

Jim has now given us some Cessna Pilots Association input on the recommended way to check the prop governor, and has also called our attention to the recent excessive erosion and sandblasting of the 182 prop.

Now, in his teaching, Paul has always emphasized treating the prop right, but I think we need to look hard at ourselves and attempt to be more careful. It's not just the maintenance expense and possible hidden damage: it's also the impression we leave on the people we depend upon, and on new prospects -- and on ourselves as well -- if our props continue to get chewed up or suffer other unnecessary abuse.

Over the years, API has had a certain amount of unnecessary prop damage. Some of it could be considered normal wear-and-tear, except that we know it's possible to cut this down significantly by being more careful during ground handling, taxiing, running up, taking off, and landing. Some of the damage history was due to certain characteristics of the Mooney, which on occasion, could trip up the un-practiced or the unwary. Now, of course, the Mooney is someone else's problem, but we still need to be careful with the Cessnas. The rest of the incidents were due to simple distraction or carelessness. The price of this history has been a certain amount of extra maintenance expense -- plus the general unease about blades and crankshaft that lingers in our minds after a prop incident, even though the affected pieces might have been inspected and pronounced still airworthy.

### Ground Handling and Preflight

Most people know the prop must be treated with the same respect as a gun. That is, it's the sort of hazard that needs to be thought of as "always loaded." The reason for this is that if by some error, failure, carelessness, outside chance, or long string of unhappy coincidences, the engine should in fact be ready to fire, then if the prop is moved to where the impulse coupler clicks, the engine *will* fire, instantly transforming the prop into a murderous, gasoline-driven cleaver. It's best not to turn the prop by hand unless the airplane is tied down or someone is on the brakes. Even with the mixture cut off, the throttle closed, and the primer locked, there still might be a few drops of fuel or a few cubic inches of combustible vapor lurking somewhere in the engine, able to kick the prop blades over (or sometimes back) with bone-breaking force if the coupler clicks and the mag is not safely grounded. Or with the fuel on and the engine all set to run, all it takes is one twitch of the blade past the spot where the coupler clicks, and it's running -- something seaplane pilots know (and something we ourselves can see every day with our present easy-starting engines in the Cessnas). Therefore, do not turn the prop by hand *at all* if you can help it -- but if you do have to do it (for example when doing the cold start procedure), do it safely by following *all* the precautions outlined below. If you can't be bothered to do that, then, as Jim says, eat lots of onions, for that will make the hamburger more flavorful.

It's also important to be sure that the ignition switch, in its "Off" position, is really and truly grounding both magnetos. While the usual mag check at run-up shows grounding of each mag individually (among other things), it is well to specifically test the grounding action of the switch for both magnetos when the switch is turned to the "Off" position, every great now and then. (This must be done right, or you risk causing a backfire. For a complete discussion, see <http://www.hartzellprop.com/> > product support > general service and maintenance.)

Sometimes it is necessary to move the blades to attach the tow-bar, or position them so that water and ice does not collect in the spinner or the hub. (When leaving the aircraft outside, blades should ordinarily be left horizontal (2-blade prop) or with one blade horizontal (3-blade prop). Then too, with an unheated engine in cold weather, it's a good idea to pull the prop through several times to "limber" the oil and spread it around. And to be sure, the full cold-start procedure means pulling the blades through several times in order to load the engine with a combustible mixture and prepare it to fire (and keep on going).

If you do move the prop by hand, you must always do it so your fingers, hands, arms, and body will be completely out of harm's way if it should fire unexpectedly. Never hook your fingers over the blade, or hang onto it during a pull-through: always step back and away from the path the blades will take (in either direction!) if a cylinder should fire. Always have the plane restrained so it can't go anywhere, and check that the ignition key is in your pocket.

It doesn't matter that you may be moving the blades only a little bit, i.e. not pulling them clear through, or moving them only very slowly. They're still quite dangerous. If a cylinder has combustible mixture in it, all it takes is one click of the impulse-coupler on a live magneto to have it fire! (See below under 'Cold Starting' for more detail on the correct way to move the blades or pull the prop through).

While prop accidents are rare (typically a dozen or so per year in the US), they are invariably pretty serious! Therefore, pay close attention to the prop safety procedures. This is one place where you cannot afford to screw up, not even once!

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To move the airplane on the ground, do not push or pull on the prop blades, even at the roots. The aluminum blade bends easily, and the root-attachment and pitch mechanisms are delicate and expensive. Likewise, don't push on the spinner: it's apt to crack the spinner bulkhead (a \$100 item). Don't push on the cowling, either. Pushing hard on struts and leading edges elsewhere on the airplane is frowned upon, as well. While the lightest kind of force (e.g. that needed to roll the airplane on level pavement) can be tolerated by struts, leading edges, and blade roots, the serious force needed to roll the plane uphill or into a wind, or over a bump, or out of a pot-hole should only be applied to the nosewheel, via the tow bar. Also: when pushing the airplane back into the hangar or a tiedown spot, discourage any ham-handed friends from applying excessive force to

empennage, fin, or struts. Do not try to steer by pushing the tail down and sideways as one might do with a 150. On bigger planes like ours, the forces required are too large, and damage to the elevator leading edge, the dorsal fin, or the control surfaces will result. *Use the tow bar.* (But then, as described below, don't forget to remove it!)

The prop blades should always be secure, and show no play. There should be no creepage of oil, no loose bolts or retainers, no signs of corrosion, no ice trapped in the spinner.

Check the spinner security by gently attempting to wiggle its nose in a circular motion. Don't overdo it: the attachment bulkhead is flimsy.

Prop blade leading edges should be smooth and free of dings exceeding 1/32" in depth. Sighting and feeling along the blade leading edge should reveal no notches or bends. Dents big enough to deform the blade surface or "upset" the metal (displace it laterally) are dangerous. Raw scratches are bad. Also bad is a general pitting or sandblasting of the leading edge, or of the front and back blade surfaces. All such imperfections are stress-raisers. The effect of an un-treated stress-raiser only gets worse as time goes by. The blade continues to flex and stretch in operation, promoting a crack, and stress-corrosion may start, making things worse. Out near the blade tips the G-forces in the rotating inertial frame are maybe 1000 times those of gravity with the propeller stopped. If the stresses cannot distribute themselves, the molecules of aluminum at the stress concentration site just might not continue to hold hands with each other! Dressing the blades is a job to be done only by experts. They have to remove metal over a region about 10 times as long as the depth of the ding, in order to redistribute the added stress along the length of the blade.

In alloy-strengthened aluminum, despite the strength conferred by the alloying elements, the aluminum remains a basically weak, limber, and easily bent substance. When in good condition, it's plenty strong enough, but any damage weakens it all out of proportion to the level of harm that might be intuitively apparent. Alloyed aluminum corrodes and breaks just like "pot-metal." Cracks are not self-limiting; and failure can progress rapidly. The material is only used for props because it's light, cheap, zero-water-absorbing, and easy to machine.

Stress concentration due to corrosion is the big prop-killer. Aluminum is pretty far down the list in the electromotive series, which means that many things will attack it. Though in clean, dry air, its oxide protects it, it corrodes readily in salt air, or polluted air. Bird-crap, contact with dissimilar metals, stress, surface damage, moisture, and the presence of alloying elements all promote corrosion and an increased chance of blade failure.

It has often been remarked that remodeling a \$40 steel tow-bar with a \$3000 aluminum prop blade is a real tough way to do it. If one of our airplanes is on one end of a tow-bar, the hand of the person towing it *must* be on the other. Always disengage the tow-bar from the nose wheel if towing is finished or interrupted, or if you need to let go of the handle for any other reason. The tow-bar is all too easy to forget. Hidden by the fuselage, it won't be visible to the pilot or passengers once everyone is aboard.

Indeed, be aware that you can't see underneath the airplane at all, once you have climbed aboard. When clearing the prop ahead of a start, always shout "Clear" and look around. Get a thumbs-up from anyone who is able to see the prop area. If nobody is around to give you such a sign, be sure you know for a fact where tow-bar, ladder, luggage, passengers, tie-downs, traffic-cones, saw-horses, pets, and toddlers are, *before* you start cranking! Climb out and check if you're not sure! Then too, always pause a moment after yelling and before you turn the key. You want give the movers, who just appeared from nowhere, a chance to get themselves and their grand piano out of the way before you start turning the prop. (But don't wait so long that they forget that you might be about to start!)

If after getting a start, you encounter heavy "wash-machine" vibration, shut down and check the prop and spinner. Ice in the spinner is the usual culprit. Never attempt a takeoff if there's an unusual vibration (or even a slightly different sound) up front.

### Cold Starts and Propping

When cold-starting the engine by limbering the oil and pulling the prop through, it helps a lot when starting to deliberately load the cylinders with gasoline vapor so that they will be all set to fire. Obviously, this requires the exercise of great care, for in doing the cold-start procedure, you are doing everything except actually starting the engine by swinging the prop with the ignition live.

Before you touch the prop, tie the airplane down or put someone knowledgeable on the brakes. Make sure the keys in your pocket. Remove any loose clothing, watchbands, rings, or jewelry. Push on the nose to be sure the airplane can't move. Then, on a good, non-slip footing, with feet well-planted, turn your shoulder in so your arms will swing down free of the blade arc, and place your hands flat on the face of the blade. Do not hook your fingers over the trailing edge! Then, keeping your fingers flat on the blade, pull it through, stepping back and away from the prop each time. When doing the cold-start procedure, do not omit any of these simple precautions! You absolutely must defeat the forces of Murphy!

**On the other hand, *don't try to actually start the engine by propping*** unless you are completely checked out on the drill *by a qualified person*. (*Don't* try to do it by just reading about it -- either here or elsewhere!) Both the inside and outside guy must know exactly what they're doing vs. the stages of the process, and know what they are going to if it doesn't start, or there's a fire, etc. Never improvise or enlist the aid of unqualified persons! (Don't ask line men to help you prop: line men are generally not allowed to do it for good reason -- it's too hazardous!) As the famous home video of a starting accident shows, ignorance or bone-headedness can do an immense amount of damage in a very short time. Do not trust the inside person -- push on the nose, make him/her show you the key, etc. And once started, even though you yourself know about the danger from the rotating prop, do not trust your own ability to avoid a dumb move just by instinct alone. People who have certainly known better have been killed by unthinkingly reaching

through the spinning prop's disk to disconnect cables or remove chocks! As with other invisible lethal hazards, screw-up all too easy to do!

Also, as noted elsewhere, propping may not be the right answer anyway. Realize that even if you do get the engine started by hand-propping, if the battery is dead, the alternator won't "catch." That means you won't have any radios or electrical instruments with which to fly the plane. It's better (and definitely safer) to get a jump start. Then run the engine briefly to warm it up and charge the battery a bit. Then shut down. After the jump-start cable has been disconnected and everything put away in peace and quiet, start up again as you normally do -- without exposing yourself or anyone else to danger from the turning prop!

The important thing to bear in mind here is that people who are not accustomed to working around subtle lethal hazards (props, explosives, high voltage, intense radiation, crane hoists, etc.) have *no idea* of what hideous danger lurks in a wrong instinctive move, or a moment's forgetfulness. And no matter how much you may have emphasized avoiding the prop or its invisible disk to your passengers, *they may still forget*. Therefore, never let friends, passengers, wives, girl-friends, children, airport bystanders, or automotive types help with a start. Maintain ironclad positive control of kids and pets. Do not allow anyone, including fellow pilots, leave the aircraft, or board it with the engine running. Nobody should be allowed near the airplane when the prop is turning, or is about to turn.

In this last regard, beware of a possible rush of excited friends and relatives across the ramp or onto the field when you arrive with your passengers at some out-of-the-way place. All the post-9/11 security stuff should help with this one, but unescorted, naive people can still appear suddenly and give you a fright! Be prepared to forcefully wave everyone back; be prepared to shut down instantly!

A prop-strike victim will probably get sent quite speedily to his reward in the Great Beyond and thus be put promptly and thoroughly "out of it," but friends and family will have to live with what happened for the rest of their days. (I know a young woman in Norway who lost her father to a prop strike when she was little -- a loss that did a number on her and her family. I would hate to be the PIC who did that, and have the continuing family tragedy as well as the accidental death on my conscience for the rest of my life!)

### **Taxiing, Run-Up, Takeoff, Landing**

When taxiing, look out for pavement drop-offs, gopher-holes and ruts; look out for puddles or soft places. Likewise, look out for traffic cones, tall grass, or iron stakes hidden in the weeds. Where the ramp pavement sticks up a bit above the surrounding turf, do not drive the nosewheel up onto the pavement or let it plunge down off of it: you may dink or splay the wheel rim, or excite prop-endangering up-and-down oscillations of the nose. Watch out for an evenly-spaced series of ruts or pot-holes that might induce a progressive buildup of such oscillations. Especially in winter (when snowplows can break them or dislodge them), don't taxi over drain grates. If there's the least question of a

condition that might endanger the prop, shut down, get out, and walk the intended route on foot. Once the engine is warmed up, it doesn't hurt it to shut down briefly and then start it up again. Disregard the old wives' tales about extra wear! Protect the prop!

Avoid raising rocks, sand, or broken pavement by using excessive prop rpms on poor surfaces. Never try to haul the airplane out a low spot with the prop. Get help (and supervise where and how hard the helpers push!). Where poor airport surfaces are expected to be a problem, keep tires and nose-struts inflated to the maximum allowable extent. On poor surfaces, hold the wheel back when taxiing to take the load off the nose-wheel and to maintain the best possible prop clearance vs. the ground.

At the prop governor check during run-up, the most important thing is to be sure that the rpm returns to its originally-set value after exercising the prop. The other things to check are that the warm oil flows smoothly in and out of the governor (you should see a slight engine oil pressure drop), and that there is no surging or rpm instability. The prop control should work smoothly. As others have pointed out, dragging the rpms way down with the prop control is not necessary or advisable. A brief 200 rpm pull-down and a carefully noted prompt return to the original throttle-set speed ought to do it.

When taxiing, running up, or taking off, adjust your technique to the conditions that prevail. Try to find a good spot to do the run-up. Realize there is nothing magic about the book-recommended rpms for run-up. On really bad surfaces, keep the rpm down to maybe 1400 max. At some places, you may want to content yourself with a rolling mag check at a modest rpm. (Skipping the run-up and mag check altogether is not a good idea.) Likewise, on bad surfaces (runway length and obstacle clearance permitting!), start the takeoff at a low initial rpm, add power gradually, and get some speed before firewalling it.

As pointed out elsewhere, the point where the air disturbance from the prop first meets the ground under a moving airplane quickly moves aft as the rolling speed increases, making it possible, if you're careful, to come and go from unimproved surfaces without dinging the prop in the least! (The nose and wing struts, the main landing gear, and the elevator may still take some abuse, but at least you will spare the prop!). Once you are rolling at a modest speed at low rpms, the prop will be pretty much out of danger. Apply more power and accelerate some more, then smoothly apply full power (and get full fuel flow and rpms) for the actual takeoff and initial climbout. (Never use partial-power for takeoffs. Partial power never did anybody or his/her engine any favors!)

If you do hit something with the prop, or if you should encounter rpm surges or other instabilities, abort any intended takeoff. (Should you find yourself already in the air without room to land ahead, and the airplane seems to be holding together, proceed to go around and land, using minimum power and rpms. If it's a governor failure, throttle back enough to stay below redline. On the other hand, if it's a prop failure and vibration is

extreme, you need to throttle back and land ahead, immediately, any way you can. The one thing you must *not* do in any of these situations is add throttle or lose a blade!

Do not try to nurse a plane with a stricken prop to another destination. Like it or not, you have a serious emergency. You really have no idea how long engine and prop might hold together! A governor failure usually means an oil circulation failure of some kind, which means that engine seizure may be imminent. In the case of a prop failure, if a blade tip lets go, the vibration will be severe; but if a whole blade lets go under power, the resulting imbalance will tear the engine right out of its mounts and leave the plane uncontrollable. Before that happens, you definitely want to be on the ground!

Once on the ground, shut down and inspect the prop for damage. Do not attempt to fly the plane if the prop has been notched, or if the tips have been bent, or if the metal has been pushed out-of-plane or off-contour in any way, or if there are paint marks, blood, or grass stains on the blade. This is “no fooling – you bet your ass!” territory! Leave any grounding/flying/ferrying decisions to a qualified mechanic.

Not all strikes are obvious. A smear of orange means you might have hit a plastic traffic cone (which itself might have been flung into the next county). Blood means a bird or animal strike. Green stains and paint scratches indicate you hit some weeds or high grass. Paint cleaned neatly off the prop tips may mean that the tips encountered water or soft mud. Any such untoward events are of serious concern. If the engine was developing power (or even if it wasn't), damage to the prop hub, or to the engine itself is likely to have occurred. Prop and engine will need to be checked by a mechanic. If the engine was developing power, it might have to be torn down for crankshaft inspection, obviously an expensive proposition. If dinged, the prop will probably need to be dressed and re-balanced (an operation that eats into its expected life and seldom leaves it anywhere near the prop-manufacturer's original level of perfection. Replacing a blade doesn't restore initial conditions either. The new blade may have to be filed down to match the other blades, with perfection not likely to be achieved.

Preserving prop balance is critical. To be legal, the prop must be kept within strict dimensional and balance limits, and there are many other fine points besides. Even a mildly out-of-balance prop is annoying. The resulting vibration increases chafing of the wiring and the engine baffles, encourages failure of vibration mounts, destroys landing light filaments, and breaks various other knick-knacks. Don't be the person who destroys the pleasure the rest of us take in flying behind a freshly-overhauled or brand-new, perfectly-balanced prop!)

Don't attempt any prop maintenance beyond wiping off the bugs and bird-crap. (It's true that some bush pilots dress their own props or burnish the leading edges with the shank of a screwdriver, but then they do a lot of hairy things. Don't use any tools or chemical cleaning agents on the prop. For us, dressing the prop is a job for the mechanics. So is applying anti-glare paint to the blade backs. (We have excellent prop maintenance shops here in New England; they need to do their thing!)

Prop noise is a very sore subject in many localities. Where safe to do so, follow local noise abatement procedures. On takeoff, reduce rpm before crossing the airport boundaries, if possible. A reduction of 100 – 200 rpm makes a big difference in the amount of noise produced. *Don't* reduce throttle – during climbout, the engine needs full throttle and full fuel flow for proper cooling.

In flight, prop ice is generally considered a more immediate threat to flight safety than structural ice. On the Cessnas, a dangerous icing problem usually manifests itself as severe prop icing first, as shown by heavy vibration, a peculiar sound to the engine, and a loss of airspeed. If prop ice begins to form, change the power settings occasionally to flex the blades and shed the ice (and get yourself out of there!). Some people swear by anti-ice spray coatings applied before flight, but lately, these seem to have disappeared from the market. Aircraft Spruce still supplies an anti-ice coating in aerosol spray cans, but at an awful price. The safest, most direct, (and legal) thing to do is to stay out of ice in the first place.

At any time, making controlled, deliberate rpm changes is important. When descending, don't let the windmilling prop drive the engine; carry enough power to prevent this. Stay away from any power settings that produce noticeable vibration. When preparing to land, don't push the prop control in all at once while still carrying significant power, or everybody will know you're coming!

When landing, to avoid potential damage to the prop, don't drop the plane in or let it mush down on the nose. For the same reason, be ready with a serviceable bounce-recovery technique, should you need it. At some big place, don't let ATC intimidate you into trying to land at 140 knots. At a small place, watch out for animals or drag racers on the runway. Watch out for poor or deteriorated surfaces. If you need to, go around, or go somewhere else. Don't hesitate to do whatever it takes to save your hide and your very expensive, delicate prop!

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Now, none of this is exactly new. If we fly according to what we already know, we wouldn't have any more prop incidents!