

and lubrication systems result in a harder-starting engine, which makes the starter work more than necessary.

Anything that makes it more difficult to start the engine is bad for the starter. For instance, during low-ambient-temperature starts, use engine preheat and external power. A properly applied preheat helps the crankshaft turn more easily. Another problem associated with cold-weather starts is a weak battery. The application of external power assures full amperage to the starter immediately for quick engine cranking.

Running the starter for a long time is especially harmful to the starter motor. Most pilot operating handbooks publish starter time limitations, usually one minute or less. The limitation is related to cooling. Cranking the starter for longer than recommended causes the motor to overheat, which can melt the solder that holds the field and armature windings; the starter can literally self-destruct! If the engine does not start within the recommended starter limitation time, something probably is wrong with it. Don't continue to grind away; find out what the problem is with the engine. The three most common reasons an engine won't start are mixture in cutoff position, fuel selector off, or magnetos off.

Most airframe manufacturers recommend routine starter-system inspection and maintenance at least at the annual inspection. Some handbooks recommend inspection twice a year. The starter is susceptible to cumulative damage, and the manufacturer's recommendations should be followed closely.

Starter cable terminals should regularly be checked for corrosion. If present, wash the area with baking soda and water solution and dry. Then coat terminals with petroleum jelly. At the same time check for a loose terminal-to-battery stud connection and tighten it as necessary. Another vulnerable point is where the cables actually enter the battery terminal. They should fit tightly with no loose strands or partial breaks. Also inspect the general security and integrity of the insulation. These may seem like trivial points, but even loose strands can cause a loss of cranking power.

If there is concern about the system, you can conduct a voltage-loss test to locate high-resistance connections, which reduce efficiency. Using a low-reading voltmeter, have someone crank the engine while you check the voltage loss from battery post to start motor terminal. Maximum loss is .3 volts per 100 amps; a 200-amp system would allow a maximum voltage loss of .6 volts. The maximum voltage loss from the battery ground post to the starter frame is .1 volt per 100 amps. Great caution must be exercised when conducting this test. Be sure you disable the engine so it will not inadvertently start. The best way to do that is to remove the spark plug leads. Also, stay clear of the prop, as the starter can turn it fast enough for it to be lethal. Have an experienced mechanic do the test or at least check you out on how to do it safely.

## TROUBLESHOOTING

The electrical system is probably one of the most difficult systems in an airplane to understand and troubleshoot. Any information you can give to your mechanic, even seemingly unrelated items, may make a difference. This is primarily due to the fact that many other systems somehow relate to the electrical system. For instance, a hydraulic gear system will use an electric pump. Another quirk of electrical appliances is that