AIRCRAFT USE AND SAFETY HANDBOOK

FOR SCIENTISTS AND RESOURCE MANAGERS

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DEVELOPED BY THE

UF UNIVERSITY *of* FLORIDA

ABOUT THE AUTHORS

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Dr. H. Percival Franklin is Courtesy Associate Professor and Unit Leader of the Florida Cooperative Fish and Wildlife Research Unit. Its employees and cooperators, regardless of employment, are bound by strict aircraft training and use regulations of the Department of Interior. Dr Franklin has been a strong proponent of aircraft and other safety issues in the workplace.

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Terms in **bold type** are defined or explained in the Glossary.

DOCUMENT OBJECTIVE

This document is meant to impart safety-related information to those now using, or intending to use, small aircraft for scientific research or resource management. It provides guidance in the selection of aircraft, vendors, and pilots, as well as important safety considerations before, during, and after flights.

DISCLAIMER

No document of this size can exhaustively cover all the factors affecting mission safety. The reader is encouraged to learn more about aircraft, airspace, and weather limitations, as well as resource survey techniques. A select list of references is provided in Appendix A.

The final responsibility for the safe operation of any aircraft rests with the pilot-in-command. Still, project leaders must work cooperatively with pilots, aircraft owners, mechanics, and airport personnel to ensure crew members fully understand—and continually work to minimize—the inherent risks of fight.

JUSTIFYING THE USE OF AIRCRAFT

Flight Risks

The advantages of using aircraft as observation platforms or for transportation to isolated areas are readily apparent to most scientists. Certainly, some research objectives can only be achieved through their use and small aircraft have proved instrumental for an assortment of survey and monitoring programs. Nevertheless, such flights also constitute one of the most dangerous things scientists, resource managers, and students do. They are often conducted close to the ground, at slow airspeeds, over relatively remote terrain, and may require steep turns or other special maneuvers. For these reasons, aircraft accidents remain the number one work-related cause of death for field biologists.

If not already established, we recommend every organization using aviation services form an in-house aviation safety committee to create and oversee safety protocol. Project leaders should also check with their organization's financial and legal advisors regarding payment options, insurance requirements, and liability concerns. For safety and liability reasons, only mission-critical personnel should be permitted in the aircraft.

Alternate Methods of Data Collection

Because of the risks inherent in the use of small aircraft, project leaders should consider all alternate methods of data collection. Those needing to follow the movements of radio-tagged animals, for example, might calculate whether their study subjects can carry somewhat larger **satellite (GPS) transmitters**. For photographic images, the internet can help locate existing private- and government-generated photography or photographic services. Unmanned aerial vehicles (small, GPS- or remote-controlled airplanes and helicopters) are becoming more capable of providing a reliable and safe platform for photographic missions. When, as in some survey flights, one or more observers are needed in the air, investigators should check to see if flights and personnel might be shared with other projects or organizations working in the same geographic area.

AIRCRAFT SELECTION

Once other alternatives have been ruled out, project leaders must select the type of aircraft best suited for their needs. The two categories of aircraft most used for aerial observations or tracking are small, **piston-engine**, **fixed-wing** aircraft (airplanes) and piston- or **gas turbine-engine, rotary-winged** aircraft (helicopters). For transporting research teams and gear to remote airports, **airstrips**, or **landing zones** ("point-to-point" missions), larger aircraft may be required.

Airplanes have several advantages over helicopters. The first is cost. A typical 4-place Cessna 172 with pilot will rent for around 180 – 240 USD/hr (2010). By comparison, a helicopter with the same capacity will cost between 500 – 800 USD/hr depending on the model (piston engine or turbine). Other advantages relate to sound and vibration. Fixed-winged aircraft are generally quieter and smoother than helicopters, a consideration for aerial photography, using binoculars, wildlife disturbance, and radio tracking.

Helicopters, obviously, have advantages all their own. Most notably, they are capable of hovering flight and thus able to take off from, and land in, relatively confined and/or **unimproved** landing zones. They are also able to fly over observational targets with little or no forward **airspeed**. This can be important when focusing on individual targets such as a single bird nest or radio-tagged panther, or closely evaluating a particular habitat component for more than a few seconds.

Fixed-winged Aircraft

The choice of airplane depends on both the mission and the load. Those used for photography or surface observations are generally of the **high-wing** type to maximize ground visibility, with Cessna and Maule being the predominant U.S. manufacturers. Piper Cubs are used in some areas, but because of limited carrying capacity and power, we do not recommend their use. The Piper Super Cub, although still only a 2-place aircraft, is more powerful and can be used safely in many applications.

The Cessna 152 is a 2-place aircraft designed primarily for flight training and, because of its limited power, rarely used for other commercial flights. We do not recommend the 152 for flights requiring special maneuvers (e.g., steep turns, circling, altitudes below 500 ft **above ground level [AGL]**) or flights to or from short airfields.

The Cessna 172 is the most commonly used airplane for biological research. It is capable of carrying a pilot and up to 3 passengers, but when low airspeed or special maneuvers are required, we recommend no more than 2 passengers (and limited gear) be carried. The same is true of the Maule piston-engine aircraft.

The Cessna 182 is more powerful yet and can accommodate a pilot and 3 passengers at lower altitudes with relative ease. When over-water operations (flights beyond gliding distance from shore) require the use of floats, or when flying at altitudes over 10,000 ft. **above sea level**, the Cessna 185, Cessna 205/206, and Maule turbine-engine models are preferred. These are also commonly used with **short takeoff and landing (STOL) kits** necessitated by airfield runways shorter than those typically found at most airports. STOL kits might also be requested where minimum airspeeds (lower **stall speeds**) are needed. The Cessna 210 is a 6-place aircraft with retractable gear. For even greater carrying capacity, the **turboprop** Cessna Caravan or Pilatus PC-6, also available with STOL capabilities, might be the best options. For extended over-water operations, we highly recommend a multi-engine aircraft such as the Cessna 337 or larger DeHaviland Twin Otter.

There are certain factors which might tempt project leaders to consider the use of ultralight or light sport aircraft. In addition to being transportable via trailer, these types are generally less expensive to operate; takeoff, land, and stall at lower speeds; and often provide a high degree of visibility compared to general aviation aircraft. Because of the multitude of designs, the fact that many are home-built from kits, and most are classified as "experimental," their safety record is not well documented. Furthermore, except for certain applications (e.g., training, aerial tours), these light aircraft are generally not permitted to conduct commercial operations. We therefore do not recommend their use for research or management applications. If no other options are available, twin-engine models such as the AirCam and those with optional ballistic recover systems (whole-aircraft parachutes) can provide some additional margin of safety. Check with your organization's legal advisor regarding insurance and liability.

Rotary-winged Aircraft

Due to higher costs of operation, insurance, and training, helicopters and their pilots are more expensive to hire and typically less available. For most research and management (R&M) applications, 2- or 4-place helicopters are the most economical and efficient sizes. Manufacturers include Schweizer, Robinson, Enstrom, Eurocopter, Bell, and MD (formerly McDonnell Douglas). Like small airplanes, small helicopters are more susceptible to wind gusts and generally take more skill to fly in most weather conditions. They may be powered by either piston or turbine engines—turbines being more expensive to purchase and operate, but also more powerful and reliable. The Robinson R22 is a popular 2-place, piston-engine model. Because of its modest power and useful load, however, we do not recommend its use. The Schweizer/Hughes 300C is more powerful and can carry a single passenger (though very little gear) with a somewhat greater margin of safety. The Enstrom 280FX and F28F are powered by turbocharged piston engines and carry a pilot and 2 passengers. The Robinson R-44 is a 4-place model but, like the Cessna 172, we recommend no more than 2 passengers and limited gear for optimal performance.

Turbine-engine helicopters include the 2-place Schweizer 333 and the 4-place MD 500 series (C, D, E), the more powerful 530F, and the no-tail-rotor ("Notar") 520N. The Enstrom 480 and Eurocopter EC 120 can accommodate up to 4 passengers, and the Bell 206 Jet Ranger and Long Ranger can carry 4 to 6 passengers, respectively. Note that all helicopters flying over-water operations must be equipped with floats. Also be aware that a helicopter's performance is negatively impacted by warm temperatures and high altitudes—both contribute to reduced air density. Keep in mind that rotors are difficult to see when in motion and extremely dangerous to anyone who might come into contact with them. When the engine is powered up, never approach a helicopter from the rear or from higher adjacent ground, always wait to get an approach signal from the pilot, and always crouch when boarding and disembarking small helicopters.

Project leaders should either hire an experienced commercial pilot as a consultant—preferably one with research or management flight experience—or confer with potential leasing agents well before budget estimates are finalized. They will help determine the most efficient and safest aircraft capable of meeting their specific flight objectives. Other factors to consider, besides range, include special instrumentation like GPS receivers, radios, and radar altimeters, and equipment such as camera mounts, amphibious floats, and cargo pods.

FIXED-BASED OPERATORS (AND OTHER AIRCRAFT SERVICE PROVIDERS)

Fixed Base Operators (FBOs) are private, aircraft- or air cargo-related companies typically located on or close to civil airports or airstrips. Most aircraft renters operate their own FBOs or work closely with an FBO owner. The National Business Center's Aviation Management Directorate (AMD, sometimes referred to by its old acronym, OAS, for Office of Aircraft Services; http://amd.nbc.gov/) provides cooperating agencies with a list of approved providers, aircraft, and pilots. Federal agencies (e.g., FWS, NPS, USGS, and BLM) are required to use aircraft and pilots with the more stringent AMD certifications and inspection schedules. Although other organizations are typically not obligated to use them, if such aircraft are available in your area, we believe the higher safety standards more than justify any additional costs. Of course, this does not mean that non-AMD certified aircraft cannot be operated as safely, or even more safely, that those that are.

Aside from the type of aircraft they have available, one obvious consideration when selecting an FBO is its location. Investigators typically attempt to depart from an airport close to their study area to minimize flight time and cost. If ground travel to such an airport is especially difficult or time consuming, an FBO near the researcher's office or residence might prove more cost efficient.

A second factor concerns the number of aircraft and pilots available at a particular FBO. Aircraft must be periodically serviced. They occasionally have mechanical failures and they (and their pilots) can be stranded at other airports due to weather. The more frequent or time-sensitive the flights, the more aircraft and pilots an investigator or manager would want available. If the preferred FBO has only one plane and pilot, for example, users are wise to make arrangements with a second (or even third) FBO as backup. Project leaders should also consider an FBO's relationship with their certified aircraft mechanic. As with planes and pilots, frequent and time-sensitive flights will necessitate greater access to their services.

Renters must be aware of competition for both an FBO's aircraft and pilots, as well as the "pecking order" of potential users. An understanding (or better yet, a written agreement) should be reached concerning whose flights have priority when schedules conflict, especially after a flight cancellation or delay.

Finally, an inquiry should be made into the FBO's accident/incident history, as well as any FAA citations that might relate to the airworthiness of its aircraft or competence of its pilots. Any hesitation by the FBO owner or staff to fulfill such a request for information should be considered a red flag and other options should be investigated.

PILOT SELECTION

As important as the selection of aircraft is the selection of pilots. To carry passengers for hire, the Federal Aviation Administration (FAA) requires pilots to have commercial certification. Pilots with an additional AMD certification are more regularly tested to ensure they have the prerequisite flight time and skills needed to safely operate the aircraft throughout the flight. Beyond general competence, AMD-approved pilots are further certified, or "carded" for "special use" flights which entail higher-risk maneuvers (e.g., steep turns, mountain flying) or altitudes less than 500 ft AGL. Again, as with airplanes, many exceptional pilots do not hold AMD credentials. In either case, be sure to review the pilot's license, medical card, and (if applicable) AMD certification prior to establishing a relationship with the aircraft owner or FBO. Good pilots expect such examinations. If a pilot seems put-off by such a request, think twice about hiring his or her services.

Beyond a pilot's technical qualifications and availability, researchers should also consider his or her behavior and disposition. Pilots, for example, are trained to follow preflight checklists. If they skip such safety procedures or are constantly distracted by personal or other matters, strongly consider asking for an alternate pilot. Similarly, pilots who seem uninterested in your mission plan or are slow to communicate problems regarding the aircraft or weather may not have your best interests at heart. If your research involves repeated flights requiring special equipment or flight maneuvers, constantly changing pilots can prove problematic. It's important, then, to interview all of the FBO's pilots before establishing long-term relationships. That said, even after taking several flights with one pilot, investigators should never hesitate to request another who is more in tune with their research or management objectives, as well as safety concerns.

KNOW YOUR AIRCRAFT

Although pilots remain the final authority with respect to flight safety, passengers can also contribute to this effort. Pilots, after all, are human. They do not operate without error and cannot perceive every potential hazard. Good pilots are always open to sincere concerns or questions relating to aircraft condition, flight operations, or other safety issues. Researchers and managers should acquire a basic understanding of flight theory and some general knowledge of their aircraft's components, maintenance requirements, instrumentation, and flight limitations. Investigators can learn about specific models of aircraft from online sources or by purchasing operating manuals from manufacturers, online stores, or FBOs.

Mechanics of Flight

Most aircraft attain flight by moving a specially-shaped **airfoil** through the air—either the fixed-wings (and fuselage) of a forward-moving airplane or the spinning rotor blades of an otherwise unmoving helicopter. An airfoil produces lift (or thrust in the case of a propeller blade) as a function of its shape. As the airfoil is pushed through the air, half the air moves over the top, curved portion of the wing or blade and an equal amount moves over the lower, less curved portion. Because air flowing over the top travels a greater distance, air molecules are pulled apart from each other. This is similar to the air in a closed syringe being stretched apart when the plunger is pulled upward: the same amount of air, in an increased volume results in lower air pressure within the syringe. This area of low pressure in a syringe can "draw up" whatever fluid is below it. Similarly, the lower air pressure above a wing or rotor blade can draw it up into the lower pressure area just above it. This upward force is referred to as "**lift**." Below a minimum forward or rotational speed, wings and rotors begin to lose lift and the aircraft eventually succumbs to gravity.

A special condition affecting the flight of airplanes is the **stall**. Stalls occur when the loss of smooth airflow over the wing results in a rapid loss of lift. It can occur, obviously, at low speeds, but also at higher speeds if the aircraft is pitched upward such that the smooth flow of air over the top surface of the wing is disrupted. Stalls also occur at higher speeds with increased bank angle, so researchers should refrain from requesting steep turns unless the aircraft is moving well above that for straight-and-level flight. The same effects occur when flying at higher altitudes—this time as a result of lower air density.

Airplanes are designed (and pilots are trained) to avoid stalls and, if a stall does occur, to recover from it. However, a stall always results in some loss of altitude. Furthermore, if a plane is overloaded, or if passengers and cargo are placed too far aft, a recovery may be more difficult or even impossible. For this reason, pilots should conduct **weight and balance calculations** before every flight. Researchers and managers need to be aware of the stall speeds (in various flight attitudes and altitudes) for the airplanes they use and work with their pilot to develop protocols that ensure a generous margin of safety during takeoff, landing, and all required maneuvers throughout the flight.

Airframe, Instruments, and Avionics

While owners, pilots, and mechanics all possess principal responsibility for the condition of the aircraft, researchers should be knowledgeable enough to recognize obvious problems with engines, **airframes**, and instrumentation. Although pilots conduct preflight inspections of the aircraft, passengers can provide an additional level of safety. They should know the basic components of the power plant and airframe so that they can communicate with the pilot about potential points of mechanical failure. For example, passengers should take note of debris in the aircraft's tie-down area that might be drawn into propellers, rotors, or landing gear. They should scan the ground for signs of leaking fluids and look for physically damaged or loose components on the fuselage or **control surfaces**. And they should check for loose items in the cabin that might interfere with rudder pedals or other control mechanisms. Anything that seems the least bit unusual or out of place should be brought to the pilot's attention.

Field crews should also have a general familiarity with the operational limits of the aircraft in which they fly and the instruments that provide critical data to the pilot. They should at a minimum know weight, altitude, airspeed, and flight duration limits, and should be familiar with the **flight instruments** that indicate attitude, airspeed, altitude, direction, and fuel reserves. They should be instructed how to use the on-board radio to request emergency assistance and how to set the emergency code 7700 on the **transponder**. For a good overview of flight principals and **avionics**, we highly recommend the **AOPA** Air Safety Foundation's Pinch-Hitter® manual and video (See Appendix A).

Pilots should provide passengers a complete safety briefing before each flight. This includes the identification of hazards such as propellers and main/tail rotor blades; the operation of doors, seats, and safety harnesses; as well as the location of fuel cutoff switches, fire extinguishers, first aid/survival kits, and **Emergency Locator Transmitters** (ELT).

KNOW YOUR ENVIRONMENT

In addition to the aircraft, researchers should be familiar with the region over which they are flying. This includes the study area itself, but also surrounding airspace and airports. Factors to consider include terrain and vegetation cover, **controlled, restricted, and prohibited airspace**, potential hazards to flight (towers, buildings, power lines, birds colonies, etc.), and emergency landing/refueling sites.

Pilots generally carry **sectional charts** that contain information about topography, navigational aids, airspace delineations, and airports. Investigators and passengers should become familiar with the basic components of these maps. Google Earth and other aerial photography can provide additional information about vegetation cover and potential landing zones. Beyond the aircraft's own navigational aids, we strongly recommend the front seat observer carry additional maps or photographs and at least one preprogrammed handheld GPS receiver. These can serve as redundant sources for navigational data, but also can show survey paths, record search tracks in real time (as when radio-tracking), determine the most direct path to predetermined target locations (e.g., bird colonies, landing zones), and indicate hazards to flight (e.g., radio towers). An initial **reconnaissance flight** over the study area is highly recommended at the start of any new project, especially if low-altitude flying will be required during data collection. Apart from making your mission more productive, such a flight can identify suitable emergency landing sites in advance of a potential need.

Familiarity with the environment also includes keeping track of regional climate patterns and daily weather forecasts. (A good online source includes http://www.weather.gov/.) Weather and terrain affect visibility, **cloud ceiling**, and air turbulence, and winds can influence maximum and minimum **ground speed**. Research and management flights are almost always conducted under **Visual Flight Rules** (VFR) rather than **Instrument Flight Rules** (IFR), thus certain minimum weather conditions are dictated by the FAA.

Altitude, climate, and weather, along with terrain, must also be taken into consideration when choosing clothing and survival gear.

Principal investigators should inform their pilots and research crews at the beginning of the project the weather conditions required to successfully complete their mission. Pilots, in turn, need to explain how the weather affects aircraft performance and flight safety. If either the pilot or passengers are not comfortable with the current or anticipated weather conditions, the flight should be postponed or aborted. Always err on the side of caution.

KNOW AND PLAN YOUR MISSION

Planning is an important part of maximizing safety. Scheduling flights with sufficiently advanced notice will reduce conflicts with other FBO clients. Clearly communicating each mission's objectives and parameters (such as route, altitude, ground speed and flight duration) with the pilot minimizes airtime and can reduce both cost and risk. Be sure to allow for additional time prior to the start of each flight for these pilot briefings. For complex flight itineraries, a consultation one or two days prior might be called for.

Developing equipment and safety checklists can help reduce takeoff delays. Maintaining lists containing target locations, airport communication info, telemetry transmitter frequencies, and other pertinent information help make flights more efficient and productive. Carrying backup batteries or memory cards for all your electronics and cameras could prevent flights from being prematurely terminated. Even something as simple as packing extra motion-sickness pills, pencils, data sheets, or **headsets** might be the difference between a flight's success and failure. It may help to designate one crewmember to be responsible for organizing and maintaining all flight-related gear.

FLIGHT/OBSERVATION TECHNIQUES

Once in the air, investigators can adopt techniques to both increase productivity and reduce risk. A search of the available scientific literature can provide a starting point from which flight protocols might be developed. Locate and talk to other scientists and pilots who are doing similar work in similar habitats. Surveys, for example, can be more efficient at certain altitudes or groundspeeds. Transect widths need sufficient overlap to ensure full visual coverage. Photography might be better with particular cameras or under certain light conditions, and telemetry results can depend on search pattern and altitude. Whatever the chosen technique, investigators and pilots need to work together to minimize low-altitude, low-speed and/or high-bank-angle flying; all these greatly increase the likelihood of potentially catastrophic stalls. Every pilot and every crew member needs to be aware of the standardized practices before leaving the ground and the consequences of deviating from them. Whenever research or management objectives interfere with the safe operation of the aircraft, safety must always take precedence.

Researchers and managers should also understand that pilots must be just that—pilots. They should never be solicited to act as supplemental observers. Numerous accidents have been attributed to pilots whose attention was taken away from flight control, navigation, and airspace monitoring. This is especially true when circling a target animal or location in a fixed-wing aircraft. Monitoring **flap** position, altitude, airspeed, and bank angle is a full-time job and critical if the pilot is to avoid a stall.

Additional Reductions of Risk

Training

In most work-related activities, advance training will prove to be the difference between success and failure. In the case of flying, that can mean the difference between life and death. We strongly recommend aircraft users and managers take, at a minimum, the AMD online safety training modules that comprise the B-3 Combination Helicopter/Airplane Safety Course. These cover a wide variety of safety-related subjects. Additional modules in the Basic Aviation Skills section, including "Overview of Aircraft Limitations and Use" and "Aviation Radio Use," will likely also be of value.

Several "hands-on" training courses will also increase user safety. When flying is done primarily over water, we recommend an aircraft ditching course (plane and/or helicopter) and, if applicable, a coldwater survival course. For those who fly the front (copilot) seat on a regular basis, consider investing in a "Pinch-Hitter" course, one in which non-pilots can get enough flight training to navigate the aircraft to an airfield and land it safely should the pilot become incapacitated. "Heli-Pal" courses provide similar levels of training for helicopter users. While this type of instruction (both video software and certified pilot instructor) requires time and money, it could prove invaluable in this rare, but extremely serious, emergency situation.

In the event of a crash or forced landing, every crewmember would benefit from basic wilderness survival and first aid courses. Indeed, this sort of training should be considered essential for all employees who work in remote areas or with dangerous equipment of any kind.

We list some sample training courses in Appendix A and encourage readers to gather additional information online.

Protective Clothing and other Gear

Clothing worn during a flight needs to be both comfortable and protective. DOI employees are required to wear specific gear when flying special use missions. These include flame-resistant Nomex® flight suits and gloves, over-the-ankle leather boots, and an approved flight helmet. Anyone flying for any period of time below 500 ft AGL would be well-advised to purchase and use these protective items. There are a number of online sources.

We strongly concur with the DOI that only natural fiber clothing be used otherwise. Commonly worn synthetic fabrics will melt and adhere to the body when exposed to flash fire. This rule applies to socks as well. Clothing should be relatively loose-fitting and comfortable. Long pants at a minimum and, if at all practical, long-sleeve shirts will offer the most protection. Boots should be leather unless crews are planning to exit onto wet ground conditions. Baseball caps are often useful in shielding eyes from direct sun, especially to those flying in the front seat. Sunglasses are considered essential gear by most flyers, but be sure they have a cord or strap to prevent loss. If the aircraft does not come with headsets for the intercom system, be sure to purchase several and make one available to each crewmember.

Many aviation users make a point to carry basic tools and small first aid kits in their pockets or fanny-pack. This ensures their availability after a forced landing in the event other aircraft contents are lost to fire or deep water. Multi-tools and knives are versatile and relatively compact, as are small flashlights and magnesium fire starters. Nylon cord, reinforced tape, and emergency/survival blankets also require minimal pocket space. A reasonable amount of nonperishable food can prove valuable. And a waterproof bag to store a cell phone and GPS would also be important to keep at hand. Because smoking is generally prohibited in small aircraft, heavy smokers should consider carrying nicotine replacement gum. A list of useful items is found in Appendix B.

Filing a Flight Plan/Establishing Flight Following

There are additional precautions aircraft users can take to minimize the risks associated with flight. One of the most important is filing a flight plan. An “official” flight plan is a communiqué from the pilot to aviation authorities (typically **Flight Service Stations**) containing information about the aircraft, its destination, expected takeoff and landing times, proposed route, and number of passengers. “Unofficial” flight plans provide the same information to others who have an interest in the flight. These might include the project supervisor, the FBO operator, aircraft owner, and any others who would be able to contact the authorities in the event your aircraft becomes **overdue** or **missing**. Establishing a flight plan can greatly reduce the time between an emergency landing and the onset of a search mission. Give one person primary responsibility for monitoring a flight and contacting emergency agencies. Create a map containing regularly used flight paths and waypoints and, if possible, save it electronically (e.g., as a PDF or JPEG file). This map can then be distributed to various agencies via fax or e-mail in the event of a search.

An even higher level of safety can be achieved through Flight Following. Flight Following involves either a constant or periodic update of an aircraft’s position with ground personnel throughout the duration of the flight. These updates can be done automatically with GPS-integrated electronics aboard the aircraft, or manually through periodic radio communications between the pilot and ground stations. A slightly lower-tech method is to send periodic text messages to those monitoring the progress of the flight—either to relay exact coordinates or to report reaching specific waypoints. Whichever the case, search and rescue missions can be initiated hours or even days earlier and might make the difference between life and death.

When a flight is delayed or cancelled, care must be taken to advise anyone who might initiate a search and rescue mission. In such cases, flight plans need to be promptly modified or withdraw. When the flight is successfully completed, researchers must remember to contact all parties to terminate the flight plan. Setting a phone/watch alarm or placing a note on a post-flight checklist, on an equipment case, or in ones vehicle can serve as a good reminder.

Weather tracking

Many regions experience rapid changes in weather that can affect flight success and safety. Researchers and managers should make every effort to track weather forecasts in the days and hours leading up to a scheduled flight. Whenever possible, flights should be scheduled for portions of the day with the most stable and predictable air, typically the early morning. Most aviation radios can “dial in” weather reports from local FSS or airport locations throughout the duration of flight. Some aircraft possess avionics that can display real-time weather graphics, and there are now portable cell phones and GPS receivers that can access similar data from satellite sources.

Looking Out for Air Traffic and Birds

Although rare, mid-air collisions are often catastrophic. All passengers need to be vigilant and communicate with the pilot about potential hazards whenever they are unsure of the pilot’s awareness. Vultures, geese, and other large birds can do substantial, sometimes fatal damage to small aircraft. Most pilots welcome respectful attempts to confirm they have other aircraft or birds in sight. Crewmembers should talk with their pilot about when and how to best inform him or her of such dangers.

Securing/Handling Aircraft Contents

Researchers who use aircraft typically bring with them an array of equipment, data logs, and writing instruments. Though essential to the work, such items can prove dangerous if allowed to move unfettered within the **cabin**. Stowing and securing each item—be it survival kit, equipment case, notebook, or camera—is essential to the safe operation of the plane or helicopter. Loose items tossed by turbulence can interfere with flight controls such as rudder pedals, break flight instruments, injure the pilot, and even damage the aircraft itself. In a crash landing, binoculars, telemetry receivers, and laptop computers can become deadly projectiles. Heavier items can affect the weight and balance within the aircraft and must be placed and secured with added attention.

To minimize such problems, unnecessary equipment should be left on the ground and care should be taken with everything brought on board. Pens and pencils should be attached to notebooks with string or Velcro. GPS receivers should be tied or taped in place. When in doubt, ask the pilot for advice on stowing and securing necessary equipment. Hazardous materials that require special containers or handling are found in Appendix C. All should be brought to the attention of the pilot.

Additional care must be taken when equipment has access to the outside of the aircraft. Cameras and firearms, for example, must shoot through an open door or window. Telemetry antennas and associated wiring are often secured externally. In such instances, for the safety of both those in the aircraft and on the ground below, every effort must be taken to prevent the loss of such items.

Airsickness

While not a safety issue *per se*, airsickness can make flying an unpleasant experience at least, and at worst completely unproductive. Even those not particularly prone to motion sickness can succumb when using cameras, GPS receivers, notebooks, laptops, or binoculars in turbulent air or steep turns. Warm temperatures often increase susceptibility, so check with the pilot about opening windows or air vents. If possible, avoid looking down, writing, or reading during turns. Looking at a stable horizon for a few moments can sometimes help one's orientation.

Motion sickness preventatives like Dramamine®, Bonine®, Marezine®, Scopalamine®, and equivalent generic products are all in the same family of drugs, but often have different effects (and side effects) on different people. Many are quite helpful but must be taken 30-60 minutes prior to the flight in order to work. Most users experience some degree of drowsiness and a few will deal with stomach irritation. Non-drowsy formulas can reduce drowsiness slightly but may do less to decrease stomach nausea. Some preventatives are available in dermal patches that deliver their contents closer to the inner ear and may reduce side effects. These patches and other, more powerful drugs can be obtained with a prescription.

There are also non-drug alternatives to combat motion sickness. One type is the acupressure wrist band which has proved effective for some individuals when worn correctly. A variant of this technique is provided by ReliefBand®, a watch-like device which emits a mild electric charge to interfere with the nerves that produce nausea symptoms. Unlike drugs, it produces no side effects and can be helpful even after the initial onset of symptoms. Individuals who retain a high sensitivity to motion sickness should avoid flight duties if possible or consult with their physician about other defensive measures.

Even when preventative measures are taken, it is likely that one or more passengers will eventually succumb to airsickness. Some owners and pilots maintain a supply of airsick bags onboard, but passengers would be prudent to include suitable alternatives in their own equipment bags and keep them at hand during the flight. Resealable zippered plastic bags or elongated plastic bags that can be easily tied off would both be effective options.

Another means of reducing the stomach irritation associated with motion sickness or medication is to consume soda crackers periodically throughout the flight. These might not, by themselves, prevent illness, but by absorbing stomach acid, they can keep some flyers from taking that last unpleasant step. For those who do fall victim, crackers help cleanse the mouth and calm the stomach.

Limiting Unnecessary Conversation

Communicating with a pilot before, during, and after a flight is important, but in some instances casual conversations during flight operations can actually pose a hazard. Talking, particularly during **taxiing**, **run-up**, take-off, and landing may distract pilots from the critical tasks at hand. A good rule of thumb for passengers is not to speak unless spoken to anytime the aircraft is in motion within 10 nautical miles of an airport or landing site. These are the moments a pilot's attention needs to be on communicating with traffic controllers; looking out for, and speaking to, other pilots in the vicinity; and carefully monitoring his or her flight instruments. The exception to this rule, of course, involves conferring with the pilot about potential hazards to flight.

Emergency Communications

Flying can never be made risk free, so like it or not, researcher must always be prepared for **forced landings**. There are a number of options available in the realm of emergency communication—both low- and high-tech. Low-tech solutions include hand-held smoke and pyrotechnic flares, pistol-type flare guns, signal mirrors, fires, and flashlights.

There are also a variety of electronic devices capable of signaling for help. If the aircraft does not have a 406 MHz Emergency Locator Transmitter, portable units (Personal Locator Beacons; PLB) can be purchased from pilot supply catalogs. Hand-held, battery-powered **aviation radios** (sometimes referred to as NAV/COM radios or transceivers) can serve as a backups to damaged aircraft radios and make distress calls to overhead aircraft. Depending on the remoteness of one's study area, either cell phones or **satellite phones** could provide additional communication abilities. Once contact is made, the aircraft's GPS receiver or a handheld version can provide coordinates.

Given their relatively low weight and bulk, a combination of both low- and high-tech devices would seem important additions to any gear pack.

SURVIVAL PLANNING

The saying goes, "Hope for the best; plan for the worst." This is especially true when it comes to aviation. Proper equipment and training could, on any given flight, be critical to surviving a crash.

The first priority is stabilizing any injured personnel. Always carry a well-equipped and well-protected first aid/survival kit in the aircraft. All AMD-supplied aircraft are required to stow both such kits, but researchers need to check every time they fly and be prepared to step in to fill any void. These kits must also include first aid/survival manuals. Personnel should carry additional clothing such as rain gear or water survival suits to protect against environmental conditions once on the ground. Be cognizant of biotic hazards such as poisonous plants, biting insects, and large carnivores and be sure to pack any repellants needed to handle the potential encounters. In extremely cold weather, check with the pilot before bringing any type of stove fuel or burners on an aircraft. For most regions, a simple lighter or fire-starter is sufficient. For a more complete list of emergency items, see Appendix B.

The second priority is communication. Radios and phones should be accompanied by emergency contact frequencies (121.5 MHz; often radios have a dedicated key on this frequency) and phone numbers (in addition to 911). Field crews should also carry a laminated list of phone numbers for the FSS, home airport, FBO, and those conducting flight following services in the event of an unscheduled landing at another airport or airstrip. If flying over water, at least one phone should be kept in a waterproof case or bag at all times. A blank contact form and Flight Plan can be found in Appendix C.

Remember, search teams are much more likely to see a downed aircraft than people on the ground, so use the resources at hand and stay with the aircraft as long as possible. If for some exceptional reason that is not an option, try to leave information for the search and rescue team about your intended direction of travel and/or destination.

Flying Outside the United States

Flying in small aircraft outside the United States poses a unique set of challenges to researchers and resource managers. US Department of Interior policies do not apply outside the country, so additional scrutiny must be exercised both initially during the procurement process and subsequently during the actual flights. Because English is the universal language of pilots and flight controllers, most will, in theory, be able to understand English speakers. Still, having a command of the local language or a skilled translator will help ensure all communications are complete and effective.

Project leaders should conduct as much research as possible prior to selecting aircraft/pilot providers. Seek the recommendations of trusted colleagues and associates who have experience in that (or even an adjacent) country. Contact any pilots or pilot associations that may have information. Embassy personnel or the US Department of State also have experience traveling in various countries and might serve as intermediaries with service providers. Finally, one can check with commercial airlines or package delivery companies for any advice they can offer.

Once in country, many of the same considerations that factor into flight safety here also apply there. Ask to see the pilot's license. Inquire about his or her flight experience and accident history. Pay special attention to the condition of the aircraft. Check for leaking fluids and other signs of poor condition. Make sure operators are using blue-tinted 100-octane, low-lead "avgas" for their piston-engine aircraft and not lower octane, typically pink-colored auto gas. Look out for missing or broken instruments. Inspect maintenance records if at all possible. Be prepared to provide backup emergency communication and other safety/survival gear. In short, apply a healthy dose of common sense and always err on the side of caution.

In Summary

Airplanes and helicopters are remarkable tools to help advance research and management objectives. They offer observers a "bird's eye" view of the landscape. They move us quickly over difficult terrain. And they carry personnel and field gear to distant and remote locations. But along with their great promise comes the potential for great harm. Organizations whose employees use aircraft have a responsibility to ensure all reasonable efforts are made to reduce the inherent risks of flying. Researching and planning, informing and training, organizing and reviewing...all these steps are critical if we are to increase margins of safety. We owe it not only to our own aviation users, but to all those whose lives might be impacted by a failure to act proactively—other flyers, people on the ground, and the friends and family of everyone involved. Prevention must be paramount.

GLOSSARY OF TERMS

Above Ground Level (AGL) – the distance from the aircraft to the ground directly below it, measured in feet. (In aviation, all altitudes are measured in feet. Over 18,000 ft. in the U.S., altitude is given as "flight level"—an altitude based on a standard barometric pressure of 29.92 in.-Hg divided by 100. Thus 27,000' is FL 270.

Above Sea Level (ASL) – the distance above mean sea level. Below 18,000 ft, aircraft altimeters are adjusted to reflect their height above mean sea level. This universal standard allows a common reference for all pilots and aircraft control personnel communicating in a given airspace.

Airfoil – the cross-sectional shape of a wing or rotor blade that permits lift as a consequence of the movement of air over its surface. Airfoils differ depending on the desired lift/drag ratio.

Airframes – the entirety of the aircraft excepting the engine, flight instruments and propellers/rotors.

Airspeed – the speed of the aircraft relative to the surrounding air. Fixed-winged aircraft require certain minimum airspeeds to maintain enough airflow over the wing to produce adequate lift. Airspeed differs from ground speed depending on direction and strength of winds at the altitude the flight is being conducted.

Airstrips – runways with no or minimal associated infrastructure (as compared to Airports).

AOPA – Aircraft Owners and Pilot Association; an excellent source of aircraft- and safety-related information. http://www.aopa.org.

Aviation Radios – two-way radios for communicating specifically on aviation frequencies, typically 118 - 136 MHz. Such radios come in hand-held as well as in-panel designs.

Avionics – electronic instrumentation specifically designed for use in aircraft. These include units for communication, navigation, weather, aircraft systems management, flight following, and sometimes flight altitude and attitude.

Cabin – the part of the airframe interior designed to carry flight crew and passengers.

Cloud Ceiling – the lowest altitude of cloud cover defined as "broken" or "overcast." Typically, flights operating under visual flight rules must be conducted below this altitude.

Control Surfaces – movable parts of the airframe designed to adjust an aircraft's orientation during flight, typically ailerons, flaps, rudder, and elevator.

Controlled Airspace – airspace where traffic levels and movements necessitate clearance by air traffic controllers (ATC). Such airspace typically surrounds moderately- to heavily-trafficked areas around major airports and military installations.

Ditching – a force landing on water without the aid of floats or an amphibious hull.

Emergency Locator Transmitter (ELT) – a battery-powered radio transmitter designed to transmit distress signals exclusively on the emergency frequencies (for aviation applications) of 406 (or 121.5) MHz to initiate and aid search-and-rescue efforts. ELTs mounted in aircraft are designed to activate automatically as a result of moderate to severe impact, as well as manually.

Fixed-wing – a type of aircraft with that includes airplanes, but excludes lighter-than-air aircraft, paragliders, and rotary-winged helicopters and gyrocopters.

Flaps – movable extensions of the wing's trailing edge that can be lowered to increase drag and lift.

Flight Instruments – mechanical or electronic devices designed to indicate essential flight, navigational, and mechanical information. These include aircraft altitude, speed, direction, and orientation, and engine variables such as RPM, oil pressure, and fuel supply.

Flight Service Stations (FSS) – an air traffic facility that provides traffic, airspace, and weather information to pilots prior to and during flights. These are different from control towers which are associated with airports and provide flight clearances and directly manage the movements of air traffic in their vicinity.

Forced Landings – an unplanned landing that results from mechanical failure, lack of fuel, extreme weather, in-air collision, or some other hazard to normal flight. Forced landings are typically off-airport and thus risk damage to the airframe and injury to the pilot and passengers.

Gas Turbine (engine) – a rotary engine that creates thrust through the continual flow of combustion gases and compressed intake air.

Ground Speed – the speed of an aircraft relative to the ground. Ground speed can affect mission parameters such as observation time, photograph clarity, and flight duration.

Headsets – headphone/microphone combinations designed for communications within the aircraft, as well as between the pilot and other aircraft, traffic controllers, and airport personnel.

High-wing – a design of airplane where the wing is attached to the top of the fuselage/cabin. High-wing planes permit relatively unobstructed views of the ground. Contrast with low-wing airplanes where the fuselage is above the wings.

Instrument Flight Rules (IFR) – regulations and procedures applied to aircraft flying with reference only to instruments and navigational aids onboard the aircraft. Contrast with Visual Flight Rules (VFR) where the pilot must have visual contact with the ground and significant horizontal visibility.

Landing Zones – typically refer to areas intended to accommodate helicopter takeoffs and landings.

Lift – any force acting on an aircraft that tends to move it away from the ground, but typically the upward force acting on an airfoil as it moves through the air. The force of lift must exceed the force of gravity to maintain or increase the altitude of a flying aircraft.

Main Rotor Blades – the large, horizontally-oriented blades position atop a helicopter. These are often difficult to see when in motion and extremely dangerous to anyone who might come into contact with them. For this reason, never approach a helicopter from higher adjacent ground when the engine is powered up, always wait to get an approach signal from the pilot, and always crouch when boarding and disembarking small helicopters.

Missing – as it relates to an aircraft, one that has been reported "overdue" and either cannot be contacted/located by any (FSS) ground station or has exceeded its maximum flight duration.

Overdue – as it relates to an aircraft, one that exceeds its predetermined radio contact period or estimated landing time.

Piston-engine (aircraft) – one that is powered by a reciprocating piston engine (rather than gas turbine). Most small (< 6 passenger), civilian airplanes are of this variety.

Prohibited Airspace – airspace in which flight operations are prohibited. These often include areas of military, aerospace, and national security concerns.

Reconnaissance Flight – a flight designed to familiarize the pilot and/or researchers with the study area, including terrain, ground cover, hazards to flight, alternate airfields or landing zones, and the distribution of any objects of interest.

Restricted Airspace – airspace in which flight operations are restricted. Such restrictions may be permanent or temporary in nature.

Rotary-winged – a type of aircraft in which lift is generated by moving rotor blades, as on a gyrocopter or helicopter.

Run-up – a check of engine and flight instrument performance conducted just prior to take-off. The term refers to a "run-up" of engine RPMs.

Satellite (GPS) Transmitters – in this context, a transmitter designed to be fitted to an animal and capable of autonomously determining its position using GPS satellites. These location (and sometimes biometric) data are then transmitted via communication satellites or ground stations for scientific analysis.

Satellite Phones – a phone capable of two-way calling via communication satellites. Although more costly to purchase and use than standard cell phones, "sat" phones are not reliant on standard cell tower feeds and thus effective when operating in very remote locations.

Sectional Charts – maps designed for visual navigation of slow- and medium-speed aircraft. They contain topographic information and visual references such as rivers, railroads, major roads and other distinctive landmarks. They also include locations of airports, controlled and restricted airspace, and major obstructions to flight (e.g., radio towers).

Short Takeoff and Landing (STOL) Kits – modifications or additions to the airframe (typically the wing) or engine that allow for shorter-than-normal takeoffs and landings.

Stall – the (often sudden) loss of lift resulting from a disruption in the smooth flow of air over the top surface of the wing or rotor. Stalls can occur when airspeed is reduced below a minimum required rate, when the bank angle is substantially increased, or when the wing/rotor is pitched up relative to oncoming airflow. With proper thrust and attitude control, stalls can be recovered from, but always result in some loss of altitude. For this reason, stalls initiated at low altitudes can sometimes prove catastrophic.

Stall Speed – the airspeed at which an aircraft (typically an airplane) will stall. Stall speeds vary with aircraft design, weight and balance, bank angle, and air density. Most small airplanes have stall warning devices that indicate an impending stall. Stalls may also be preceded by a mild to moderate buffeting of the airframe.

Tail Rotors Blades – relatively small, vertically-oriented rotor blades fixed to the tail boom of a helicopter. These counteract the torque created by the main rotor blades (and thus keeping the helicopter fuselage from spinning in the opposite direction). Moving tail rotors are difficult to see and extremely dangerous to anyone who might come into contact with them. For this reason, never approach the aft region of helicopter when the engine is powered up.

Taxiing – the movement of an aircraft (under its own power) while on the ground or water. Typically, this refers to movements between the active runway and tie-down (parking) areas, hangers, terminals, or fueling areas.

Transponder – an electronic instrument on an aircraft that actively sends radar signals to ground controllers to more accurately indicate your aircraft on their radar screens. A 4-number transponder code of 1200 is typical for VFR flight in uncontrolled airspace. Flight controllers may request another code be entered to differentiate your transponder signal from other airplanes'. Entering 7700 indicates your aircraft is experiencing an emergency.

Turboprop – a power source consisting of a gas turbine engine attached to a propeller. Compare to piston-engine aircraft.

Unimproved – as it relates to landing areas, one in which little or no modifications have been made to mitigate potential dangers.

Visual Flight Rules (VFR) – regulations and procedures applied to aircraft flying with visual reference to the ground and significant horizontal visibility. Contrast with Instrument Flight Rules (IFR) where the pilot flies using only instruments and navigational aids onboard the aircraft.

Weight and Balance Calculations – those designed to ensure the total weight and distribution of passengers and cargo within the cabin allow for sufficient control. Overloaded or poorly balanced airplanes can result in the loss of lift, in-flight instability, and the inability to recover from a stall.

Appendix A

Online Resources (current as of January 2010)

Aviation Management Directorate (AMD) Flight Safety
https://www.iat.gov/Training/pages/online.asp

Aircraft Instruments
http://en.wikipedia.org/wiki/Flight_instruments

Ditching and Coldwater Survival
http://www.survivalsystemsinc.com/unused_pages/avcourselist.htm

Pinch-Hitter® Course
https://www.aopa.org/asf/osc/loginform.cfm?course=pinch_hitter&project_code=&

Heli-Pal® Course
http://www.palmbeachhelicopters.com/

AOPA International airport info
http://www.aopa.org/members/airports/pdfs/international_ops.pdf

Aircraft Supplies/Manuals/Safety Equipment
http://www.sportys.com/
http://www.skygeek.com/

Unmanned Aerial Vehicles
http://uav.ifas.ufl.edu/Home.html

First Aid Equipment
http://www.cpr-savers.com/principal/firstaidkits.html
http://www.skygeek.com/survival-kits.html

First Responder Info
http://www.wildmed.com/medical-professionals/wilderness-first-responder.html

APPENDIX B

SAFETY EQUIPMENT

(FROM DOI AGENCY LIFE SUPPORT EQUIPMENT HANDBOOK)

PERSONAL SURVIVAL/FIRST AID ITEMS (CARRIED IN POCKETS, VEST, FANNY PACK)

Fire Starter/Waterproof Matches
Laser Rescue Light/LED Light
Signal Mirror/Whistle
Nylon Cord (12')
Knife/Multi-tool
Water Purification Tablets
Sealing Clear Plastic Bags
Nonperishable Food for 1 Day (*continued on next page*)
Mylar Emergency ("Space") Blanket
Personal Locator Beacon/Cell Phone
Adhesive Bandages – Elastic Knit – 1" x 3"
Alcohol wipes (individual pouches)
Handkerchief or Bandana
Waterproof Adhesive Tape
Aspirin or Acetaminophen
Compress Bandage, 4"

AIRCRAFT SURVIVAL/FIRST AID ITEMS

Magnesium Fire Starter/Waterproof Matches
Laser Rescue Light
Signal Mirror/Whistle
Mylar Emergency Blankets
Knife/Multi-tool
Water Purification Tablets
Collapsible Water Container/Sealing Clear Plastic Bags
Large Plastic Trash Bags
Wire Saw, Axe, Hatchet, or Machete
Nylon Rope or Parachute Cord (50' minimum, 1/8" diameter)
Water (one quart/person, adjusted according to expected freshwater availability)
Food (2 days [7 days for Alaska] nonperishable emergency rations @ 1000 calories/person/day)
First Aid Kit
Survival Guide, Waterproof Paper, Pencil/Marker
At least one of the following: Automated Flight Following Equip., Satellite Phone, Personal Locator Beacon, Handheld UHF or VHF Radio

OTHER ITEMS TO CONSIDER DEPENDING ON ENVIRONMENTAL FACTORS

Flashlight/Batteries, Chemical Light Sticks
Signal Flares
Assortment of tackle (hooks, lines, sinkers, flies, plastic worms)
Collapsible Shovel
Insect Repellent/Head nets
Sunscreen/Sunglasses
Sleeping Bag (1 per 2 persons)
Inflatable Life Vests/Raft
Snowshoes
Survival Guide

APPENDIX C

HAZARDOUS MATERIALS

(FROM USDA/OAS INTERAGENCY AVIATION USER POCKET GUIDE)

Transportation of these materials by air is regulated by laws which require special containers, specific labeling, special handling, etc. The pilot must be notified of hazardous material before it is loaded on the aircraft. Common hazardous materials include:

Explosives ● Diesel Fuel ● Solvents ● Fuses ● Argon Bottles ● Propane ● Jet Fuel ● Kerosene ● Wet Cell Batteries ● Gasoline ● Aerosols ● Pressurized Containers ● Foam Concentrate

EMERGENCY CONTACT LIST

	Name or Agency	Phone #/Radio Frequency/E-mail
Flight Following	____________________	________________________________
Dispatcher	____________________	________________________________
Flight Service Station	____________________	________________________________
Fire	____________________	________________________________
Rescue	____________________	________________________________
Ambulance	____________________	________________________________
Air Ambulance	____________________	________________________________
Coast Guard	____________________	________________________________
Hospital	____________________	________________________________
Burn Center	____________________	________________________________
Poison Center	____________________	________________________________
Other Medical	____________________	________________________________
Airport or Site Security	____________________	________________________________
Police	____________________	________________________________
Sheriff	____________________	________________________________
Other Law Enforcement	____________________	________________________________
FBO/Rental Agency	____________________	________________________________
Aircraft Owner	____________________	________________________________
Project Leader	____________________	________________________________
Organization Safety Manager	____________________	________________________________
Other	____________________	________________________________
.	____________________	________________________________
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.	____________________	________________________________
.	____________________	________________________________
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FLIGHT FOLLOWING/FSS INFORMATION

Flight Plan Type	___________________
Aircraft Tail Number	___________________
Aircraft Type	___________________
Aircraft Color	___________________
Operator	___________________
Pilot's Name	___________________
Number Aboard	___________________
Departure Point	___________________
Departure Date/Time	___________________
Route	___________________
Destination	___________________
Estimated Time of Arrival	___________________
Fuel on Board (in Hours)	___________________
Last Contact (time, location, freq.)	___________________