U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Airmen Transition to Experimental or Unfamiliar Airplanes

Date: 3/30/11

Initiated by: AFS-800

AC No: 90-109

Change:

1. PURPOSE. This advisory circular (AC) provides information and guidance to owners and pilots of experimental airplanes and to flight instructors who teach in these airplanes. This information and guidance contains recommendations for training experience for pilots of experimental airplanes in a variety of groupings based on performance and handling characteristics. This AC does not address the testing of newly built experimental airplanes. The current edition of AC 90-89, Amateur-Built Aircraft and Ultralight Flight Testing Handbook, provides information on such testing. However, if a pilot is planning on participating in a flight-test program in an unfamiliar experimental airplane, this AC should be used to develop the skills and knowledge necessary to safely accomplish the test program using AC 90-89. This AC may also be useful in planning the transition to any unfamiliar fixed-wing airplanes, including type-certificated (TC) airplanes.

2. BACKGROUND.

a. Experimental Airplanes. The experimental airplane community is an important part of the civil aviation industry in the United States; some of aviation's greatest technological achievements were developed by amateur airplane builders. The amateur builder community is foundational to General Aviation (GA) in the United States (U.S.); however, recent trends in experimental airplane accidents have indicated a need for increased effort to ensure the preparation of pilots for the challenges of these airplanes. Historically, experimental airplane flight operations represent a small component of flight hours, but a significant percentage of GA accidents.

b. Examples and Data. For example, 2009 accident data indicated that while experimental airplanes are involved in approximately 27 percent of fatal accidents in the United States, they fly only 3.4 percent of the total GA fleet hours. This represents a nearly 8 to 1 ratio of fatal accidents per flight hour over the mainstream GA community. The predominant factor in experimental airplane fatal accidents is pilot performance, particularly in the transition phase to an unfamiliar airplane. While some increase in risk in experimental airplane flight operations might be acceptable to the GA community and the general public, in order for the recreational, educational, and experimental benefits of amateur-built airplanes to flourish, both the Federal Aviation Administration (FAA) and industry agree on the need for improvements in safety. Through collaboration between the FAA, GA, and amateur-built community, the recommendations developed in this AC mitigate some of the risks found in experimental airplane operations.

3. DEFINITIONS. The following are terms, defined for use in this AC.

a. Hazard. A condition or factor that has the potential to cause harm or damage.

b. Risk. The likelihood and severity of the harm or damage caused by a hazard.

c. Risk Mitigation. Controls implemented to reduce the likelihood and/or severity of the harm or damage caused by a hazard.

4. DISCUSSION.

a. Flight Standardization Board (FSB). The development of this AC used an existing model of risk management (RM) in airplane operations. In large and turbojet-powered airplanes, the FAA establishes a FSB; the FSB evaluates airplanes as they are completing their certification process to determine the specific requirements for training, checking, and operation in revenue service. The operations component of the FSB studies the airplane systems, performance, limitations, and procedures and flies the airplane to determine what requirements need to be established. The maintenance component of the FSB reviews the systems, structures, and powerplants to determine specific maintenance procedures, training, tools, and processes required to maintain the airplane in revenue service. The final report of the FSB establishes the baseline training and procedural requirements for an operator to fly and maintain the airplane.

b. Tabletop Group. The development of this AC used the same general considerations of an FSB, but in a "tabletop" fashion. Under the authority of the General Aviation Joint Steering Committee (GA JSC), the FAA assembled experts from within the FAA and industry to develop these recommendations to pilots of experimental airplanes. Participants included personnel from the FAA's Flight Standards (AFS), Aircraft Certification (AIR), and Accident Investigation and Prevention (AVP) organizations and representatives from the Experimental Aircraft Association (EAA), Aircraft Owners and Pilots Association (AOPA), and the National Association of Flight Instructors (NAFI). These participants brought substantial experience in amateur-built airplane operations and maintenance. Using the "tabletop" methodology, the group established "families," or categories of airplanes with similar handling, performance, configuration, or complexity, and identified the knowledge and skill required to safely fly an airplane of that category.

c. Reviewing the Risks. Since pilots may come from a variety of backgrounds, the tabletop group determined that the best course of action would be to first identify the hazards presented by each category of airplane. Once the hazards were identified, the risks (the likelihood and severity of the harm or damage caused by a hazard) could be assessed. With the hazards identified and the risks assessed, we can establish mitigations to reduce the likelihood and/or severity (the risk) of harm from those hazards. Prior to flying an unfamiliar airplane, all pilots should review the hazards and risks outlined in this AC, and complete the training recommended before operating the airplane. Accident data have shown that there is as much risk in "moving down" in performance as "moving up". For example, consider a pilot who has substantial experience in high performance corporate, airline, or military airplanes. The knowledge and skills used to safely fly at high speed, high altitudes, and over long flights will, by themselves, not prepare the pilot for the challenges of a low-inertia, high-drag airplane. Likewise, a pilot with considerable experience limited to light, low-powered airplanes will need specific training to successfully transition to high-performance experimental airplanes.

d. Additional Assistance. Kit vendors, aircraft owners, and type clubs may offer additional assistance related to the training and operation of the airplane. See the EAA and AOPA Web sites:

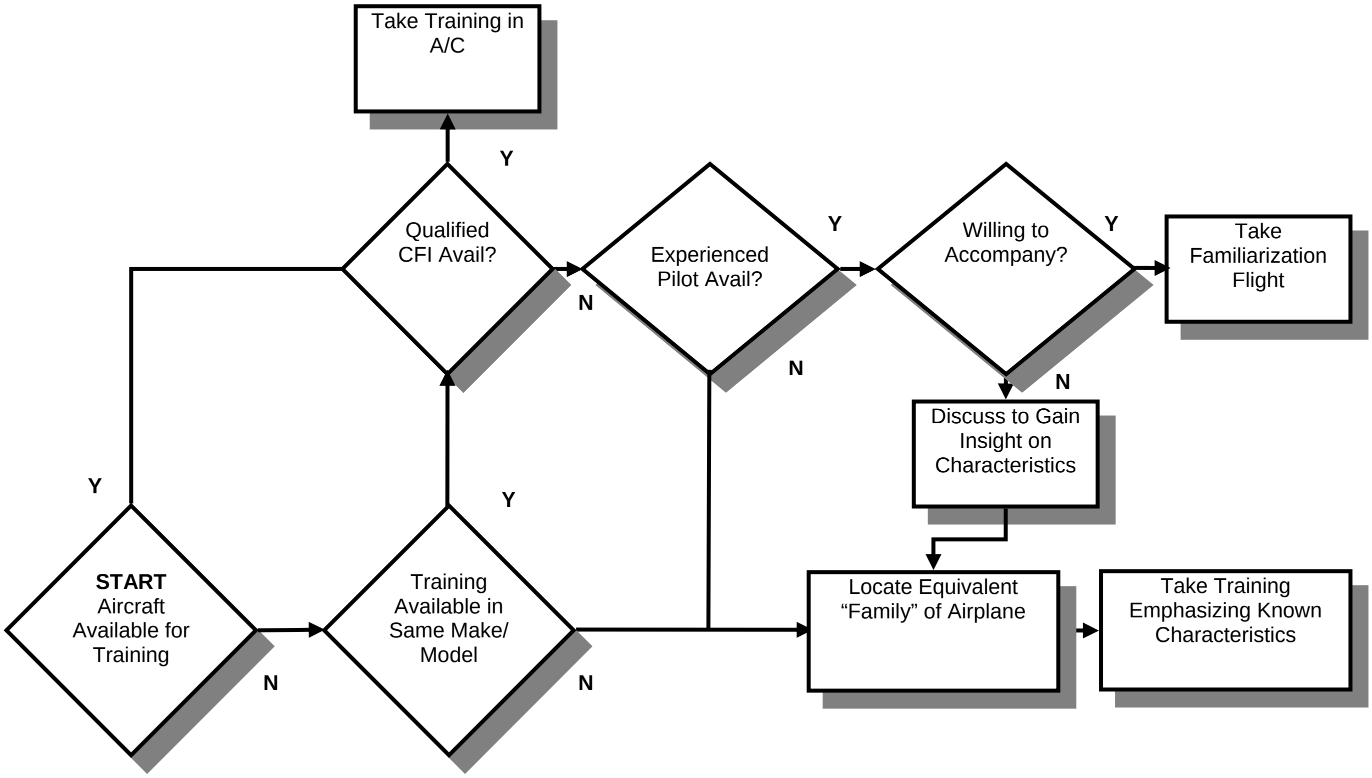
- EAA – The Spirit of Aviation, http://www.eaa.org/.
- AOPA Online, http://www.aopa.org/.
- FAA Safety Team, http://faasafety.gov/.

e. Flight Advisor Program. Another source of education and guidance is the EAA Flight Advisor Program. Under this program the EAA Flight Advisor helps prepare the pilot for flight in a newly built or restored aircraft or to transition to an unfamiliar aircraft. Additional information is on the EAA Web site referenced above.

NOTE: All pilots should consider the first flight in any particular experimental airplane a test flight, and should see AC 90-89, as well as this AC.

f. Experimental Airplane Flight Training. The choice of airplane and instructor used for this flight training is very important. To accomplish the best training, use that specific airplane, with a well-qualified instructor experienced in the specific make and model. The second best choice would be in the same model as the one the pilot is planning to fly. The third choice, is to fly an airplane with similar characteristics (see Appendix 2), which may include a TC'd airplane. Due to construction or rigging differences, note that non-TC'd airplanes of the same model may have different handling and performance characteristics. Figure 1 is a decision chart that summarizes the recommended approach.

FIGURE 1. RECOMMENDED EXPERIMENTAL AIRPLANE TRAINING APPROACH



(1) Current accident analysis indicates that subsequent owners and/or pilots of experimental airplanes, during initial flight time, have a higher accident rate than that of the original owner/pilot. Therefore, the recommendation is that the subsequent owners/pilots of experimental airplanes receive airplane-specific training before operating the airplane.

(2) Analysis indicates that pilots conducting operations in challenging conditions without significant experience in type are at a greater risk for fatal accidents. Several type clubs, such as Lancair Owners and Builders Organization (LOBO) and Cirrus Owners and Pilots Association (COPA), recommend that pilots accumulate significant day visual flight rules (VFR) flight time prior to conducting more challenging operations such as a night or instrument flight rules (IFR) flight.

(3) The new buyer of an experimental airplane may not fully understand the challenges of transitioning to a new airplane, particularly one which has characteristics outside his or her previous aviation experience. The FAA recommends that owners engaged in selling their experimental airplane provide a copy of this AC to prospective buyers, or refer the buyer to the FAA Web site to download a copy. In addition, an owner considering allowing another pilot to fly his or her experimental airplane should consult this AC, along with the prospective pilot, to prepare the new pilot to safely operate the airplane. The EAA provides a checklist for the prospective buyer of an experimental aircraft (see the EAA Web site referenced above).

g. How To Use This AC. Pilots transitioning to experimental or other unfamiliar airplanes need to develop a training strategy for mitigating the risks of operation of the new airplane.

Some of these risks are inherent to any airplane which is unfamiliar to a pilot, while others are specific to the handling characteristics, performance, configuration, systems and operation, and maintenance considerations of the new airplane.

(1) To develop the training strategy appropriate to the airplane the pilot is transitioning to, the pilot should first see paragraphs 1 through 6 of this AC in their entirety. These paragraphs establish the basic training considerations for any transition to an unfamiliar aircraft. Pilots should then assess the characteristics of their particular airplane in light of the "families" of characteristics provided in Appendix 1. For convenience, Appendix 2 provides a "Reverse Lookup Table" for many common experimental amateur-built airplanes. Each family of characteristics has guidance provided in Appendices 3 through 9.

NOTE: An airplane may fit in more than one "family". For example, a high-inertia, low-drag airplane might also employ nontraditional configuration or controls. In this case, the training strategy should reflect the considerations of both families.

(2) The pilot should develop the training strategy as a function of the guidance provided in the appropriate appendix or appendices. These families are somewhat wide in scope and capture aircraft that display varying levels of the specific characteristics of that family. For example, a Piper Cub exhibits low-inertia/high-drag characteristics when compared to the average GA airplane available for rental, such as a Cessna C-172 or Piper PA-28. However, the Piper Cub does not display these characteristics as strongly as certain other aircraft within that family, such as the Kolb Firefly. The reader will have to make an assessment of the criticality of the characteristics in developing a model-specific training strategy. Variances in construction may affect certain critical characteristics of the airplane. The assessment process is not complete until fully understanding the specific handling and performance characteristics of the aircraft in question.

(3) In addition to the general guidance contained in paragraphs 1 through 5 of this AC, and the appropriate family-specific guidance contained in Appendices 3 through 9, Appendix 10 provides additional guidance for transitions to higher performance airplanes, and may also be applicable.

5. CONSIDERATIONS COMMON TO ALL AIRPLANES.

a. Hazard Identification, Risk Assessment, and Risk Mitigation. All flying comes with some inherent risks. It's up to all pilots to mitigate those risks. A proven approach when transitioning into an unfamiliar airplane is the RM approach used by professional test pilots. RM is the process by which:

- Hazards are identified;
- An assessment is made of the risks involved;
- Mitigating procedures are implemented to reduce or eliminate the risks; and
- A conscious decision is made, at the appropriate level, to accept residual risks.

(1) Hazard Identification. The pilot determines the specific safety hazard, or list of hazards for review. For example, a significant hazard is a loss of control such as stall/spin, or a loss of directional control on takeoff or landing.

(2) Risk Assessment. Each risk assessment should first analyze the two elements of risk: severity of the hazard and likelihood of occurrence. Every time a person flies, there are several specific hazards experienced which have potentially fatal consequences. This situation is tolerable because the likelihood of experiencing this hazard is extremely low.

(a) Another way to look at the situation is using the term "exposure" in place of "likelihood". A specific hazard may be fatal, but the exposure to the hazard may be small. For example, inadvertent visual meteorological conditions (VMC) into instrument meteorological conditions (IMC); on a clear day, the exposure to this hazard is zero. Another is stalling on the turn from base to final; the potential consequence of this hazard can be fatal, but exposure is only a small fraction of every flight.

(b) Always consider hazard severity and likelihood of occurrence to get a realistic understanding of risk for your flight. Try to think of all possible hazards and remember that the lack of historical data on a particular hazard does not exclude the hazard as being applicable to your airplane.

(3) Risk Mitigation. Risk mitigation is taking actions to minimize, understand, or respond to a risk. They should be actions the pilot can control. The following items are examples, but are by no means all-inclusive, of considerations in mitigating risks.

(a) Obtain specific training in your airplane or an airplane like it.

(b) Use specific safety equipment (parachute, helmet, fire extinguishers, etc.).

(c) Evaluate the condition of the airplane, including such things as total time, cycles, inoperative components, and maintenance and inspection history.

(d) Review the FAA-issued operating limitations, and the designer/vendor's operational information/recommendations.

(e) Plan your flights for a conservative build-up of maneuvers. Do not take on more maneuvering or conditions than you are ready for, such as cross-wind takeoffs and landings.

(f) Review your flight environment (temperatures, winds, visibility, etc.).

(g) Use performance predictions; what level of performance do you expect from the airplane today? Takeoff distance is just one example.

(h) Limit the number of people who fly with you until you get more familiar with the airplane, the exception being instruction.

(i) Evaluate your own health, fitness, and fatigue level. (IMSAFE checklist, see the current edition of the Pilot's Handbook of Aeronautical Knowledge, FAA-H-8083-25.)

(4) Acceptable Risk. Even after applying risk mitigations there will always be residual risk. The pilot will need to decide if this residual risk is acceptable depending upon the nature of the flight. If the residual risk is unacceptable, apply additional mitigations until the risk is acceptable or the pilot decides not to conduct the operation.

b. Stall Characteristics. The airplane may not provide adequate natural or artificial stall warning to the pilot. The airplane may produce unexpected, violent, or extreme attitude changes that can result in disorientation, out-of-control flight, and difficulty recovering from the stall. Regardless of the airplane's stall warning and stall behavior, the stall may result in significant altitude loss.

c. Discussion.

(1) TC'd small airplanes require adequate stall warning, and fairly benign stall and stall recovery characteristics. The warning must be obvious and readily discernable by the pilot under all conditions, and provide enough of an airspeed margin for recognition and avoidance. The allowable change in airplane attitude caused by a stall is very limited and recovery must not require unusual skill, strength, or alertness. Additionally, if the altitude lost during the stall and recovery is excessive, this figure may be published in the airplane flight manual.

(2) There are no rules for stall behavior with experimental airplanes. Some experimental airplanes can be flown in a carefree manner with the stick all the way back, while others can depart controlled flight dramatically without any perceptible warning. The reasons for these behaviors might be inherent in the airplane design, due to its construction, the result of improper flight control rigging, or a host of other reasons. Since amateur-built airplanes are built by individuals, there can be a wide variation in the stall behavior of identical models. It is essential that every experimental airplane pilot be aware of the variety of possible stall characteristics among experimental airplanes and become familiar with the characteristics of his or her airplane.

(3) Whether the stall warning is a natural airframe buffet or a warning device triggered by an angle of attack (AOA) sensor, it needs to be several knots faster than the stall speed, but not so much faster that it becomes a nuisance or the pilot ignores it. A sufficient stall margin should exist for all flap and landing gear configurations, and provide reliable warning even when maneuvering. In addition to the airspeed margin between warning and stall speeds, the warning must be obvious enough to ensure the pilot notices its occurrence. A weak horn in a noisy cockpit or gentle buffet masked by turbulence can go unnoticed.

(4) There are measures you can take to help avoid an inadvertent stall due to insufficient stall warning. Ensure the airplane's construction meets the kit vendor's specifications. Consult the kit vendor to determine whether your airplane's stall warning is representative of the design. Consider adding stall warning devices or stall characteristic improvements (with the manufacturer's concurrence) such as a warning horn, AOA system, or stall strips. Insure that existing and new systems receive proper calibration regardless of what stall warning system, if any, you install; you should receive training in stall warning recognition in your airplane from a qualified instructor. Practice stall warning recognition and stall avoidance until proficient.

NOTE: Any modification should be thoroughly evaluated during design and flight test.

(5) The airplane's response to control inputs usually degrades at slower speeds, requiring larger deflections to achieve the desired response. These larger control surface deflections can actually precipitate a stall, making it incumbent on the experimental airplane pilot to become familiar with their airplane's behavior in case it has this characteristic. Ideally, every airplane would stall with a clearly defined, slight pitch break without rolling off to one side, but that's not always the case with experimental airplanes. Some planes can abruptly drop a wing 45 degrees or more. Applying an intuitive opposite aileron control input may actually aggravate this roll-off and induce a yaw in the same direction. This is not a good situation when you consider that a stalled wing and a yaw rate are the two ingredients required for a spin.

(6) It's also possible, even for a seemingly carefree handling airplane, to achieve what some have called a deep stall, where there is not sufficient nose-down pitch authority to break the stall, possibly creating an unrecoverable situation. Some airplanes can pitch nose-up before the stall, resulting in a rapid stall entry unless the pilot counters with a conscious forward yoke/stick motion.

(7) An airplane that stalls wing-level, but results in an excessive altitude loss, can lead to trouble should an inadvertent stall occur near the ground. Airplanes with carefree handling at minimum flying speed can inspire a false confidence if the descent rate is high at low airspeed. Some experimental airplanes have very powerful engines turning large propellers; while these planes might enjoy a performance advantage, stalling with a high power setting may introduce significant attitude, rate, and acceleration variations, even violently disorienting motions. This is a possible accident scenario during a go-around when the pilot rapidly applies power without controlling the pitch and yaw tendencies.

(8) There are steps you can take if your airplane's stall characteristics are beyond what you consider benign:

- Ensure the airplane is built according to kit vendor's specifications;
- Consult the kit vendor to determine whether your airplane's stall behavior is representative of the design;
- Receive training in your airplane on stall avoidance and recovery from a qualified instructor; and
- Adhere to stall-free flying by establishing and honoring minimum airspeeds for all flight phases.

(9) It's possible for an airplane to have perfectly acceptable stall warning traits and still have a nasty stall. Conversely, a plane can be lacking in stall warning but have a non-threatening stall. Either of these situations could be acceptable or not, but the pilot needs to know whether his or her airplane behaves this way and how to best fly that plane to maximize safety. Stall recovery should be easy to perform any time during the warning phase or after the stall. The airplane should respond as expected to intuitive control inputs with no tendency for a control-induced secondary stall. Knowing whether your experimental airplane performs this way is essential knowledge for the safe operation of your plane.

(10) While some altitude loss may occur, excessive altitude loss following a stall is obviously problematic. Ensure the airplane's construction meets the kit vendor's specifications. Consult the kit vendor to determine whether your airplane's stall characteristics and recovery performance are representative of the design. Ensure your engine and propeller are operating properly. Practice stall recoveries, after receiving instruction, at a safe altitude. Learn how to optimize your plane's stall recovery performance without entering a secondary stall. Take note of the worst-case altitude lost, and keep this figure in mind when maneuvering or flying in gusty conditions at low altitude.

(11) The following list is not all-inclusive, and it's up to every pilot to determine his or her airplane's sensitivity to these factors through education, training, and practice under safe, controlled conditions. Some other issues that can significantly affect an airplane's stall characteristics include:

- Weight;
- Center of gravity (CG);
- Wing contamination such as a minor "ding" or dead insects near the leading edge (particularly for laminar flow wing designs);
- Sideslip/yaw (which can raise the stall speed and result in a rolling/yawing departure);
- Rate of speed decay (deceleration); or
- Normal acceleration (G Load) increase.

d. Recommended Flight Training.

(1) Know your airplane's systems, limits, and recommended procedures before you begin flying; consult the kit vendor for advice. Discuss your situation with type club members and owner/builders of your airplane model. Internet forums and chat rooms may provide valuable information, but remember that participants may or may not have the technical expertise you seek, and their airplanes may exhibit different stall behavior than yours.

(2) A thorough airplane check-out by a qualified instructor with experience in your airplane model is always a good idea. If you built the airplane yourself, consider obtaining this training from the kit vendor or owner's group, preferably in your airplane. If you purchased your plane from a previous owner, learn all you can from him or her. Periodically practice stall avoidance and recovery at a safe altitude after you've received enough instruction to feel comfortable. Stall recognition and recovery should not be self-taught. Your first experience should not come from an inadvertent stall that catches you by surprise.

e. Additional References (current editions).

- AC 23-8, Flight Test Guide for Certification of Part 23 Airplanes.
- The Advanced Pilot's Flight Manual, Kershner, Iowa State University Press.

6. STABILITY AND CONTROLLABILITY. An airplane may exhibit positive, neutral, or negative stability characteristics. Neutral or negative stability can result in significantly increased workload for the pilot, leading to distraction from other necessary piloting tasks. Worse, it can create a pilot induced oscillation (PIO) scenario, or even result in an uncontrollable situation.

a. Discussion. Stability, controllability, and maneuverability are aviation terms that are frequently misunderstood. The following definitions apply to this section.

- **Stability.** The airplane's tendency to remain at its current steady flight condition or to return to its steady flight condition after being disturbed.
- **Controllability.** The ease or difficulty of changing an airplane's flight condition.
- **Maneuverability.** Addresses how quickly the flight condition can be changed.

(1) An airplane that exhibits strong static stability is reluctant to change its flight condition. Too much static stability can mean high control forces and difficulty when trying to make changes to the plane's altitude or flight path. Too little static stability could make a plane feel "twitchy" or overly sensitive to control inputs or atmospheric upsets like wind gusts. This could also make the plane difficult to fly precisely.

(2) Once the plane is disturbed from its steady condition, dynamic stability comes into play. A positively stable airplane will return to its pre-disturbed flight condition upon removal of the disturbance. It might do this slowly or quickly, with or without oscillations. A plane with negative dynamic stability will develop larger deviations from its original flight condition following a disturbance. Again, this can happen slowly or quickly, with or without oscillations. Obviously, an airplane with negative dynamic stability could be difficult, if not impossible, to fly.

(3) The following are a few stability modes, along with their effect on piloting.

(a) Negative Longitudinal Static Stability. If the plane deviates from its trimmed airspeed, the deviation will increase until the plane stalls or exceeds the never-exceed speed (V_{NE}). The pilot must continuously monitor the airspeed indicator and make corrective pitch control inputs to correct any airspeed deviation.

(b) Negative Longitudinal Dynamic Stability (Phugoid). If the plane deviates slower (or faster) from its trimmed airspeed, it will accelerate (or decelerate) beyond its trimmed airspeed, then decelerate (or accelerate) again beyond its trimmed airspeed in ever-increasing airspeed and altitude deviations until it stalls, exceeds $V_{NE,}$ or impacts the ground. The pilot cannot rely on the plane to self-correct even minor airspeed deviations caused by control input, wind gust, thermal activity, etc. This can result in fatigue, as the pilot must continuously suppress the excursions.

(c) Negative Longitudinal Dynamic Stability (Short Period). Short period is a pitch oscillation caused by a change in AOA; excursions grow larger with each oscillation. Unlike the phugoid, these oscillations can occur very fast with each cycle taking only 1 or 2 seconds. Due to the high frequency of these rapid pitch direction reversals, the short period is felt as G Load excursions that can become intolerable, despite the seemingly small initial pitch attitude changes. There are presently no known experimental airplanes that exhibit this behavior, but should it occur, the excursions will increase with every cycle until the airplane either stalls or exceeds a structural limit. This is not a PIO, as the airplane will continue its oscillation without pilot control input. Suppressing a negative short period is likely to be extremely challenging due to the requirement for perfectly-timed counter pitch control inputs of the proper size.

(d) Negative Spiral Stability. An airplane in a bank angle will continue to increase its bank angle unless the pilot prevents it by applying opposite roll control. This is particularly dangerous during night and IMC flight unless the pilot closely monitors the plane's attitude when turning. Any roll-off due to this characteristic is usually subtle, depriving the pilot of cues such as rolling motion, changes in wind noise, cockpit control position, etc.

(e) Negative Lateral-Directional Stability. Dutch roll, a yawing, rolling oscillation caused by sideslip or relative wind coming from the left or right of the airplane's nose. Excursions grow larger in yaw, roll, or both with each oscillation. There is presently no known experimental amateur-built airplane that exhibits this behavior, but should it occur, the excursions will increase with every cycle until the airplane either departs controlled flight or exceeds a structural limit. Suppressing the Dutch roll requires well-timed, properly sized counter control inputs. The most effective control is usually the rudder; however, aileron may also be effective in some airplane designs.

(4) TC'd airplanes must exhibit positive static and dynamic stability, but experimental airplanes may or may not. Just because an experimental airplane shows positive stability traits during cruise flight does not preclude it from becoming unstable in the landing pattern or vice versa. Pilots might not notice a mildly unstable airplane, because the attentive pilot is always making small control inputs for minor deviations, often without even realizing he or she is doing so. The hazard with this kind of airplane is when the pilot is distracted and doesn't initially notice a deviation in altitude or path, and must then make a large correction, which now distracts him or her from other piloting responsibilities. Some examples of documented instabilities in experimental airplanes during some flight regimes include:

(a) Following a small airspeed deviation slower than the trimmed speed, the plane will continue to decelerate until it stalls, unless the pilot intervenes. This is an example of negative longitudinal static stability.

(b) Following a small airspeed deviation faster than the trimmed speed, the plane will continue to accelerate until it exceeds V_{NE}, unless the pilot intervenes. This is an example of negative longitudinal static stability.

(c) Following a small rudder pedal displacement, the plane will continue to yaw to a larger sideslip angle, unless the pilot intervenes with opposite pedal displacement. This is an example of negative directional stability.

(d) Following a deviation (either faster or slower) in airspeed, the plane alternates slowing and speeding up with each oscillation larger than the previous one, until it either stalls or exceeds V_{NE}. This is an example of negative longitudinal dynamic (phugoid) stability.

(e) After establishing the plane in a bank angle, it continues to roll toward increasing bank, unless the pilot applies opposite aileron. This is an example of negative spiral stability.

(5) These examples pertain to several experimental airplane designs, hundreds of which have been flying for years. Although this statement may appear to minimize the concern, it is intended to illustrate that some experimental airplanes have behaviors that can be kept in check under normal circumstances, but can rapidly develop into an emergency situation unless the pilot remains absolutely vigilant at all times. A common analogy is balancing a broomstick in the palm of your hand; it is possible, but doing it successfully while copying a clearance or programming a Global Positioning System (GPS) is much more difficult, and if it tilts too far, no amount of effort or concentration can save it.

(6) The airplane's control system plays a major role in the pilot's impression of its stability, controllability, and maneuverability. An airplane with weak stability but high control force requirements might feel more stable because the pilot would have to apply a substantial force to the controls to cause a small control surface deflection. If that small deflection, however, resulted in an unexpectedly large airplane response, the pilot might have to spend an inordinate effort to keep the responses manageable. Likewise, an airplane with very low control forces and highly maneuverable response can easily lead to over-controlling with a series of alternating inputs in an attempt to arrest airplane excursions. Both scenarios of airplane-pilot coupling are PIOs and can escalate very rapidly into an out-of-control situation.

(7) The freedoms allowed in experimental airplane design and also in individual builder's construction decisions may significantly influence the airplane's stability and controllability. The following list provides some examples of what may affect stability and controllability; all have an effect that can range from negligible to disastrous:

- Small errors in wing or tail incidence angles;
- Irregularities in lifting surface finish;
- Improper CG location or calculation;
- Addition of flight control gadgetry like springs, bobweights, and dampers;
- Aileron-rudder interconnects; and
- Addition of protuberances like antennas or scoops.

(8) If your airplane exhibits negative stability behavior, consult a reliable source, such as the designer or type club, to determine whether this is inherent in the design or peculiar to your airplane. Modifications may be available to minimize the undesirable characteristics; be extremely careful about making changes to your airplane. If you do make changes, develop a thorough and well-conceived flight test plan for evaluating not just the characteristic to be improved, but also for unintended changes to the existing characteristics.

b. Recommended Flight Training. Know your airplane's systems, characteristics, limits, and recommended procedures before you begin flying. Consult the kit vendor for advice. Discuss your situation with type club members and owners/builders of your airplane model. Internet forums and chat rooms may provide valuable information, but remember that the participants may or may not have the technical expertise you seek, and their airplanes may exhibit different stability characteristics than yours. A thorough airplane check-out by a qualified instructor with experience in your airplane model is always a good idea. If you built the airplane yourself, consider obtaining this training from the kit vendor, preferably in your airplane, but the company demonstrator may provide sufficiently similar characteristics. If you purchased your plane from a previous owner, learn all you can from him or her.

NOTE: Pilots transitioning to experimental airplanes must be aware that the habits and reflexes they learned flying TC'd airplanes may yield hazardous results when used in experimental airplanes.

c. Additional References (current editions).

- AC 23-8.
- The Advanced Pilot's Flight Manual, Kershner, Iowa State University Press.
- Flight Testing Homebuilt Aircraft, Askue, Iowa State University Press.
- The Illustrated Guide to Aerodynamics, Smith, TAB Books (division of McGraw-Hill).
- Aerodynamics for Naval Aviators, Hurt.

7. TRANSITIONING TO A NEW AIRPLANE. Even if a pilot is experienced and knowledgeable about the characteristics of a particular airplane, transitioning to a new airplane of the same family can still be challenging. This is especially true in experimental airplanes, as system design, switch and control appearance and location, and types and locations of indicators may be different, even in airplanes of the same model.

a. Transition Training. In order to complete a successful transition to a new airplane, in addition to the training and experience described in the group appendices, pilots should follow an organized methodology to become familiar and competent in the new airplane. This study or training should include, as applicable:

(1) Systems.

- Fuel.
- Electrical.
- Hydraulic.
- Flight control.
- Landing gear.
- Ventilation/heating/pressurization.
- Avionics.

(2) Procedures.

- Normal.
- Abnormal.
- Emergency.

(3) Performance.

- Takeoff and landing.
- Climb.

- Cruise.
- Descent.
- Glide.

(4) Limitations.

- Weight.
- CG.
- Speeds.
- Kinds of operation.
- Crosswind.
- Landing surface.

b. Systems. When "checking out" in any airplane, regardless of the airplane's size and complexity, or the pilot's experience level, approach airplane systems with an open mind. Even in simple airplanes of a similar design or even the same model, the innovation of individual designers and builders may cause problems for a pilot new to the airplane.

(1) One way of studying airplane systems is to think about the "flow" of that system. All systems have some kind of flow. For example, a fuel system is understandable if studied from the perspective of how fuel moves from the filler port through to the cylinder or combustion chamber and exhaust. Consider the following questions when learning the fuel system of a carbureted single-engine airplane by using the "flow" method:

(a) Fuel enters a filling port.

- What kind of fuel is required?
- What color is it?
- Where is that port?
- How many are there?
- Is there an order to refueling?
- Is there a special grounding procedure or fuel additive required?

(b) Fuel is stored in a tank.

- How many are there?
- Is there a requirement to use one particular tank when taking off and landing? If so, why?
- Are there any fuel tank drains?
- Where are they?
- How do you check them?
- How is fuel quantity measured? In what units?

(c) Fuel is controlled by a fuel valve.

- Where is the valve?

- Where is the cockpit control?
- Can you find and operate it by feel?
- What positions are there?
- How is position selection indicated?
- If “both” is a position, how do you know fuel is being supplied from both tanks?
- What is the procedure to change tanks?
- Is there a maximum fuel imbalance level?
- How do you balance fuel in-flight?
- Which tank or kind of tank is used for takeoff and landing?
- Does the fuel tank selection affect the quantity indicator(s)?

(d) Fuel leaves the tank at a fuel line pickup.

- Is there an electric fuel pump in the line?
- When is it supposed to be on?
- Where is the switch?
- What indication of fuel pressure is there?
- How do you know if the fuel pump is working?

(e) Fuel enters the engine at the carburetor or injectors.

- How does the pilot control the mixture?
- When is “Full Rich” required?
- When is the fuel mixture leaned?
- What indications are there for leaning?
- What is the desired leaning procedure for best power? For best economy?
- When does the pilot use carburetor heat, if applicable?
- How is its operation checked?

(2) Similarly, a description of electrical systems can work by considering the flow of current from the battery or generator(s)/alternator(s), to the busses on the airplane, to the appliances and components that use electrical power. Study flight controls by looking at the pilot input in the cockpit, through the mechanical linkages and hydraulic boost assists, to the actual movement of the control surface.

(3) Any system on the airplane is capable of description by the flow methodology, and it offers a lot of opportunity to understand the components and their location and function, which can give great insight to normal, abnormal, and emergency procedures. Also, understanding the location and function of accessible components can greatly enhance safety in that pre-flight inspections can be more effective in identifying unsafe or marginal conditions.

c. Procedures.

(1) The use of checklists was not common to early aviators. In fact, the modern checklist was not widely adopted until a takeoff accident involving the Boeing 299, the prototype which became the B-17 bomber, in which a highly experienced and skilled crew attempted to takeoff with the controls locked. The thought at the time was that the Boeing 299 was so complex an airplane that the procedural steps required to fly it needed to be written down and “checked-off”.

(2) Today, checklists are expected in every kind of airplane, even the most simple. There are hundreds of accident and incident reports over the years involving pilots who declined to use a checklist because they thought their airplane was “so simple to operate, why do I need one?” Many a gear-up landing, loss of control on takeoff due to miss-trim, and engine failure due to fuel mismanagement, as well as crashes on takeoff with locked controls, were avoidable by use of a checklist.

(3) In order to safely operate an airplane, develop procedures that take into account the airplane’s design, limitations, performance, and intended use. Procedures generally fall into the following categories:

- Normal,
- Abnormal, and
- Emergency.

(a) Normal Procedures. If there are no checklists for your airplane, make one and base it on the designer’s recommendations and your study of the airplane systems. If it is simple, consider making it a placard as some TC’d airplanes do; when designing a checklist, consider as a logical cockpit pattern the prestart, start, and shutdown procedures. Normal procedures include:

- The preflight inspection,
- Start,
- Taxi,
- Pre-takeoff,
- Takeoff,
- Climb,
- Cruise,
- Descent,
- Approach and landing,
- After landing, and
- Shutdown operations that are part of every flight.

(b) Abnormal Procedures. These address circumstances when systems or components of the airplane are not operating properly or have failed, but the situation is not threatening. Generally, abnormal procedures are those that do not rise to full emergency status on their own, even in more challenging conditions. An example might be the in-flight failure of an electric trim system. The abnormal procedure may include securing the system (trim switch off, or trim circuit breaker pulled). After applying the procedure, there should only be a slight increase in pilot workload.

(c) Emergency Procedures. These procedures require a timely response to ensure continued safe flight and may involve significant changes in flight profile. Obvious emergencies are:

- Engine failures;
- Fires;
- Loss of pressurization at altitude;
- Loss of a control system; etc.

NOTE: The level of threat, or risk, in continued operation may be related to the conditions the airplane is flying in; an alternator or generator failure is likely a mere inconvenience in day VFR local operations, but could be an emergency during a night or IFR flight.

(4) Perhaps the most important factor in the successful outcome of a system failure is the proper identification of a problem; the "flow" methodology helps here, as well. By understanding the "flow", a pilot can easily identify the normal function of a system. For example, in an engine, the engine oil pump circulates the oil under pressure. When the engine is cold, the oil is more viscous (thicker). After engine start, the oil pressure will be fairly high and will likely remain so until the oil heats up, becomes less viscous (thinner), and circulates more freely. Therefore, it is normal to see high oil pressure immediately after start, and to see more moderate pressure in flight. There may be something seriously wrong if the pilot observes high oil pressure in cruise, as well as low oil pressure after start. A pilot cannot tell when a system is malfunctioning unless he or she knows what it looks like when operating normally.

(5) Once the pilot has identified the situation and determined the correct checklist to apply, knowledge of the controls and indicators related to that system will prove invaluable because it may be that system performance is compromised by malfunctioning valves, pumps, relays, and other components relied upon by the checklist. Understanding what the checklist item is, and what the expected outcome is of the individual steps taken, can help the pilot identify failed components and develop a course of action that best answers the problem.

d. Performance and Limitations.

(1) While there may not be any official performance or regulatory limitations specified for an experimental airplane, pilots must be able to identify an acceptable, safe flight envelope and operate within it. Base this envelope on the designer's data and the experience gained in the flight test program and post-test phase operation.

(2) For example, if demonstrated that the stall speed of the airplane is more than the designer's data indicates, adjust accordingly any takeoff and approach, and landing data derived from the standard airplane. Actual flight experience, coupled with close observation of density altitude, can validate that adjusted data and give the pilot a high level of knowledge about his or her specific airplane's performance. Until the pilot achieves that level of knowledge, avoid operations to smaller fields, particularly at higher weights and density altitudes.

8. REQUEST FOR INFORMATION.

a. Contact Information. You may direct questions about this AC to:

Federal Aviation Administration
Flight Standards Service, General Aviation and Commercial Division, AFS-800
800 Independence Avenue SW, Washington, DC 20591
Telephone: 202-267-8212
Fax: 202-267-5094

b. Web Site. You may also find more information on the Flight Standards Web site at http://www.faa.gov. On this Web site, you will find links to Flight Standards programs, ASI handbooks and documents, the current aviation regulations of 14 CFR, ACs, and other FAA information.

/s/ for

John M. Allen
Director, Flight Standards Service

APPENDIX 1. AIRPLANE FAMILIES

1. FAMILIES AND EXAMPLES. This appendix describes the families of airplanes considered in this advisory circular (AC). However, an airplane can be included in one or more families. For example, the Long EZ is both Nontraditional Configuration or Controls, and High Inertia and/or Low-Drag. In a case such as this, the pilot should develop an integrated risk mitigation training strategy drawn from the appendices for each family. These families are broad, and include example airplanes which display characteristics of the family at different levels. Pilots should consider this in developing their risk mitigations. For example, in the low-inertia and/or high-drag family, both the Piper Cub and the Kolb Firefly are included. Both exhibit low-inertia and high-drag characteristics, but the Kolb Firefly significantly more so. See Appendix 2 for more information on the categorization of example airplanes into families.

Airplane Families and Examples

Family of Airplanes	Examples of Experimental Airplanes	Examples of Comparable Type Certificated (TC'd)/Special Light-Sport Category Aircraft (SLSA) Airplanes	Refer to Appendix	Notes:
Light Control Forces and/or Rapid Airplane Response	Zodiac 601, RV series, Pitts, Lancair 200 & 300 Series, etc.	Pitts (TC), Extra 300, Grumman AA-1, Swift, Zlin, etc.	3	
Low-inertia and/or High-drag	Challenger II, Flight Star, Kolb Firefly, Rans S-12, Pietenpol, Fly Baby, etc.	Quicksilver GT-500, Cub, Champ, etc.	4	
High Inertia and/or Low-Drag	Skyfly, SX300, Questair Venture, Glasair, Lancair, Long EZ, etc.	Columbia, SR-22, Mooney, Piper Comanche, etc.	5	
Nontraditional Configuration or Controls	Varieze, Velocity, Dyke Delta, Wright Flyer, Quickie, Air Cam, Breezy, Long EZ, etc.	Sky Arrow, Lake Amphibians, etc.	6	If training in the experimental airplane is not possible and is going to be done in a comparable TC'd or SLSA, take care to ensure that there is commonality in the nontraditional configuration or controls.

Family of Airplanes	Examples of Experimental Airplanes	Examples of Comparable Type Certificated (TC'd)/Special Light-Sport Category Aircraft (SLSA) Airplanes	Refer to Appendix	Notes:
Nontraditional or Unfamiliar Airplanes System Operations	Auto conversions, other than the Volkswagen or Corvair, (i.e., two-cycle, Wankel engines, etc.) and folding/removable wing airplanes.	Civil Aviation Regulation (CAR) 3 Airplane (systems), Remos, Soloy Conversion Airplanes, etc.	7	If training in the experimental airplane is not possible and is going to be done in a comparable TC'd or SLAS, take care to ensure that there is commonality in the nontraditional configuration or unfamiliar system operations.
Nontraditional or Unfamiliar or System Component Maintenance Requirements	Auto conversions, other than the Volkswagen or Corvair, (i.e., two-cycle, Wankel engines, etc.) and folding/removable wing airplanes.	Dependant on airplane-specific characteristics.	8	Ground training should be specific to maintenance and preflight procedures of these airplanes.
Specialty Airplane	One-off airplane, limited production, unique, extremely high power to weight ratio, jet-powered, electric-powered, turboprop-powered, rocket-powered, etc.	Dependant on airplane-specific characteristics. Airplanes may be available with some similar characteristics or systems. Consider retaining the services of a qualified test pilot.	9	Conduct in-depth ground training on the operation of the specific airplane. Recommend pilot follow guidance in the current edition of AC 90-89, Amateur-Built Aircraft and Ultralight Flight Testing Handbook, for first 40 hours of flight testing if flight training is not available in the specific airplane.

APPENDIX 2. CATEGORIZING DESIGNS OR MODELS

1. AIRPLANE CATEGORIES. The purpose of this appendix is to orient the reader to the aircraft families which are most likely associated with the identified airplane designs or models. This appendix describes a general categorization of common experimental amateur-built airplanes into the families considered in Appendices 3 through 6 of this advisory circular (AC). Significant effort has been made to properly categorize each model; however, any evaluation of this kind is somewhat subjective. Construction variances, installed equipment, and other factors may cause a model to have characteristics of a family not identified in this table. As mentioned in Appendix 1, different airplane models categorized in a family may display varying degrees of the characteristic of that family. The reader is advised to seek additional information from the designer, kit vendor, or type clubs. Another source of information is the Comparative Aircraft Flight Efficiency (CAFÉ) Foundation, which maintains a Web site at www.cafefoundation.org.

> **NOTE: The risk mitigations described in subparagraph 4f(2) apply to all models of airplanes whether listed or not. In addition, if there is an "X" in one or more family columns, see the appropriate appendix or appendices for guidance to develop your specific risk mitigation training. If a model is not listed in this table, you must decide what family or families apply based on airplane characteristics. In the event that a model in this table has no "X" marks indicating categorization to the families considered in Appendices 3 through 9, the subparagraph 4f(2) guidance applies.**

Airplane Categories

Airplane Model (Airplanes may be listed in more than one family of airplanes)	Light Control Forces and/or Rapid Airplane Response (Appendix 3)	Low-inertia and/or High-drag (Appendix 4)	High Inertia and/or Low-Drag (Appendix 5)	Nontraditional Configuration and/or Controls (Appendix 6)	Nontraditional and/or Unfamiliar Airplanes System Operations (Appendix 7)	Nontraditional and/or Unfamiliar System Component Maintenance Requirements (Appendix 8)	Specialty Airplane (Appendix 9)
ACRODUSTER SA750		X					
AcroSport II		X					
AERO CANARD				X			
Aerocomp CA-7							

Airplane Model (Airplanes may be listed in more than one family of airplanes)	**Light Control Forces and/or Rapid Airplane Response (Appendix 3)**	**Low-inertia and/or High-drag (Appendix 4)**	**High Inertia and/or Low-Drag (Appendix 5)**	**Nontraditional Configuration and/or Controls (Appendix 6)**	**Nontraditional and/or Unfamiliar Airplanes System Operations (Appendix 7)**	**Nontraditional and/or Unfamiliar System Component Maintenance Requirements (Appendix 8)**	**Specialty Airplane (Appendix 9)**
Air Camper (Pietenpol)		X			X	X	
AIR-CAM		X		X	X		
ARV 582		X					
AVENTURA II		X		X			
AVID FLYER							
AVID Magnum							
AVID-CATALINA				X			
BABY ACE D		X					
BAKENG DUCE		X					
BD-5	X						X
BEARHAWK							
BD-4							
Breezy		X		X			
Buccaneer 2		X		X			
MIDGET MUSTANG	X		X				
CASSUTT	X		X				
Fisher Celebrity		X					
Zenair CH-801		X		X			
CHALLENGER II		X		X			
CHINOOK PLUS 2		X					
CHRISTEN EAGLE II	X						
CIRRUS VK30			X	X			X

Airplane Model (Airplanes may be listed in more than one family of airplanes)	Light Control Forces and/or Rapid Airplane Response (Appendix 3)	Low-inertia and/or High-drag (Appendix 4)	High Inertia and/or Low-Drag (Appendix 5)	Nontraditional Configuration and/or Controls (Appendix 6)	Nontraditional and/or Unfamiliar Airplanes System Operations (Appendix 7)	Nontraditional and/or Unfamiliar System Component Maintenance Requirements (Appendix 8)	Specialty Airplane (Appendix 9)
COZY			X	X			
DEFIANT RUTAN				X			X
DRAGONFLY II				X			
Early Bird Jenny		X			X	X	
EDGE 540	X		X				
Emeraude							
Europa				X			
EXPRESS (Wheeler)			X				
F1 ROCKET	X		X				
Falcon		X					
Falco							
FLY BABY		X			X	X	
Giles/Aerotec	X		X				
SLIPSTREAM GENESIS		X		X			
GLASAIR			X				
Glastar					X		
GP-4			X				
Quicksilver GT-500		X		X			
HARMON ROCKET 2	X		X				
Hornet		X		X			
HUMMEL BIRD					X	X	X

Airplane Model (Airplanes may be listed in more than one family of airplanes)	Light Control Forces and/or Rapid Airplane Response (Appendix 3)	Low-inertia and/or High-drag (Appendix 4)	High Inertia and/or Low-Drag (Appendix 5)	Nontraditional Configuration and/or Controls (Appendix 6)	Nontraditional and/or Unfamiliar Airplanes System Operations (Appendix 7)	Nontraditional and/or Unfamiliar System Component Maintenance Requirements (Appendix 8)	Specialty Airplane (Appendix 9)
JODEL D-9							
KELLY "D" BIPLANE		X					
KitFox					X		
Kolb		X		X			
Lancair 200/300 Series	X		X				
LANCAIR ES			X	X			
LANCAIR IV/IVP			X	X			
Lancair Legacy			X				
Lancair Evolution/ Propjet			X	X	X		X
LIGHTNING			X				X
M Squared		X			X		
Long EZ			X	X			
One Design DR 107	X						
Marquart Charger		X					
Murphy Rebel/Moose							
WW-I Replicas		X		X			
PITTS	X	X					
Pulsar (KIS)			X				
Quickie Q-2	X			X			
RANS S-10	X						

Airplane Model (Airplanes may be listed in more than one family of airplanes)	Light Control Forces and/or Rapid Airplane Response (Appendix 3)	Low-inertia and/or High-drag (Appendix 4)	High Inertia and/or Low-Drag (Appendix 5)	Nontraditional Configuration and/or Controls (Appendix 6)	Nontraditional and/or Unfamiliar Airplanes System Operations (Appendix 7)	Nontraditional and/or Unfamiliar System Component Maintenance Requirements (Appendix 8)	Specialty Airplane (Appendix 9)
RANS S-12		X		X	X	X	
RANS S-14		X		X			
RANS S-18		X					
RANS S-6ES		X					
RANS S-7							
Rand KR-2	X						
RV-Series	X		X				
SEA REY		X		X			
SEAWIND 3000			X	X			
SKY RAIDER II		X					
SKYBOLT		X					
SONERAI II	X				X		
SONEX	X			X			
STARDUSTER TOO		X					
Zenair CH-701		X		X			
TAILWIND W-8	X		X				
T-Bird II		X		X			
THORP T-18			X				
Titan Tornado II		X		X			
Vari Viggen				X			
Varieze				X			
Velocity				X			
Zenair CH-601 HD	X			X			
Zenair CH-601 XL	X			X			

APPENDIX 3. LIGHT CONTROL FORCES AND/OR RAPID AIRPLANE RESPONSE

1. DEFINITION. Light control forces coupled with strong control authority for rapid maneuvering about one or more axis. This section includes airplanes that have substantial disharmony between two or more axis.

2. DISCUSSION.

a. Example Accident from the National Transportation Safety Board (NTSB) Records.

(1) Accident. The pilot had constructed the homebuilt aircraft, and had flown it twice before, totaling 1.2 hours. After rotation and liftoff on his third flight, the aircraft pitched up and down several cycles then settled down. The plane climbed slowly and at 200 feet altitude, the pitch oscillation began again. The aircraft climbed another 50 feet, then rolled to the left and impacted the ground.

(2) Probable Cause. The pilot not maintaining aircraft control during the initial climb after takeoff and the inadvertent stall/spin. A factor to the accident was the pilot's total lack of experience in an accident airplane.

b. Analysis and Avoidance.

(1) Unfortunately, it is impossible to understand the exact cause of this accident. One possibility is the pilot’s lack of experience with the accident airplane as stated by the NTSB. Airplanes like the Extra 300 and Pitts are safe airplanes, with some versions even certified. However, most pilots would not be safe flying these airplanes without training because they maneuver quickly with low control forces. Of course, most pilots can look at these airplanes and understand that they will probably want additional training in them before trying to fly them solo.

(2) There are many more experimental airplanes that may look more like type certificated (TC) airplanes, but they actually have light control forces and/or very quick maneuvering response. Lightweight and lightly wing-loaded airplanes can also have the same quick, light response as many aerobatic airplanes. The hazard of light forces and rapid response is that without some level of training, the pilot may over-control the airplane. This can manifest itself during any phase of flight. The risks can vary from frustration to damage during takeoff and landing, to loss of control up to and including overstressing the airframe and structural failure.

(3) Unfortunately, there are control characteristics like these frequently on airplanes with poor stall handling characteristics. This is a deadly combination when aggressively maneuvering close to the ground. Too large a percentage of fatal experimental accidents fit in this category. Pilots considering purchasing an experimental airplane need to appreciate how much effort TC’d airplane manufacturers expend to ensure good handling characteristics. It may take weeks of trial and error flight testing to get an airplane to handle the way the manufacturer desires. This effort may include redesigning parts of the wings and tails, and their control surfaces. The General Aviation (GA) pilot community is very familiar with the handling characteristics of TC’d airplanes that have been around for decades, like the Cessna C-172 and the Piper PA-28. That same level of wide-spread familiarity does not exist with the small number of experimental airplanes. Transferring conventional GA handling techniques to aircraft with light control forces and/or rapid maneuver response can result in inadvertent stalls, loss of control, or structural failure.

3. RECOMMENDED FLIGHT TRAINING. Pilots transitioning from any one of the majority of TC'd airplanes may tend to over control an experimental airplane with light controls and quick responses. Design the pilot training needed for an airplane with light control forces and/or rapid maneuvering capability, to tailor control inputs appropriately. This cannot be simulated in an airplane that does not have similar characteristics. There are several avenues that would help to prepare you for your experimental airplane.

a. Best Training. The best training is accomplished in the specific airplane with a well-qualified instructor experienced in the specific make and model.

b. Second Best Training. The second best choice would be in the same model as the one the pilot is planning to fly.

c. Third Best Training. The third best choice is to fly an airplane with similar characteristics.

APPENDIX 4. LOW-INERTIA AND/OR HIGH-DRAG

1. DEFINITION. Airplanes which rapidly lose energy (airspeed and/or altitude) when there is a loss or reduction of power.

2. DISCUSSION.

a. Example Accident from the National Transportation Safety Board (NTSB) Records.

(1) Accident. It was the first flight of a newly completed homebuilt airplane. The 600-hour private pilot had no previous time-in-type. On his first landing, he misjudged the amount of power required during the landing flare and the airplane struck the runway nose-first. The nose gear collapsed.

(2) Probable Cause. The pilot misjudged the power required during the landing flare, which resulted in a hard landing on the nose wheel. A factor associated with the accident was the pilot's lack of experience in the airplane.

b. Reduction of Drag.

(1) One major theme throughout aircraft development over the past 100 years of aviation is the reduction of drag. Airplanes with less drag require less thrust for the same performance, requiring less fuel and thus increasing efficiency and utility. High-drag airplanes have all but disappeared in the production-airplane world. However, they still exist in surprising numbers in the experimental airplanes ranks.

(a) First, some pilots don't want to be in an enclosed fuselage; they want the wide-open freedom of an open-structure plane like a Breezy or a Quicksilver MXL.

(b) Second, many pilots want to build a good-quality airplane in the least amount of construction time and at the lowest cost. A high-drag round aluminum tube is just as strong as a streamlined one, but usually procured locally and at a significantly lower price. A builder could spend tens of hours sculpting a low-drag fiberglass fairing, or just cover tubing with fabric and move on to the next part of the project.

(c) Third, some pilots want to get off the beaten path in short takeoff and landing (STOL) planes like the Zenith CH-701 or the Highlander. The highly cambered airfoils used by these planes produce a lot of lift, allowing the airplane to safely fly slow, but with a high-drag penalty.

(d) Finally, there are people who prefer the look of planes designed before drag reduction became popular. There is something special about flying open cockpit biplanes like the Hatz or Baby Great Lakes, or classic monoplanes like the Pietenpol or Fly Baby. These airplanes are often light in weight. When combined with high-drag, that means the airplanes slow quickly when reducing power or when the G Load rises.

(2) Most pilots don't take their initial training in these types of airplanes. They become accustomed to the drag characteristics of the type certificated (TC) airplanes in which they learned to fly. Many "low and slow" experimental airplanes glide at a lot steeper angle than these pilots are accustomed to, and this can cause problems.

(3) In the accident described in the beginning of this section, the pilot was flying a popular low-cost STOL airplane with a fat, high-lift airfoil. He reduced the power for landing, and probably expected a glide path like the TC'd airplane he had learned to fly in. Instead, he got a much steeper approach than he expected, and found himself nearing the ground at a high rate of descent. He undoubtedly attempted to flare to flatten the approach, and probably tried to add some power. But the lightweight airplane quickly decelerated and kept descending at an excessive rate.

(4) Since power is often the method of compensation for the effects of low-inertia and high-drag airplanes, engine reliability can be critical. Light, low-cost homebuilt airplanes often use non-TC'd engines. These can provide more power in a smaller, lighter package, but reliability may suffer. The consequences of an engine failure in this family airplane may be significant.

(5) These characteristics affect a surprising number of pilots. Half the accidents involving one popular low-inertia/high-drag airplane occur during landing, versus about 30 percent of homebuilt accidents overall. Half the pilots involved had less than 12 hours in type versus 60 hours for the overall homebuilt fleet.

3. RECOMMENDED GROUND TRAINING. Pilots operating low-inertia/high-drag airplanes with experimental engines should avail themselves of any available training on operating their engine. For example, to minimize the chances of power interruption, operators of two-stroke engines should receive training on how to avoid cold seizures and how to properly manage the engine to maximize reliability. Another example is that pilots operating airplanes using propeller-speed reduction units should understand the power modes and revolutions per minute (rpm) ranges to avoid.

4. RECOMMENDED FLIGHT TRAINING.

- The best training is accomplished in the specific airplane with a well-qualified instructor experienced in the specific make and model.
- The second best choice would be in the same model as the one the pilot is planning to fly.
- The third choice is to, fly an airplane with similar characteristics, which may include a TC'd airplane.

a. Simulating. In some cases, simulating the drag characteristics of these airplanes using a TC'd training airplane, such as a Cessna C-150 maneuvering with 40 degrees of flaps (in accordance with the airplane limitations) is possible. The deceleration upon power loss can be similar, and the steeper descent rates can help prepare them for operation of their own airplanes. This is especially important for simulated forced landings after engine failures. By flying the conventional airplanes in a high-drag configuration, pilots can experience how fast the speed decays and how lowering the nose further achieves a normal approach speed.

b. Power Landing. Pilots should also consider using power-on, controlled approaches with power maintained throughout the transition to touchdown. Use of power during landings can approximate the glide angle that the pilot is used to flying. Delay experimentation with throttle-closed approaches and landings until the pilot has sufficient experience with the airplane.

c. Other Hazards. Hazards of low-inertia/high-drag airplanes are not limited to power management issues. While all airplanes experience an increase in stall speed with an increase in load factor, such as during turns, these airplanes may also experience significant airspeed decay with increased load factor. This, coupled with low cruise speed to stall speed margin, make these airplanes particularly susceptible to unintentional stalls.

APPENDIX 5. HIGH INERTIA AND/OR LOW-DRAG

1. DEFINITION. Airplanes that slowly decelerate when power is removed.

2. DISCUSSION.

a. Example Accident from the National Transportation Safety Board (NTSB) Records.

(1) Accident. The homebuilt airplane landed long and could not make a complete stop on the available runway; the airplane bounced three times. On the third bounce, the pilot lowered the tail wheel; the main landing gear came off the ground, indicating too much airspeed. He applied power to go around with 300 feet of runway remaining. To avoid trees, he pulled up abruptly, then pushed over again. The engine quit momentarily during the pushover (likely due to negative G Load’s), and the airplane crashed on a nearby golf course.

(2) Probable Cause. The pilot’s failure to maintain airspeed and his failure to perform a go-around. The pilot's misjudgment of speed and distance during the landing is a contributing factor.

b. Inherent Risks/Hazards.

(1) As stated in Appendix 4; drag reduction was and still is a major objective in airplane design. These airplanes are on the leading edge of this design trait. They are beautiful, sleek, and even sitting on the ground just look fast. Airplanes in this family are generally fast, efficient, and may have significant range; however, the hazard is that unless managed, these airplanes can build excessive speed during critical flight phases such as approach and landing. The risks of unmanaged speed include overshooting final approach, inadvertent stalls, loss of control, wheel barrowing, and runway excursions.

(2) These risks are not inherent to only high-performance airplanes. For example, airplanes resembling motor gliders may experience substantial float and overshoot a substantial amount of runway with only a few knots of extra speed on landing. This family also includes airplanes designed for high-speed cruise. In some cases these airplanes have relatively high stall speed and, consequently, high approach and landing speeds. Airplanes with high landing speeds can be a challenge for pilots experienced only in type certificated (TC) airplanes. High landing speed can easily translate to long touchdowns, runway overruns, and late go-around decisions. Also challenging for pilots of these airplanes is following a slower airplane into the traffic pattern or a fly-in event such as AirVenture.

3. RECOMMENDED GROUND TRAINING. Pilots transitioning to this family of airplanes should spend some time reviewing the proper power, airspeed operating limits, altitude, and configuration for their specific airplane’s approach and landing. Discussion should include configuration and speed control for a stabilized descent and approach. Performance calculations for landing distance and safe margins for runway length should be done so pilots are aware of the runway lengths needed for safe operations. Decisionmaking on when to reject landings and go around should be made before flying.

4. RECOMMENDED FLIGHT TRAINING. Flight training includes descents from altitude, pattern work, and landing distance awareness. Practice descents to determine distance versus altitude to begin a proper descent profile. A properly planned descent should permit the aircraft to descend without large reductions in power and to avoid over-speeding the aircraft. If the airplane is equipped with speed brakes, incorporate them into the training. Pattern practice should emphasize proper power, altitude, and configuration for the approach and landing phase of flight. Demonstrate the landing distance required under various aircraft configurations and then practice for repeatability. There needs to be an emphasis on control and understanding your airplane’s stopping distance.

APPENDIX 6. NONTRADITIONAL CONFIGURATION AND/OR CONTROLS

1. DEFINITION. An airplane whose external configuration is sufficiently different from traditional type certificated (TC) single-wing, empennage-mounted tail designs so that it displays non-traditional handling qualities. Flight control surfaces different from typical elevator-aileron-rudder-engine/prop arrangements and/or flight control systems are different from typical stick/yoke-pedals implementations.

2. DISCUSSION.

a. External Configuration. TC'd airplanes follow a fairly standard external configuration. There's usually one main wing, each with one aileron and possibly a flap, and a tail consisting of a vertical and horizontal stabilizer with trailing edge rudder and elevator. There can be slight variations such as a stabilator instead of a stabilizer and elevator, or a V-tail design that uses ruddervators to perform both yaw and pitch functions. Compliance with regulations ensures that regardless of the configuration, all TC'd airplanes behave in expected, intuitive, and acceptable ways.

b. Innovations. The experimental community has a long history of innovation, including non-traditional configuration and controls. Traditional wing/tail combinations are common, but so are canards and wing-mounted pushers. There might be flaperons performing double duty as roll controllers and high-lift devices leading edge slats, multiple lifting wings, differential spoilers, all-moving vertical tails, etc. In the cockpit, an experimental airplane might have a yoke or a stick, and that stick could be an outboard side-stick or one between two seats. It might pivot traditionally or translate/slide for pitch control while pivoting for roll control. Some experimental airplanes have the throttle on the pilot's left, some on the right, and some have both, leaving the option of which hand to use to the pilot. There are even some with the throttle on the floor between the pilot's legs. The hazard is that such variety of cockpit control locations and operation can lead to potential misuse of the controls due to the unfamiliar human-machine interface.

c. Canards.

(1) Canards are very popular in the experimental airplane world. While they offer several aerodynamic advantages, they also carry unique risks. Since both the canard and wing lift upward, this is a more aerodynamically efficient design than a traditional wing/tail airplane. Designed properly, the canard should always stall before the main wing, thereby generating a recovering nose-down pitch. Unlike traditional wing/tail planes, however, there may not be noticeable buffet prior to the stall. A canard that stalls during the landing flare will likely result in airplane damage or worse.

(2) Canard designs typically have a rudder on each swept wing tip with each rudder only deflecting outward. This can feel natural to the pilot and actually helps minimize adverse yaw. Unlike traditional airplanes, both rudders can be deflected simultaneously. While this can be a useful speed brake, it can also produce an unexpected pitching moment, due to the fact that the deflected rudder changes the air flow over the outboard wing section, which is aft of the airplane's center of gravity (CG). Likewise, aileron effectiveness could be affected if it's within the influenced air flow.

(3) The dramatic wing sweep of canard design exists to locate the rudders far enough aft to be effective. An inevitable consequence of the sweep is a strong rolling tendency during uncoordinated flight. A sideslip can be generated by rudder deflection or a wind gust. In both cases, the airplane will likely weathervane back into the relative wind, but it will also roll away from the sideslip. In some canard designs, particularly during slow flight, this rolling tendency can be more powerful than can be countered with the ailerons.

(4) These designs often incorporate wheel brakes operated by applying force to the rudder pedal after fully deflecting the rudder. This design saves weight and space that normally accompanies a traditional toe brake system, but it means there is no braking without full rudder. The system usually works well for taxi steering, but it warrants consideration and familiarity for crosswind takeoffs and landings.

d. Configurations. Other risks exist in the variety of control configurations.

(1) Some airplanes employ hand levers to operate the wheel brakes. Properly designed, these systems can perform adequately, although arm strength can become a factor in braking effectiveness. Unlike traditional foot-operated brakes, using hand brakes requires the pilot to release either the stick or the throttle (unless the lever is mounted on the stick). Applying differential braking with one hand operating two levers can be challenging. A setup where a single lever operates both wheel brakes works well only if it is perfectly rigged. Cable stretch, uneven brake wear, or uneven linkage wear can cause the application of more braking to one wheel without any way for the pilot to deal with it besides re-rigging.

(2) Thrust lines vary among experimental airplanes. High-wing-mounted pusher configurations are common. Unlike traditional airplanes where increasing power usually causes a nose-up pitch, some of these designs garner the opposite airplane response. Although pilots can get used to applying an opposite direction stick displacement with every throttle change, it complicates maneuvers such as an aborted landing go-around. Thorough familiarity with your airplane's power-pitch characteristics is essential for safe flight.

(3) How the pilot interfaces with the control surfaces has a large influence on workload, handling qualities, and overall satisfaction with the airplane. A short side-stick that requires a lot of effort to move limits maneuverability and will likely be worse at faster speeds. Finding the centered or neutral stick position as a primary step in an out-of-control situation can be very difficult with a side-stick. There's no flying with your knees while you fold a chart or copy a clearance with a side-stick.

(4) Some pilots enjoy a tactile reference for their stick arm, usually by resting a forearm on their thigh. Side-stick designs without an arm rest deprive the pilot of this reference, which can make fine adjustments difficult and generate unwanted control inputs in turbulence. There are side-stick applications that have the stick between side-by-side seats. Poor design implementations can limit roll control due to interference with either occupant's leg or hip.

3. RECOMMENDED GROUND TRAINING. Pilots should become thoroughly familiar with the location and force, displacement and operative sense requirements of their cockpit controls. Practice blindfold cockpit exercises and simulated emergency procedures on the ground. Know your airplane's systems, limits and recommended procedures before you begin flying. Consult the designer/kit vendor for advice. Discuss your situation with type club members and owner/builders of your airplane model. Internet forums and chat rooms may provide valuable information, but remember that the participants may or may not have the technical expertise you seek, and their airplanes may not exhibit identical handling qualities to your plane.

4. RECOMMENDED FLIGHT TRAINING. A thorough airplane check-out by a qualified instructor with experience in your airplane model is always a good idea. If you built the airplane yourself, consider obtaining this training from the kit vendor, preferably in your airplane, but the company demonstrator may provide sufficiently similar characteristics. If you purchased your plane from a previous owner, learn all you can from him or her. Your training should emphasize the unique aerodynamic behavior of your plane's non-traditional configuration and any pilot compensation required to safely fly your plane. If your airplane's cockpit controls are different from what you're accustomed to, become familiar with the advantages and disadvantages of the design and explore your plane's handling qualities under safe, supervised conditions.

APPENDIX 7. NONTRADITIONAL OR UNFAMILIAR AIRPLANE SYSTEMS OPERATIONS

1. DEFINITION. Engine, avionics, fuel systems, etc., that require operational practices that are outside the normal procedures utilized in standard category airplanes.

2. DISCUSSION.

a. Example Accident from the National Transportation Safety Board (NTSB) Records.

(1) The pilot had recently purchased the experimental, amateur-built airplane, which had a fuel system that differed from the designer's plans. The original builder had modified the fuel system by relocating the fuel selector handle from a position between the front pilot's legs to a position behind and above his or her left shoulder. There were no markings for the operating positions of the fuel selector handle, which were up for off, down for the right tank, and to the right for the left tank.

(2) The pilot received a one-half hour flight and ground checkout in the airplane by another pilot familiar with the airplane model. The checkout pilot reported that the pilot needed a seatback cushion to be in position to reach the rudder pedals, and that he had difficulty reaching the fuel selector handle while seated with the cushion added. During preflight, the pilot was not observed to visually check the fuel. A maintenance technician noted that when the pilot was seated in the airplane, he had difficulty reaching the fuel selector handle. Also, he gave the pilot a mirror to look over his shoulder to see the unmarked, non-linear, fuel sight gauges, which were located in the rear cockpit. The pilot declined an offer for additional fuel, saying he would be airborne for only about 1 hour and did not need fuel.

(3) Ground witnesses saw the airplane in straight and level flight about 350 to 500 feet over a residential area, then they heard a reduction of engine noise. The airplane was seen to pitch slightly nose-up; then it banked sharply to the right and descended nose-first into the ocean. The fuel selector valve was found in an intermediate position, about 1/3 open between the engine feed line and the right tank, and about 2-4 percent open to the left tank.

(4) Conditions were simulated using another airplane of the same design to evaluate the maneuver required to switch tanks from the front seat. The simulation revealed that four actions were required to change the fuel selector in flight:

- Remove pilot's hand from the control stick;
- Loosen shoulder harness;
- Rotate upper body to the extreme left to reach the fuel selector handle; and
- Rotate the handle to an unmarked (not logically oriented) position.

(5) During the evaluation, investigators noted a natural reaction for the pilot's right foot to depress the right rudder pedal when turning in the seat to reach the fuel selector handle. With the right rudder depressed in flight, the airplane would pitch up slightly and bank to the right.

b. Probable Cause. The NTSB determines the probable cause(s) of this accident as follows:

(1) The pilot's diversion of attention from the operation of the airplane and his inadvertent application of right rudder that resulted in the loss of airplane control while attempting to manipulate the fuel selector handle.

(2) Also, the Board determined that the pilot's inadequate preflight planning and preparation, specifically his failure to refuel the airplane, was causal.

(3) The Board determined that the builder's decision to locate the unmarked fuel selector handle in a hard-to-access position, unmarked fuel quantity sight gauges, inadequate transition training by the pilot, and his lack of total experience in this type of airplane were factors in the accident.

c. Type Certificated (TC) versus Experimental Airplanes.

(1) TC'd airplanes familiar to most pilots have standardized instrument panel layouts and system control locations; they are very similar from airplane to airplane. Most airplanes found in the training and rental fleet are of similar performance and equipment levels. Pilots have become accustomed to operating flaps, fuel systems, retractable landing gear, and engine controls in these TC'd airplanes, and can generally transition from one make/model to another without the need for extensive training.

(2) Builders of experimental airplanes are able to customize every aspect of their airplane to their own personal preferences. This extends to the installation of systems not found on standard airplanes in the training and rental fleet, such as the fuel valve location discussed in the example above. Builders also sometimes place familiar instruments and controls in unfamiliar locations on the panel or in the cockpit area. This is true even in seemingly identical examples of a particular design. The ability to completely customize the airplane is one reason builders choose to build their own, rather than purchase a standard airplane. The hazard in operating these airplanes is the potential for misuse or system mismanagement. The risks of this misuse or mismanagement can include an inadvertently induced abnormal or emergency situation.

(3) Unlike TC'd airplanes, many experimental airplanes do not have extensive pilot's operating handbooks (POH) or other documentation outlining the unique nature of the systems or controls installed in that particular airplane. This places the burden on the pilot to become familiar with the specific systems and controls in the airplane. Take care to identify every control and system on board the airplane.

3. RECOMMENDED GROUND TRAINING. The pilot should spend sufficient time sitting in the airplane on the ground learning the positions of all controls so as to be able to locate each control without the need to spend time searching. The pilot should utilize familiarization drills such as the "blindfold test", where an assistant calls out various controls and switches while the pilot locates them by memory. The pilot should not fly the airplane before gaining thorough familiarity with cockpit layout. The pilot should also seek advice from previous operators of the airplane, including the original builder. The kit or plan vendor may also have useful information and advice.

4. RECOMMENDED FLIGHT TRAINING. Flying the airplane with a previous operator, a knowledgeable flight instructor, or the original builder, prior to operating the airplane solo will help the pilot understand the reasons why the installed controls are the way they are and what operational characteristics they have. This will also guard against any unusual handling characteristics that may arise from application of a control or system that may catch the pilot off-guard, as illustrated in the example above.

APPENDIX 8. NONTRADITIONAL OR UNFAMILIAR AIRPLANE SYSTEM OR COMPONENT MAINTENANCE REQUIREMENTS

1. DEFINITION. Engine, avionics, propellers, fuel systems, etc., that require maintenance practices that are outside the normal procedures utilized in standard category airplanes.

2. DISCUSSION.

a. Example Accident from the National Transportation Safety Board (NTSB) Records.

(1) Accident. The airplane made a forced landing after the horizontal stabilizer attachment failed in flight. The instructional flight departed with the intention of practicing takeoffs and landings. On the downwind leg, the pilots heard a loud bang. The airplane lurched nose-up, then nose-down. The flight instructor took control of the aircraft and informed the tower he had a flight control problem. He was able to land the aircraft using cross control inputs. The instructor inspected the airplane and determined that the right horizontal stabilizer had separated from the fuselage due to a stainless steel "L" bracket failure. The instructor attributed the failure to a loose bolt in the "L" bracket that allowed a vibration and caused metal fatigue of the component.

(2) The Probable Cause. This accident was caused by the fatigue failure of the attachment that secured the horizontal stabilizer to the fuselage (due to improper maintenance—Federal Aviation Administration (FAA) comment).

b. Systems and Hardware.

(1) Manufacturers of type certificated (TC) airplanes, as well as manufacturers of components and systems installed in such airplanes, provide supporting maintenance and repair documentation that shows owners and maintenance personnel how to properly maintain and repair the airplane. These documents are available from several sources and readily accessed by anyone performing maintenance or repair on these airplanes.

(2) Extensive maintenance documentation typically is not available for amateur-built and other experimental aircraft. Components and systems installed in these airplanes are sometimes the same or very similar to those installed in TC'd airplanes, so maintenance guidance may be available. However, many experimental airplanes incorporate components and systems not found on standard airplanes. Much like the experimental airframe itself, maintenance and repair guidance may be difficult to find or even unavailable for these components or systems.

(3) In the accident described above, the airplane suffered a failure due to improperly secured hardware, which led to a fatigue failure. This illustrates why owners and operators of experimental airplanes must make an extra effort to find and follow appropriate maintenance and repair guidance for their airplanes.

3. RECOMMENDED GROUND TRAINING.

a. Maintenance. As mentioned under "Systems and Hardware" above, there are many possible sources of information regarding maintenance and repair of experimental airplanes. Owners/operators should explore all avenues when seeking such info. Also, owners/operators should develop maintenance routines that will aid in early detection of potential maintenance problems or continued airworthiness issues. Regular attendance at local and national aviation events will also expose the owner/operator to others who operate similar airplanes or systems, allowing for the sharing of information among all operators. Educational and informational forums at these events are also a good source of information.

b. Organization Information Sources. National organizations such as the Experimental Aircraft Association (EAA) offer both print and electronic publications that will support the maintenance and operation of experimental airplanes. Also, many of the more popular designs have active "type clubs" or other user groups that provide a good source of information relating to complete airframes as well as individual components and systems. These type clubs often have related Web sites that offer information along with a method of contacting operators of similar airplanes or systems. The owner/operator of an experimental airplane needs to thoroughly explore all of these sources.

c. Other Sources. Another source of guidance is the current edition of Advisory Circular (AC) 43.13-1, Acceptable Methods, Techniques, and Practices - Aircraft Inspection and Repair. This AC contains methods, techniques, and practices acceptable to the Administrator for the inspection and repair of non-pressurized areas of civil aircraft, only when there are no manufacturer repair or maintenance instructions.

APPENDIX 9. SPECIALTY AIRPLANE FAMILY

1. DEFINITION.

- One-of-a-kind or highly modified airplane;
- Limited kit production;
- Unique;
- Unstable;
- Extremely high power to weight ratio,
- Jet-powered;
- Turboprop-powered;
- Rocket-powered; or
- Other unconventional powerplant.

2. DISCUSSION. One of the core principles of the experimental aircraft world is the freedom to design, create, or modify. Nowhere is this more evident than with the very special one-of-a-kind designs or highly modified existing designs. In some sense, this can be the most exciting form of homebuilding as leading-edge products emerge. However, this can also be one of the highest risk categories of airplanes due to a very high degree of undetected hazards and flaws.

a. Example Accident from the National Transportation Safety Board (NTSB) Records.

(1) The single-seat, twin-engine, homebuilt airplane was of the pilot's own design, with a T-tail and a forward canard. The engines were mounted on the inboard trailing edge of each wing facing aft, in a pusher type configuration. The aircraft had not yet flown.

(2) During previous high-speed taxiing tests (35-55 knots), pitch was nonresponsive; the nose would not lift to a positive angle of attack (AOA). Ballast was added to move the center of gravity (CG) aft and a larger canard control surface (elevator) was added. This allowed the desired pitch control at 45-50 knots.

(3) The pilot was performing high-speed taxi tests and routinely raised the nose of the airplane up during the test runs. An onboard recorder showed a maximum of 9 degrees pitch during these runs. On the last run, pitch rose rapidly from 8 degrees to 45 degrees. The airplane became airborne and rose to about 120 feet, started a right-hand turn, stalled, and impacted terrain in a flat attitude. Probable cause was the pilot's failure to maintain pitch control of the airplane.

b. Become Familiar With Your Airplane. It is critical that pilots who are interested in pursuing an airplane model from this category become highly familiar with every aspect of their new airplane prior to the first flight. An option would be to seek analysis of likely performance and handling characteristics from aviation departments of universities or colleges, aircraft design software, or other sources of aeronautical design analysis. Not taking advantage of every opportunity to understand your aircraft before your first flight can result in a very bad outcome.

3. RECOMMENDED GROUND AND FLIGHT TRAINING. Develop a specific and customized lesson plan for your specific airplane. This plan should encompass all the specific parameters that make your specialty airplane unlike most other airplanes. Above all else, seek specialty training from an instructor who has experience in your type or a type that is very similar to your airplane. Do not think you can just "feel" your way into understanding the special characteristics of your airplane. For example, an amateur-built airplane equipped with a commercially available turbine engine should consider training sources such as operators or training centers who have established training on that specific engine.

APPENDIX 10. TRANSITIONAL GUIDANCE

4. TRANSITIONING TO HIGHER PERFORMANCE AIRPLANES. Transition to a complex airplane, or a high-performance airplane, can be demanding for most pilots without previous experience. Increased performance and increased complexity both require additional planning, judgment, and piloting skills. Accomplish the transition to these types of airplanes in a systematic manner, through a structured course of training administered by a qualified flight instructor.

> **NOTE: If you are transitioning from a very basic low-performance and/or complex airplane there may be new flight controls, new systems, and more complex systems.**

a. Turbocharged Engine. The turbocharged engine allows the pilot to maintain sufficient cruise power at high altitudes where there is less drag, which means faster true airspeeds and increased range with fuel economy. Aggressive and/or abrupt throttle movements increase the possibility of over-boosting, which could damage the engine.

b. Retractable Landing Gear. Retractable landing gear systems may be operated mechanically, hydraulically, electrically, or may employ a combination of the two systems. Pilot knowledge of the system, including procedures for extension when the system malfunctions, is vital.

c. Fuel Systems. Complex and high-performance airplanes may have complicated fuel systems. This can lead to fuel mismanagement. The 2009 Nall report states that almost one-third of fuel-related accidents were a result of fuel mismanagement.

d. Performance. Power management is a significant part of flying high-performance airplanes, so you should learn to “fly the numbers”. The aerodynamics that allow the airplane to fly at a higher airspeed makes them less forgiving than slower airplanes.

e. Turbopropeller Transition. The turbopropeller-powered airplane flies and handles just like any other airplane of comparable size and weight; the aerodynamics are the same. The major difference between flying a turbopropeller and other non-turbine-powered airplanes is in the engine and systems. The engine is different and requires operating procedures that are unique to gas turbine engines.

f. Jet Transition. Due to their performance, flight characteristics, and complicated systems, it is imperative that a pilot receive training in the particular jet from a knowledgeable and experienced instructor.

g. High Altitude Training. Not only are there physiological considerations, there are aerodynamic and handling considerations in operating at the airplane’s altitude limit; all this is critical to safety. Knowledge gained from this training is invaluable, even if you stay below flight level 250. There are many training courses and advisory materials available.

5. TRANSITIONING TO LOWER PERFORMANCE AIRPLANES. There are just as many challenges transitioning from high-performance to low-performance airplanes. The prudent pilot respects the challenges of flying a new airplane regardless of whether the transition is from low performance to high performance or vice versa. For example:

- The effects of weather will be more pronounced on low-performance airplanes.
- It will be affected more (as a percentage) by headwinds.
- Turbulence may be more pronounced.
- The ability to handle crosswind landings may be reduced.
- Avionics may be less capable.
- Handling characteristics will be different.

NOTE: The prudent pilot respects the challenges of flying a new airplane regardless of whether the transition is from low-performance to high-performance or vice versa. Transitioning from a multi-crew airplane to a single-pilot airplane creates its own challenges.

6. TRAINING GUIDANCE. You can find the guidance for transition training in many publications including, but not limited to:

- AC 61-107, Operations of Aircraft At Altitudes Above 25,000 Feet Msl and/or Mach Numbers (M_{MO}) Greater Than .75.
- AC 61-67, Stall and Spin Awareness Training.
- FAA-H-8083-3, Airplane Flying Handbook.
- FAA-H-8083-25, Pilots Handbook of Aeronautical Knowledge.
- Turbine Pilot's Flight Manual by Gregory N. Brown, Published by ASA.
- The Advanced Pilot's Flight Manual, by William K. Kershner, Published by Blackwell Publishing.

7. ADDITIONAL INFORMATION. Additional information can found at:

- EAA, http://www.eaa.org.
- AOPA Online, http://www.aopa.org/.
- GAMA, http://www.gama.aero/.
- FAA Safety Team, http://faasafety.gov/.