

In-Flight Electrical Fires

Although in-flight electrical fires are rare, they can happen at any time—and they can be disastrous. In this Safety Brief, we'll look at ways you can minimize the chances of a fire, and be better prepared in the event one occurs.

Recognizing an In-Flight Fire

Many pilots associate an in-flight fire with a flame-filled cockpit. Usually, though, the first signs of an electrical

Accident

Pilots have historically been taught that electrical faults are fail-safe and that circuit breakers will protect us. The airline industry learned that this was not true after investigating high-profile accidents in the 1990s, such as the SwissAir Flight 111 MD-11 accident at Peggy's Cove, Nova Scotia. The flaw with this concept was found to repeat during the investigation into an accident on July 10, 2007, in which a Cessna 310 crashed in Sanford, Florida. The pilots reported smoke in the cockpit and asked ATC for a diversion to nearby Orlando Sanford International Airport (SFB). Sadly, they didn't make it: The aircraft crashed into a residential area just a few miles from the airport, killing both pilots and three people on the ground. One day prior to the accident, another pilot had noted a burning smell following failure of the airplane's weather radar system. He pulled the associated circuit breaker and noted the discrepancy in the aircraft's log. The NTSB determined that the accident pilots likely reset the breaker, resulting in an in-flight fire. [Click here](#) to read AOPA Air Safety Foundation president Bruce Landsberg's Safety Pilot article about the accident. The full [NTSB report](#) is also available online.



In the air, an electrical fire is an emergency situation. Your attention should be focused on getting the airplane on the ground as soon as practical.

fire are much more subtle—a slight burning odor, a higher than normal electrical load, or tripped circuit breakers, for example. Abnormal behavior of electrical components (avionics, for example), or random failures of multiple components, can also tip you off to fire in a hidden area. Pay attention to the clues: Don't wait for a major problem before taking action.

Immediate Action

During any in-flight fire, every second counts: The last thing you should be doing is fumbling through the POH looking for an emergency checklist. Be familiar with the specific emergency procedures for your aircraft, so you can take action at a moment's notice. Here's a simplified checklist:

- Fly the aircraft, and stay calm!
- If you're talking to ATC, advise them that you have a fire and may need to shut down the aircraft's electrical system. Declare an emergency: There is NO penalty for doing this.
- Look for any tripped circuit breakers, then turn OFF their associated component(s).
 - If you can identify a component that is potentially involved and not essential to a safe landing, but its breaker isn't tripped, pull the breaker(s). This may stop the smoke or smell, and prevent further damage. *Remember: The underlying problem is still there. DO NOT RESET the breaker(s)!*

- If you can't immediately identify the problem, turn OFF the master switch first, then individually turn off all the other electrical components. Remember that you will lose lighting and certain flight instruments once the master switch is off.



- If flames are present, or if smoke persists or worsens, use a fire extinguisher to put out the flames.
- Prepare to land as soon as practical, even if it means an off-airport landing. If you are flying in instrument meteorological conditions, try to reach VFR conditions.

Tip

If there's smoke in the cockpit, you may need to open a door, window, or vent to let in fresh air. Or not. Opening doors and windows is effective in some airplanes but can actually *increase* the hazard potential in others. Know which is appropriate for your airplane.

Troubleshooting

Your first priority should be getting the airplane safely on the ground. A problem may smolder for a period of time, then flare into an emergency that could have been avoided. Only if time and conditions permit—or if it's necessary for a safe landing—should you start troubleshooting. Here are a few recommendations:

- Start by turning the master switch ON. If smoke persists or worsens, the master may be the culprit. If not, turn on necessary switches individually while monitoring the effects.



Never reset a non-essential circuit breaker in flight.

Priorities

While it may be tempting to troubleshoot, your first priority should be getting the airplane safely on the ground. Prioritize the tasks at hand, and if possible leave the entire electrical system OFF. For aircraft with glass cockpits, remember that loss of primary flight and/or engine instruments will occur after turning off electrical power. If power is needed momentarily, use it, then promptly turn the master switch OFF. Handheld radios and nav/GPS receivers are extremely useful under these circumstances.

- Only reset the flight-essential breakers when absolutely necessary. NEVER reset non-essential circuit breakers. Resetting circuit breakers can re-create the situation that caused the problem in the first place, potentially causing the fire to reignite.
- If the breaker(s) will not reset, there could be extensive damage to the aircraft's wiring. Leave the breaker(s) in the pulled or tripped position, and don't try to reset them again.

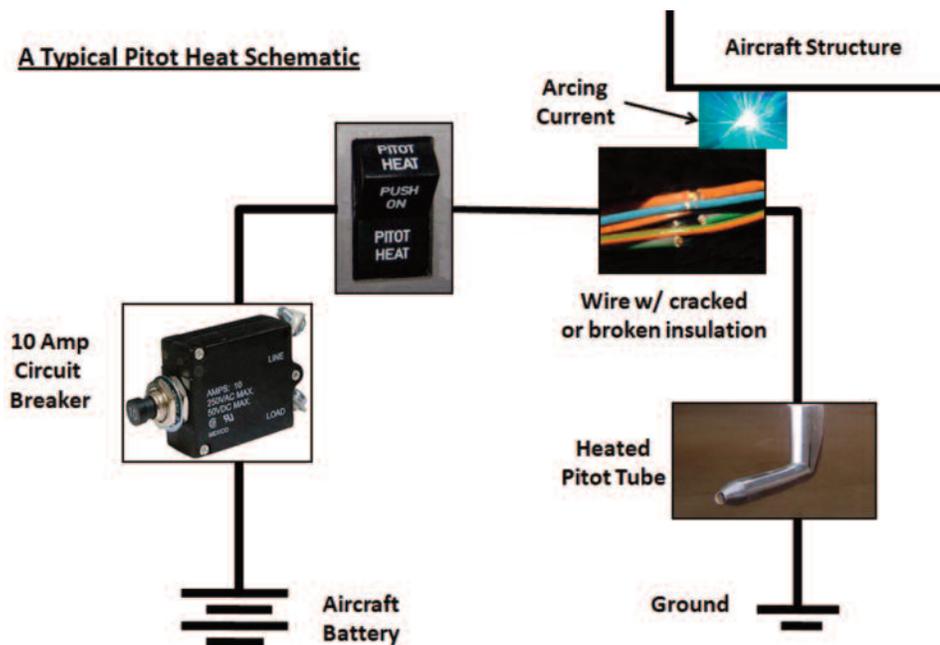
On the Ground

The presence of smoke or a burning odor is a sure indicator that wiring has been damaged—and that means the aircraft is no longer airworthy. It's important to remember that wiring damage is cumulative and that the damage will not get better without attention. Without a thorough inspection, there's no way to determine the extent of the damage. This is no place to pinch pennies: A relatively inexpensive replacement of a faulty wire, or a circuit protection device, could prevent a much more costly repair (or a total loss) in the event of a fire or accident.

Once you're safely on the ground, write a detailed description of the incident in the aircraft's maintenance log or discrepancy sheet, noting which components were in use when the problem started. The more detail you provide, the faster the problem can be found and fixed. This written entry, along with appropriately placed placards (and/or other, less formal notices), should also let other pilots know the aircraft's status and prevent it from being operated until the problem has been addressed.

Until repairs can be made, FAR 91.213 allows non-turbine powered general aviation (GA) aircraft to be operated with certain non-critical components inoperative, but only if they are: (i) *Removed* from the aircraft, the cockpit control placarded, and maintenance recorded; or (ii) *Deactivated* (normally by collaring the circuit

A Typical Pitot Heat Schematic



The purpose of a circuit breaker is to open the circuit if the current draw exceeds the rated amperage (due, for example, to an exposed wire coming into contact with another damaged wire, or the aircraft structure). This stops the flow of electricity, preventing further damage or fire hazard.

Tip

Circuit breakers should be cycled periodically (such as during annual inspections) to ensure proper function. Repeated use of circuit breakers as ON/OFF switches, however, is not recommended, as it can damage the internal contacts and lead to premature failure.

breaker to prevent it from being reset) and placarded “inoperative”; and (iii) an appropriately rated and certificated mechanic or pilot determines that the inoperative instrument or equipment does not constitute a hazard to the aircraft. An implied but essential part of this determination is to truly understand what the root problem is, and not just what the symptoms have been.

Talk to your mechanic or maintenance facility about assisting with your aircraft’s routine inspections and maintenance. It’s a perfect opportunity to become more familiar with your airplane and its electrical system. Aircraft owners should routinely interact with maintenance personnel and attend programs or seminars sponsored

Short Circuits

A tripped circuit breaker creates an “open circuit,” cutting off the flow of electricity. A “short circuit,” on the other hand, means electricity is flowing along a *different* path than the one intended. Electric current is constantly trying to find the easiest pathway back to its source. Whatever opportunity it finds, it will take—and that often means arcing between an exposed or damaged wire and a different circuit, or directly to a ground source, such as the aircraft structure. When this happens, huge amounts of current are effectively “pulled” through the wire, exceeding its rating, damaging it, and possibly starting a fire. The aircraft is now unairworthy.

by aircraft type clubs, maintenance experts, or the FAA. The AOPA Air Safety Foundation’s *Aging Aircraft* (www.asf.org/agingaircraft) online course is an excellent resource to help aircraft owners recognize and mitigate the risks associated with aging aircraft.

Know Your Electrical System

A basic understanding of the electrical system in your aircraft, and the ability to recognize abnormal conditions, is invaluable in the event of an electrical failure or fire. Although electrical systems vary, in most light GA aircraft the basic design is the same: Electric current flows in a circular path from the battery through the switch, wiring, and components, and then back to the battery through the ground connection. The amount of current drawn through each circuit varies depending on which component is being powered.

Aircraft electrical systems are designed with circuit breakers or fuses that are intended to *protect the wiring* (not a particular electrical device) by opening the circuit in the event of a current overload. Under normal conditions the circuit breaker keeps the circuit energized, allowing an electrical ON/OFF switch to power the component by manually opening or closing the circuit. A circuit breaker with a slightly lower rating than its associated wiring is used so that the breaker will automatically open the circuit (i.e., “pop”) before the rating of the wire is exceeded and it overheats.

Common Aircraft Wiring Problems



Damaged or overheated wires or connections



Insufficient clearance between wires, terminals, bus bars, or aircraft structure



Unsupported wiring with excessive tension at connections



Wiring that has been saturated with oil, hydraulic fluid, or other lubricants

Tip

Repeatedly resetting tripped circuit breakers can lead to extensive wire damage, ultimately resulting in a fire. Again, wire damage is cumulative.

Damaged wiring may cause an electrical fire by serving as an ignition source for surrounding materials such as fabric, oil, fuel, or other contaminants. On older aircraft, the wiring insulation could sustain a fire—and it may continue to burn even after the circuit breaker has tripped. In addition to flames, the smoke from the insulation or surrounding materials may be toxic and incapacitating.

Resetting the circuit breaker allows the circuit to be reenergized when the component switch is turned on. Be familiar with which circuit breakers are considered essential for safe flight or landing and may be reset if necessary. If these are not marked, label them for quick reference in the event of an electrical fire. Most recently built airplanes identify certain circuit breakers with collars. Other breakers should not be reset without determining the cause.

As aircraft age, both chronologically and in terms of flight time, many factors can affect their “true age”—and, in turn, the condition of their wiring. With the average GA aircraft nearly 30 years old, and many classic aircraft still flying past the age of 50, the condition of aircraft wiring is often given less attention than it really deserves. See the photos above for examples of problems to look out for.

Once a problem is identified, report it to your mechanic and ground the aircraft until it has been thoroughly inspected and repaired.

Summary

In the event of smoke or electrical fire in flight:

- Fly the aircraft and stay calm!
- Advise ATC.
- Turn off electrical switch(es), pull circuit breaker(s) of affected components or systems.
- Do NOT reset nonessential circuit breakers.
- Prepare to land as soon as practical.
- Be *sure* that wiring has been inspected and defective items have been repaired or removed before operating the aircraft again.



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