it's just a waste of fuel to respool the engines after touchdown and it increases the risk of FOD ingestion.

Post-Landing Taxi

Select the shortest taxi route feasible and taxi at the lowest acceptable power setting. Again, avoid riding the brakes and utilize Beta to help control taxi speed. Try to resist that high-power-induced sharp turn that I often see pilots using to squeeze into tight parking spaces.

Other Considerations

- Weight: Obviously, the heavier your aircraft is, the less fuel-efficient it will be. Inventory your airplane's contents a few times a year and offload unnecessary weight. Consider upgrading to an Electronic Flight Bag that allows you to legally remove heavy aircraft manuals and charts. This can shave many pounds and increase your useful load, as well.
- Tankering Fuel: There is the old axiom that there is nothing as useless as fuel left behind. As true as that might be, its costs fuel to carry fuel. Within reason, consider leaving fuel behind to lighten your aircraft. By all means, carry the fuel you need for the trip, the alternate(s) and reserves. But, do you really need full tanks for a 1.5-hour flight in VFR weather? It might be comforting to have it in the wings, but there is a price to be paid for imitating a tanker plane.



To help save fuel while taxiing, apply just enough power to get the aircraft rolling, while using minimum power and braking. Utilizing Beta thrust can be very effective in controlling taxi speed, lessening the need for braking.

- C.G. Location: Aerodynamically speaking, the most efficient C.G. location is the aft limit of the C.G. envelope. This is because the further aft the C.G., the less down-force the tail is required to generate to balance the aircraft in flight. Less tail down force (negative life) equals less drag, as lift (upward or downward) generates induced drag. Therefore, an aircraft flying with an aft C.G. produces less drag than an aircraft with a more forward C.G. (all other things being equal). I am not suggesting that you fly around at the aft C.G. limit all the time. But, when you load your aircraft, keep this principal in mind, especially for longer flights.
- Ice Vanes: It should be common knowledge that the ice vanes decrease available engine torque. When they are needed, use them. But leaving them extended unnecessarily will have a negative effect of available power, performance and efficiency.
- Autopilot Usage: I won't admonish any pilot for choosing to hand fly and, thereby, keep their flying skills sharp. Having said that, even the sharpest pilot cannot hand fly for long periods of time as smoothly or efficiently as a modern autopilot can. Any way you slice it, every little course or heading deviation and altitude bobble costs fuel when added up over the course of a long flight. Using the autopilot can minimize that and, thus, improve fuel efficiency.
- Clean equals efficient: When is the last time you cleaned the muck off your bird? There is no doubt whatsoever that you can absolutely improve fuel efficiency by keeping it clean and dry as much as possible, especially the leading edges of the wings.

- Maintenance: Finally, nearly anything the pilot can control to improve efficiency can be quickly mitigated by an improperly maintained aircraft. The inefficiencies of mechanical neglect can add up quickly and exponentially. This includes the disuse of your aircraft, which can often be even worse than overuse in terms causing mechanical issues. So, fly and fly often. It's good for your skills and your aircraft's systems.

In Conclusion

There is little doubt that some of the topics I've highlighted will generate some spirited discussion. Some will say that many of my suggestions are too much trouble for too little reward. To that, I say, little rewards are cumulative. Tiny fuel savings in any given area *will* add up to large fuel savings over years of flying. And, just to clarify, I have not and will *never* endorse sacrificing safety, legality, consistent training, or overall prudence for the sake of fuel efficiency. Period.

During my aviation career, I cannot count the number of times I've heard pilots and mechanics say, "Fuel is cheap, engines are expensive." Maybe once upon a time that was true. But, when I roll into a big city FBO and see Jet-A for $7.00+/gallon, I'm thinking that fuel's not so cheap anymore! KA

About the Author: Matthew McDaniel is a Master & Gold Seal CFII, ATP, MEI, AGI, & IGI. In 20 years of flying, he has logged over 10,000 hours total and nearly 2,500 hours in King Airs & the BE-1900D. He owns Progressive Aviation Services, LLC (*www.progaviation.com*), and specializes in training in Technically Advanced Aircraft (TAA's). He's also an airline pilot (currently on furlough from flying the Boeing 717), holds four turbine aircraft type-ratings and has previously been an airline Check Airman on the BE-1900. Matt can be reached at: *matt@progaviation.com* or (414) 339-4990.