Propeller Safety

The root cause of mechanically induced accidents is almost always neglect.

On takeoff, propeller tip speeds approach the speed of sound. The blades must absorb not only the punishing vibration of the engine's power pulses, but also vibration caused by the oncoming airstream. Centrifugal loads—those forces that try to pull the blade out of the hub—amount to 10 to 20 tons per blade.

The blades twist and flex. The stresses imposed on the prop are more concentrated in the small areas that are nicked or cut. These nicks and scratches act as stress risers, which can weaken the blade enough to eventually cause it to fail.

When an engine quits, the airplane can glide to a safe landing. When a propeller blade is lost, the resulting imbalance can tear the entire engine from the aircraft, putting the center of gravity far beyond limits and rendering the aircraft uncontrollable.

Statistically speaking

Although accidents and human injuries from propellers are not widespread, they are serious and most are easily avoidable.

In 2003, 14 accidents were blamed on the propeller; five were prop strikes resulting in two fatalities and three serious injuries. The remaining nine were classified as propeller system failures. Forty-four percent of these took place in homebuilt airplanes.

Four accidents involved propeller blade or hub fatigue, failure, or separation. Three were due to prop pitch change mechanism failure. Two accidents were attributed to a failed oil line to the propeller governor, which caused a loss of oil pressure.

Treat the propeller with caution.

Prop accidents break down into some general groups:

- Precautionary landings because of abnormal vibration. Often caused by a missing balance weight or deteriorated spinner.
- Precautionary landings due to propeller overspeed or runaway.
- Forced landings following a catastrophic prop failure.
- Accidents from a botched hand-propping episode.
- Ground personnel, passengers, or bystanders walking into spinning propellers.

The root cause of mechanically induced accidents is almost always neglect.

Working around the propeller

Because it is attached to the engine, the propeller deserves respect on the ground. The single most important concept you should understand is this: the propeller must always be treated as though the ignition has been left on and the engine is just a hairsbreadth from starting. Even though most pilots are careful to occasionally check that the mags properly shut down the engine, not all do. Assume the worst and you'll never be surprised.

Magneto Check

Periodically ensuring that your magneto's p-leads have not broken is a good defense against unexpected starts on the ground. These leads, which are connected to the ignition (or magneto) switch in the cockpit, are responsible for grounding the mags to keep the engine from running. Sometimes the wires or connections between the switch and the magnetos break or come loose. In this case, one or both mags may be "hot," or ready to deliver spark whenever the prop is turned. To test them, instead of shutting down the engine in the usual manner with the mixture control, use the key. Allow the engine to cool normally and idle down. Move the key slowly through both Right, Left, and then to the Off position. The engine rpm should drop slightly at both of the individual mag positions and shut down completely in the Off detent. Allow the prop to stop and then move the mixture to the idle-cutoff position. Do not try to "catch" the engine before it comes to a stop because a dangerous backfire might occur. If the engine does not stop when the key is in the Off position, shut it down with the mixture, prominently mark the prop as being "hot," and contact maintenance personnel immediately.

There are a few other caveats to consider when in the vicinity of the prop.

- Avoid pulling the airplane around by the prop. Yes, this seems the perfect solution to a vexing problem of how to change the airplane's position without having to walk around and get the tow bar, but it's worthwhile to make the extra effort. Neither the engine nor the prop particularly benefit from the loads imposed by horsing the whole airplane around.
- Avoid pushing the airplane by the spinner. The spinner and backing plate are built to be light, so they're quite fragile. Pushing on them can cause the backing plate to crack and can lead to spinner failure.
- Avoid contact with prop deice boots and associated wiring. If you want your hot prop to be toasty when it counts, stay clear of the boots.

Prop Injuries

Never attempt to load or unload the airplane with the engine running unless there are significant extenuating circumstances. If you must allow passengers or crew to board or otherwise approach the airplane, be certain that they understand the areas to avoid. Keep your hand on the mixture control and monitor the movement of the individuals without fail. If someone begins to walk in the direction of the spinning prop, kill the engine immediately. Worry about how to restart it later. Remember that passengers are unlikely to hear your cautionary shouts over the engine. Almost every year, there are injuries or fatalities from someone walking into a turning prop.

Do not attempt hand-propping without proper training.

Hand-Propping
We're not going to tell you how to hand prop an airplane because it is NOT something you learn from a booklet and it is inappropriate for nose-gear airplanes.

If you already know how to hand prop, remember to secure neckties, silk scarves, and loose clothing. Remove rings, watches, and bracelets, and have a qualified person at the controls.

Prop mechanics

Propeller technology is considered to be mature, like much of what we use in aviation. The basic designs have changed little in the past 30 years or so, although incremental advances in blade aerodynamics have improved efficiency slightly (at best, a prop is about 85 percent efficient at converting torque to thrust). Modern production techniques have also helped reduce overall weight. Nonetheless, pilots ought to be familiar with a few basic types of props.

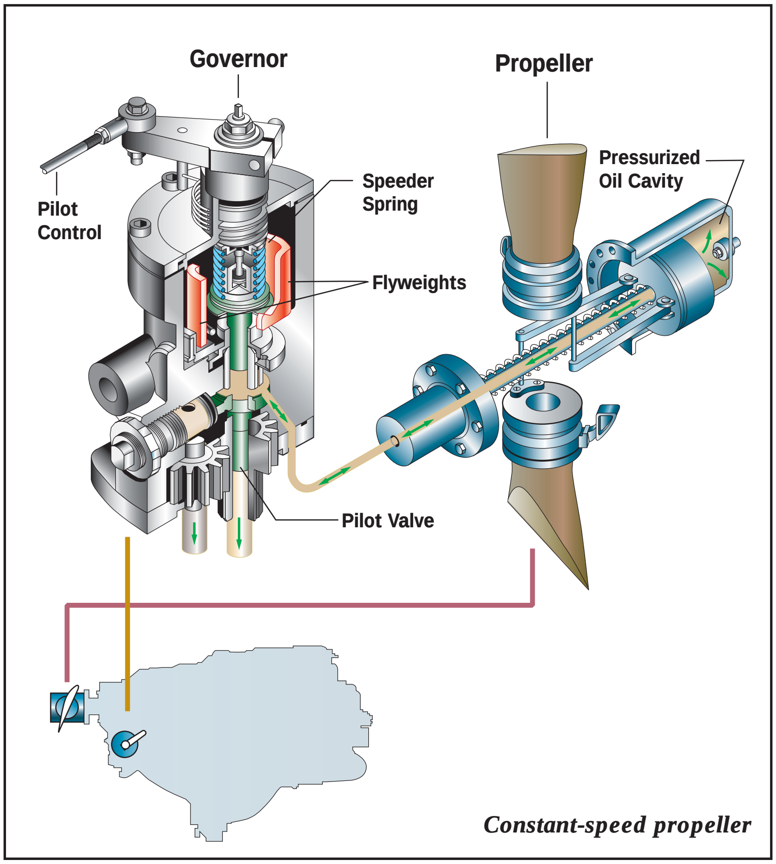
Fixed-Pitch
Used when low weight, simplicity, and low cost are needed, the fixed-pitch prop is a compromise. Because in most cases the pitch setting is ideal for neither cruise nor climb, the airplane suffers a bit in each performance category. Fixed-pitch props simplify power management and cost less to overhaul than a constant-speed version.

Constant-Speed
Before there were constant-speed props, there were adjustable-pitch models. By altering each blade's angle of attack, the prop can be better optimized for both climb and cruise performance. Early models used manual adjustment of the prop pitch, while a few pioneer inventors played with automatic pitch-change mechanisms.

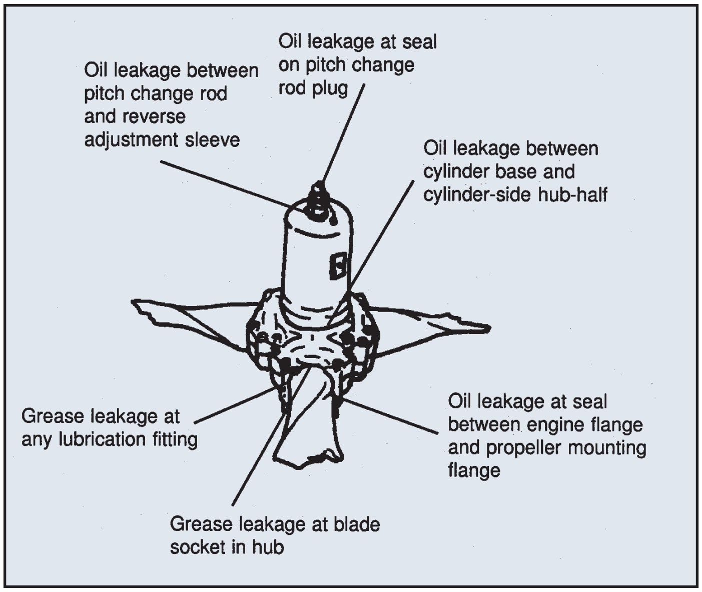
As soon as aircraft developed wide speed ranges—the difference between the slowest climb and the fastest cruise—it was clear that a better system was needed. By the early 1930s, the groundwork for the constant-speed prop had been laid, in large part by Ercoupe and Piper Cherokee designer Fred Weick.

A separate mechanism is used to alter each blade's angle of attack, with the goal to maintain a constant engine speed. In a fixed-pitch prop, as the airplane accelerates, the engine—given a fixed throttle position—will follow suit. With a constant-speed arrangement, the blades' angle of attack increases as the engine tries to accelerate, loading the engine and maintaining the set speed.

This setup provides two main benefits over fixed-pitch propellers. First, you get a more optimum blade pitch setting, and second, the engine can be made to run at a set speed, greatly reducing pilot work load and making precise power settings possible.



Constant-speed propeller



Potential areas of oil or grease leakage

A cracked aluminum hub

Corroded steel hub

Governing

Integral to the constant-speed setup is a device called the governor. It is geared to the engine and takes oil from the main engine supply. An internal pump increases the pressure of this oil and directs it, through the hollow nose of the crankshaft, to the propeller. In single-engine applications, oil pressure serves to increase the pitch of the blades (called coarse pitch), which in turn reduces engine rpm. Twins and some aerobatic aircraft operate so that engine oil forces the blades to fine pitch. Pilots should follow manufacturers' recommendations for feathering props and securing engines after failures.

Feathering

A feathering propeller is simply a constant-speed unit that can rotate the blades until they are nearly aligned with the relative wind. This provides reduced drag in the event of an engine failure. Feathering props are found on most twin-engine airplanes.

Blade Materials

Today, the vast majority of props in general aviation are metal—specifically aluminum. In the days before sophisticated metallurgy and precision metalworking tools, the wooden propeller reigned supreme, and it's still popular for ultralights, small experimental aircraft, and antique models. There are also a few composite (fiberglass, Kevlar, and graphite) props in circulation; most of these use either a foam or wood core wrapped with fiberglass cloth. Potentially, the composite prop can be lighter than a metal prop, and its stiffness-to-weight ratio is better, but so far the certificated composite propeller has proven to be too expensive for most GA aircraft.

Hubs

The function of the hub is to fasten the propeller blades to the engine. For most fixed-pitch props, the hub is integral to the blades. Constant-speed props need to allow the blades to rotate in the hub. Many different blade retention systems have been used throughout the years, with the more recent designs intended to be long-wearing and corrosion resistant.

As the fleet ages, it's becoming more common to hear of prop-hub distress in addition to the more prevalent blade maladies. Failures of hubs are comparatively rare. Typically, the hub problems involve cracking prior to failure. Corrosion pits inside the hub can cause cracks to form when the hub is subjected to operating stresses. Such incidents are particularly distressing because they are preventable with proper maintenance and overhaul. Prior to failure, a cracked hub or blade retention component may provide a warning with the sudden onset of grease or oil leakage or vibration.

Blade erosion: Bare metal corrodes rapidly. Keeping blades properly painted is inexpensive routine maintenance.

A prop in the process of failing. Note crack.

Preflight considerations

Many pilots seem to take the prop for granted, so the next time you fly, take time to carefully check it. Here's what to look for:

General condition: Is the prop clean or covered in grime? You can't tell much about the condition of the blades if you can't see them.

Are the blades scratched, pockmarked, or nicked? This is a critical question. Blade separations start with small stress concentrators in the metal. These are formed by scratches, gouges, or corrosion that allow stress to concentrate in a very small area. These stress concentrators weaken the metal, which can then crack. Constant flexing of the blade makes cracks wider until the part fails. Generally, a nick that is less than 1/32-inch wide or deep can be deferred to the next maintenance cycle, but anything larger (or if there are numerous nicks, say from a recent departure from a gravel strip) should be dressed out immediately by an A&P mechanic.

Are the blades tight in their sockets? Constant-speed props depend upon a certain amount of centrifugal force to seat the blades, but there should not be more than the slightest bit of movement.

With a spinner fitted, it's often difficult to determine the condition of the propeller hub itself, but you should be able to see the mounting hardware—look for loose nuts or backed-out bolts. Some props on GA aircraft have oil-filled hubs to assist you in finding hairline cracks that might otherwise go unnoticed. Any evidence of red oil must be investigated before flight.

Is the spinner secure? Remember that a loose or off-center spinner can self-destruct in very few hours if not corrected. If part of the spinner departs the airplane in flight, it can feel as dramatic as if a very small part of a blade itself had jumped ship. Grasp the tip of the spinner firmly and try to move it in a circular pattern. Just don't overdo it. The spinner and backing plate are easily damaged. Never move the aircraft or lift the nose by pushing on the spinner.

Prop Tip: Props can sustain a lot of damage when operating over loose gravel. If the airplane is parked on a gravel surface, move it to hard ground before starting the engine. Likewise, when taxiing to the tiedown spot—if it is on gravel, shut the engine down on hard ground and use a tow bar to move the airplane.

In the cockpit

Prior to flight, take a few precautions to ensure that your prop will perform as needed. For fixed-pitch props, listen and feel for unusual noises and vibration. Because there's so little to go wrong with a fixed-pitch propeller, you're basically on the lookout for gross problems like loose bolts or a tip that departed during the start and taxi sequences.

During the Runup

For constant-speed applications, however, there are additional considerations. Keep an eye on the oil pressure and temperature. Pressure should be in the normal, green-arc range, and the temperature should be rising according to outside conditions. Because the constant-speed prop needs both good oil pressure to do its job and oil thin enough to be pumped through the smaller passages of the prop, it's important to keep these parameters in mind, particularly for cold-weather departures. A takeoff with cold oil will result in a poorly governed prop and a possible overspeed event. In subfreezing conditions, it could take 15 to 30 minutes to get minimum oil temperature. Storing the airplane overnight in a heated hangar or calling for an engine preheat will help greatly.

Prop Exercise
When exercising a constant-speed prop, pay attention to several items:

• Does the prop control move freely? Excessive friction could indicate a frayed cable or poor lubrication. It also makes precise setting of the prop lever difficult.

• Does the prop respond promptly with warm oil? The prop should take no more than two or three seconds to respond to cycling when the oil is warm. If it fails to cycle at all, even when the oil temperature gauge indicates green-arc conditions, do not attempt to take off. There may be a broken cable, failed governor, or plugged oil passage. The latter two of these possibilities could lead to an overspeed event.

• Does the prop return to the set runup speed after cycling?

• Does the oil pressure fluctuate during cycling? Oil is pulled out of the engine during cycling, so the pressure should drop slightly when the prop is cycled and recover as prop rpm is restored.

On the Takeoff Roll

Takeoff is a busy time, but ensure that the prop and its governing systems are functioning properly.

• Watch the tachometer and listen for signs of surging or overspeeding. Know what is normal and what is excessive needle swing for your aircraft. If there is a major problem, you'll likely hear it before noticing it on the tach.

• Note that the prop has achieved redline (or near redline) speed.

• Listen for abnormal noise and vibration.

It is perfectly normal for a constant-speed prop to spin up just short of maximum rpm during the initial takeoff roll. As the airplane accelerates, the prop will unload slightly and the speed should come up. If it does not reach the redline value at climb airspeed, have the governor and/or tachometer checked.

If you see a drop in oil pressure or experience abnormal noise or vibration, you should either abort the takeoff (if there's room to stop safely) or continue around the pattern to a normal landing using low power settings.

In Flight

There is no clear pattern of propeller failures: they can happen on the takeoff roll, in steady cruise flight, or even in the traffic pattern. Stay alert to signs of prop distress in the cruise phase of flight. The sudden onset of grease or oil leakage or vibration in a failing propeller has been frequently reported. A timely and thorough investigation of such conditions is prudent.

There are two main in-flight failure modes—departure of part of a blade, balance weight, or spinner that causes strong (sometimes extreme) vibration, and governor maladies that can cause the prop to stick at the set rpm or to spin rapidly beyond the redline.

A catastrophic hub failure that allowed the blades to depart and puncture the nose.

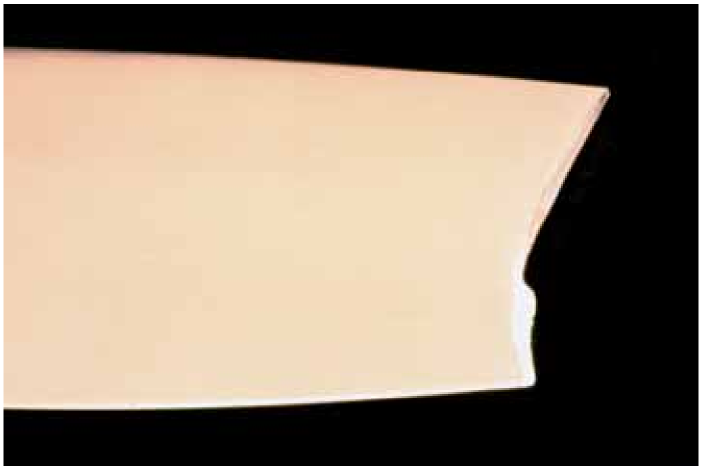
Blade Failures

It's almost too obvious to state, but the departure of any part of the prop will get your attention in a hurry. Equally obvious is the advice to stay calm.

• Immediately reduce power with the throttle.

• Slow the airplane to best glide speed—trading airspeed for altitude if you have it—and start looking for somewhere to land.

• Conduct the normal power-loss troubleshooting. Did you just run a tank dry? Are the mags acting up? Usually, running a tank dry gets you a bump or two as the fuel pressure fluctuates, then light sputtering followed by silence. Similarly, a mag problem typically manifests itself in inconsistent misfiring and possible backfiring. A prop-blade failure, on the other hand, is much more rhythmic and undiminishing in amplitude until the throttle is pulled back.



Missing blade tip

• Unless you are sure that the engine roughness is something other than the prop, do not advance the throttle again. The tremendous centrifugal forces created by a grossly unbalanced prop can tear the engine from its mounts. With the engine idling and the prop windmilling, the forces will likely be small enough to let you get the airplane on the ground before a major structural component comes unglued. If you have the time and the presence of mind, shut down the engine if you are sure some of the prop has departed. But, first things first, fly the airplane.

Governor Failures—Overspeed

The following information applies to single-engine aircraft with loss of governor oil pressure to the prop; i.e., overspeed. A governor failure that causes engine overspeed or poor prop control is also a possibility. Wild changes in prop rpm in flight can signal loss of governing control, forcing the blades into the fine or high-rpm pitch settings. When this happens, get the engine speed down before it does any damage.

Governor Failure

If a governor fails to supply oil to a propeller, the failure effects are different depending on whether the propeller is a pressure-to-decrease-pitch or pressure-to-increase-pitch design. On multiengine aircraft, loss of pressure will cause the prop to feather. On most single-engine aircraft, loss of pressure will cause an overspeed.

If a governor is not doing its job and a propeller overspeeds, the amount of overspeed is controlled by two things: engine power output and airspeed. Reducing throttle and airspeed will minimize the amount of overspeed. In an overspeed condition on a single-engine aircraft, it would be better to fly to an airport while overspeeding than to shut down the engine and risk an off-airport landing. If you are faced with propeller overspeed, take the following steps:

• Immediately reduce the throttle to idle.

• Set best-glide airspeed, and start looking for a place to land.

• Check the oil-pressure gauge. Many prop overspeeds result from broken oil lines or oil starvation. Dropping oil pressure and increasing temperature are the classic indications.

• If oil pressure is good (cross-check with temperature if you have unusual gauge indications), then slowly advance the throttle and note the prop's reactions.

• Chances are good that you will be able to maintain some power before the prop rpm reaches the redline. With good oil pressure and temperature, pick a throttle setting that will allow you to maintain sub-redline engine speeds. Still, remember that it's better to fly to an airport with an overspeeding engine than to land in a field because you cut the throttle.

• Plan for landing as soon as practical. You may have a broken oil-supply line to the governor (this was common for a while on some engines that used external prop-supply lines), which will exhaust the oil supply and seize the engine. A spun bearing or other internal leakage may be restricting flow to the prop.

There also may be loss of oil pressure and subsequent seizure of the engine. It may not happen, but something caused the prop to overspeed, and it's a good bet it's oil pressure-related.

Prop Strikes

It's a sad tale that's repeated several times a year. The overworked pilot, perhaps coming home from a difficult day of flying terminated by a challenging instrument approach, gets distracted and forgets to put the gear down. At the first sound of crunching metal and the strange stroboscopic blur of the prop taking chunks out of the runway, many pilots' first reaction is to add power and try to salvage the situation. Two words: ***Do not!***

As soon as the first blade tip hits the concrete, that prop is ruined, unable to carry the aerodynamic and structural loads imposed by the go-around. If it stays on the air-

Don't try to salvage this situation.

plane long enough to make it around for a wheels-down landing, you'll be beating the odds.

In this instance, the choice, though certainly not palatable to many aircraft owners, is simply to keep the throttle at idle and ride the belly landing to the bitter end. Fatalities and injuries from inadvertent wheels-up landings are extremely rare. However, executing a go-around with damaged blades is very risky. Even if the propeller stays sufficiently intact to prevent serious vibration, damage could be so severe that climb performance is seriously degraded.

Maintenance matters

A big part of preventing in-flight emergencies is to keep on top of propeller maintenance. Many aircraft owners believe the prop is a no-maintenance item. That is not the case.

Take the opportunity at the normal oil-change interval to have a more detailed look at the prop. Have the mechanic file out any nicks now, while you have the time. This is not, incidentally, a procedure a pilot can legally undertake, nor should you attempt to file the prop with supervision unless you've been specifically trained. Dressing prop blades is an art: just enough must be filed to remove the nick but not so much that a lot of blade is sacrificed to do it. The idea is to get completely to the bottom of any nick so that there can be no stress riser that can later cause blade failure. There are blade minimum dimensions, and if too much is filed off, it must be replaced. Any propeller overhauler can provide the dimensions, or you can request service information from the propeller manufacturer.

Tachometers

Have the tachometer checked annually. Mechanical tachs are notoriously inaccurate and subject to drift over their lifetimes. If your engine and prop combination has one or more yellow arcs or red restricted arcs within the normal operating range—common with many four-cylinder Lycomings—it's vital that the tach accurately guides you out of these trouble spots. These limitations are in place because of vibration characteristics of the engine and prop combination and can lead to long-term trouble if routinely ignored.

Hours or Years?

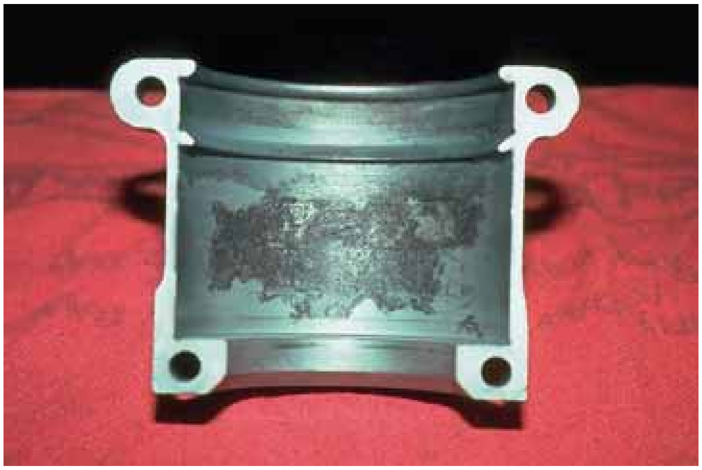
Props have recommended overhaul intervals based on calendar time and flight hours. Depending upon the prop model, this could be 1,500 or 2,000 flight hours, but there's also a calendar limit (typically five years) that too many pilots ignore. This is a serious problem in a fleet that flies, on average, fewer than 100 hours per year. At 100 hours per year, a typical 2,000-hour prop might not get checked for 20 years! This is clearly imprudent, so the calendar limit applies.

Have the prop overhauled at either the time or calendar limit, whichever occurs first. If the engine comes up for overhaul before the prop reaches either limit, most shops will recommend removing the prop and governor and having them overhauled anyway. This will get the times in sync.

Overhaul at the time or calendar limit—whichever occurs first.

Corrosion Is the Culprit

Overhaul periods deserve respect because what kills most props are not external defects, but unseen internal corrosion. Dissimilar metals in the prop and hub create an environment ripe for corrosion, and the only way to properly inspect many of these areas is through a teardown. Extensive corrosion can dramatically reduce the strength of the blades or hub. Even seemingly minor corrosion may cause a blade or hub to fail an inspec-



Corroded blade clamp

Corroded bearings

tion. Because of the safety implications, this is clearly not an area in which to skimp.

Internal corrosion can develop in critical blade retention components. Such conditions present both a hidden defect and a potential safety-of-flight issue. This is the primary reason that calendar limits are an important inspection requirement. Also, the overhaul needs to include more than just a corrosion inspection. Restoration of paint and plating are important to assure future corrosion protection until the next overhaul.

Notification

It's vitally important to keep up-to-date with airworthiness directives (ADs) or service bulletins (SBs) for your prop. Compliance with ADs is, of course, required to make the airplane legally airworthy, but it's also good form to follow the SBs—particularly those marked "mandatory"—because there may be prop maladies that manifest themselves only under certain conditions, such as aerobatic flight or harsh environments. All work performed on the prop—including AD and SB compliance—should be noted in the propeller logbook.

Airworthiness Directives and Service Bulletins

Aircraft owners are seemingly besieged by ADs and SBs. Although some owners see only an outlay of cash, paying attention to ADs and SBs, particularly where propellers are concerned, might just save your life.

For Part 91 operators, only ADs are mandatory. An airplane is not considered airworthy unless all ADs have been complied with, either by proving by model or serial number that the AD does not specifically apply, or by showing that an inspection or replacement of parts has taken place. Compliance with ADs is required to be noted in the aircraft, engine, and propeller logbooks.

SBs, even those marked by the manufacturer as "mandatory," are purely optional for Part 91 operators. Does this mean you should ignore them? Hardly. Many ADs are simply rewritten SBs, and in many cases, compliance with a previously optional SB will cover the requirements of a new AD. SBs can also provide useful service information.

A list of SBs can be ordered from the propeller's manufacturer. Current AD information can be downloaded from the AOPA Web site, www.aopa.org.

Overhaul: What Do They Do?

Upon receipt for overhaul, a document is prepared that will track the propeller components throughout the overhaul process. All applicable ADs, current specifications, and manufacturers' SBs are researched for incorporation during the overhaul process. The serial number is double-checked, and notes are made on the work order regarding the general condition in which the propeller was received.

As the unit is disassembled and cleaned, a preliminary inspection is accomplished on all related parts. Those revealing discrepancies requiring rework or replacement are recorded in the overhaul record by part number, along with the reason for the required action.

All threaded fasteners are discarded during disassembly and, with a few exceptions permitted by the manufacturer, are replaced with new components. Many specialized tools and fixtures are required in the disassembly and proper reassembly of propellers. These tools are generally model specific and range from massive 15-foot torque adapter bars and 100-ton presses down to tiny dowel pin alignment devices.

The Hub

Nonferrous hubs and components are stripped of paint and anodization and inspected for cracks using a liquid penetrant inspection (LPI) procedure. The parts are etched, rinsed, dried, and then immersed in a fluorescent penetrant solution. After soaking in the penetrant, they are rinsed again and blown dry. Developer is then applied, which draws any penetrant caught in cracks or defects to the surface. Under an ultraviolet inspection lamp, the penetrant clearly identifies the flaw. Certain models of hubs are also eddy-current inspected around critical, high-stress areas. Eddy current testing passes an electrical current through a conductive material that, when disturbed by a crack or other flaw, causes a fluctuation on a meter or CRT display. This method of inspection can detect flaws that are below the surface of the material and not exposed to the eye.

Magnetic particle inspection (MPI) is used to locate flaws in steel parts. The steel parts of the propeller are magnetized by passing a strong electrical current through them. A suspension of fluorescent iron oxide powder and solvent is spread over the parts. While magnetized, the particles within the fluid on the parts surface immediately align themselves with the discontinuity. When examined under black light, the crack or fault shows as a bright fluorescent line.

Components that are subject to wear are dimensionally inspected to the manufacturer's specifications. After passing inspection, aluminum parts are anodized and steel parts are cadmium plated for maximum protection against corrosion.

The Blades

The first step in blade overhaul is the precise measurement of blade width, thickness, face alignment, blade angles, and length. The measurements are then recorded on each blade's inspection record and checked against the minimum acceptable overhaul specifications established by the manufacturer.

Blade overhaul involves surface grinding and re-pitching, if necessary. Occasionally, blade straightening is also required. The manufacturer's specification dictates certain allowable limits within which a damaged blade may be cold straightened and returned to airworthy condition. Specialized tooling and precision measuring equipment permit pitch changes or corrections of less than 1/10 of one degree. To ensure accuracy, face alignment and angle measurements are taken repeatedly during the repair process.

A cracked hub

Precision hand grinding of the blade airfoil is done to remove all corrosion, scratches, and surface flaws. When all stress risers and faults have been completely removed, final blade measurements are taken and recorded on each blade's inspection record. The propeller blades are balanced to match each other and are anodized and painted for long-term corrosion protection.

Prop Reassembly

When both the hubs and the blades have completed the overhaul process, the propeller is ready for final assembly. Part numbers are re-checked with the manufacturer's specifications. The parts are lubricated and installed per each unit's particular overhaul manual. After final assembly, both high- and low-pitch blade angles on constant-speed propellers are checked for proper operation and leaks by cycling the propeller through its blade range with air pressure. The assembled propeller is then checked for static balance. If necessary, weights are placed on the hub areas of each "light" blade socket to bring about its proper balance. These weights should be considered part of the basic hub assembly and should not be moved during subsequent dynamic balancing to the engine. As with most aircraft components, all of the hardware on the propeller assembly must be safety wired unless secured by self-

Disassembly work stand

locking devices. Maintenance release tags reflecting the work accomplished, applicable ADs, and all incorporated service documents are then filled out and signed by the final inspector. These documents certify that the major repairs and/or alterations that have been made meet established standards and that the propeller is approved for return to service.

From the ASF Accident Database

Injury to Bystander
The pilot of the Cessna 150 stopped at the terminal after a local flight. A person standing on the ramp came over to the airplane and talked to the pilot through the open door. The engine was left idling. After the conversation had concluded, the bystander waved goodbye and walked into the propeller, sustaining serious injuries.

It's always good form to shut down the engine in the vicinity of onlookers, even if they are experienced pilots.

Wooden Prop Failure
The Taylorcraft was in cruise when a sudden severe vibration went through the airframe. The pilot shut down the engine and noted that the brass abrasion strip and part of one wooden blade had departed. Although the pilot landed the airplane in a field, it could not be stopped before plunging down a ravine. A mechanic who recovered the aircraft reported seeing dry rot in part of a remaining blade.

Constant inspection and maintenance is a necessity, particularly for the older wooden props. The pilot and flight instructor in this accident are to be lauded for keeping their cool.

Prop Strike
During the takeoff roll, the Piper Super Cub's right main gear hit a hole. The pilot said he heard the propeller strike a rock. He continued the takeoff, but after liftoff, the airplane began to vibrate. The pilot reduced engine power and landed in a river. Examination of the propeller disclosed approximately three inches of one blade missing.

Anytime you hit a solid object with the prop—whether it's during a takeoff on a rough strip or the misguided attempt to salvage a gear-up landing—you should immediately discontinue the takeoff. This pilot was lucky that the imbalanced prop did not do serious secondary damage to the engine or airframe. In the worst case, the engine can be shaken from its mounts; the loss of engine weight will, in most cases, make the airplane uncontrollable.

Broken Counterweight
The pilot of the Air Tractor noticed serious engine vibration during a spraying run. He reduced power, then reapplied power, but the vibration remained. The aircraft was landed in wet terrain and nosed over. Inspection revealed that a bolt in the propeller counterweight had broken.

Something as seemingly simple as a counterweight caused this pilot to sit up and take notice. The moral here is that quick action is the key to salvaging a prop problem; the pilot walked away without injuries.

Runaway Prop
A factory-overhauled engine had been installed in the Cessna Cardinal RG. The pilot departed on a post-maintenance test hop. Eleven minutes into the flight, the pilot reported a runaway prop. The engine seized shortly thereafter. A forced landing on a soccer field ended in a collision with two vehicles on an adjoining road; the pilot was not injured. Later inspection revealed that one of two required gaskets at the base of the prop governor pad had been omitted, allowing the engine oil to be vented overboard.

Good work on the part of the pilot for keeping this dead-stick Cardinal under control. It serves as a reminder, though, that any flight after major maintenance should be conducted as close to a suitable runway as possible.

Lost Blade
During cruise flight, about half of one prop blade departed the Beech Musketeer, resulting in substantial

engine and airframe damage. The airplane landed uneventfully at a nearby airport. Inspection later revealed that the prop blade had failed from fatigue that started from a single corrosion pit on the camber side of the blade. There were no records in the aircraft's logbooks that the prop had been serviced since it was manufactured in September 1963.

Wine may improve with age, but metal does not. That the prop had apparently been untouched for 33 years when the accident occurred is nothing short of amazing. Again, most prop makers specify, in addition to the hours-in-service limits, a calendar limitation of, on average, five years between overhauls. This one was way overdue.

Hand-Propping

The pilot of a Piper Comanche (PA-24-250) was struck in the head and elbow by the propeller as he was attempting to start the aircraft in cold weather. The pilot's operating handbook suggests pulling the prop through four to six times before attempting a cold weather start, but in this case the pilot had already tried to start the airplane without success. Leaving his non-pilot passengers on board, he exited the aircraft to pull the prop through but neglected to ensure that the magneto switch had been returned to the Off position.

Keep on top of propeller maintenance.

A couple of thoughts here: Be sure that any time you touch a propeller the magnetos are in the Off position – preferably with the key in your pocket. Even then you must assume the engine could start. That means keeping all parts of your body out of the prop arc. Had the engine started, the non-pilots in the airplane would be unlikely to help. Having a qualified pilot at the controls would have been the safest option.

Safe Pilots. Safe Skies.

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