RV-Type Training

Syllabi, Lesson Plans,

Techniques, Procedures and Handling Characteristics

RV-4/6/7/8/9 Version 2.5

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Part 1: General

Purpose. The purpose of this Guide is to provide syllabi (including objective standards), lesson plans and briefing guides, discussion, techniques, procedures and handling characteristics applicable to RV-Type transition training for upgrading pilots with or without previous experience in type. It also supports instructor upgrade and RV-type recurrent training. Five specific tracks of instruction are included: Basic Transition (TR); Advanced Transition (ATR); Advanced Top-Off (ATO), Instructor Upgrade (IPUG) and Recurrent (RECUR). Not all portions of the syllabus are applicable to all tracks. ***It is incumbent upon the instructor to evaluate upgrading pilot/instructor requirements, aircraft capability and equipment, and modify the program accordingly.*** This guide has been prepared from multiple sources and is designed to be used in conjunction with the FAA Airplane Flying Handbook (FAA-H-8083-3A) and the FAA Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25A), appropriate Advisory Circulars as well as designers/builder's information, operating limitations and weight and balance data for the specific RV-type operated. Techniques, recommendations and suggested procedures are provided to assist the instructor and upgrading pilot as well as providing a degree of standardization and continuity. This manual is not designed to replace specific FAA, designer, kit/component manufacturer or builder's guidance. At the successful completion of transition, upgrade or recurrent training, the pilot/instructor should be able to perform maneuvers to the minimum standard appropriate to pilot privileges to be exercised in the operation of the RV-type aircraft. Objective Standards of Behavior in Table 1-3 and 1-4 conform to appropriate FAA Practical Test Standards. The most current versions of FAA publications may be obtained on-line at www.faa.gov. Objective Standards for confidence maneuvers and advanced handling required for syllabus completion are "practice" vs. "proficient" (See Table 1-2 for definitions) for transition and recurrent tracks of instruction. "Proficient" is required in all tasks for instructor upgrade. Additional training in any area may be given at any time at the discretion of the instructor or request of the upgrading pilot/instructor. Although recommended flight duration and course completion times are established in this syllabus, there are no maximum time limits with the desired outcome of the upgrading pilot/instructor trained to proficiency, or practice level, as appropriate. Additionally, transition training requirements may be established by the insurance carrier in excess of the minimum time limits established in these syllabi.

Tracks. These syllabi are designed to support multiple tracks of instruction. They contain information for basic transition (Basic Course); advanced transition (Advanced Course); instructor qualification (Instructor Upgrade); advanced top-off (Top-off); and recurrent training (Recurrent). The Basic Course is designed for upgrading pilots transitioning to RV types without prior experience in RV type aircraft. It includes takeoff, landing, basic air work and emergency procedures. The Advanced Course is also designed for upgrading pilots without prior RV type experience/qualification but includes all-attitude maneuvering. The advanced top-off is designed for RV qualified pilots that desire all-attitude maneuvering training. Instructor Upgrade is designed to qualify and standardize instructors to provide all tracks of transition and recurrent training in RV-type aircraft. Recurrent training is designed to meet the requirements for a flight review.

Track Descriptions.

(1) ***Basic Transition.*** The basic transition course consists of Operational Risk Management (ORM)/Aircrew Decision Making (ADM) review and 4 blocks of training. Each block consists of academics (.75 hour), situational emergency procedures training (.75 hour) and one training flight with an average duration of 1.25 hours with .75 hours allotted for brief, and .5 hours allotted for debrief. Each block is designed to be completed within 5-6 hours total time, including breaks. Academics include RV type aerodynamics; performance; weight and balance and Experimental/Amateur Built (EAB) airworthiness determination. The basic transition course covers preflight, ground operation, takeoff, landing, basic air work (including slow flight and stalls) and emergency procedures. It is designed to qualify the upgrading pilot for basic, non-aerobatic operation of RV type aircraft. For documentation purposes, Basic Transition courses are coded "TR."

(2) ***Advanced Transition.*** The advanced transition course is structured identically to the basic transition course, but includes confidence maneuvers and advanced handling (aerobatics). It is designed to qualify the upgrading pilot for operation of RV type aircraft in all areas of operation, including all-attitude flying. For documentation purposes, Advanced Transition courses are coded "ATR."

(3) ***Advanced Top-Off.*** The advanced top-off course is designed for upgrading pilots already qualified in RV-type aircraft. In addition to review of basic operation and emergency procedures, it includes confidence maneuvers and advanced handling designed to prepare the upgrading pilot for all-attitude operation. It consists of 2 blocks of training. Each block consists of academics (.75 hour), and one training flight with an average duration of 1.25 hours with .75 hours allotted for brief, and .5 hours allotted for debrief. A .5 hour Risk Management Review is included in Block 1. Each block is designed to be completed within 4-5 hours total time, including breaks. For documentation purposes, Advanced Top-Off courses are coded "ATO."

(4) ***Instructor Upgrade.*** Instructor upgrade mirrors the advanced transition track, including instruction of Operational Risk Management/Aircrew Decision Making. The upgrading instructor will prepare, brief, conduct and debrief all training associated with completion of the advanced qualification syllabus. An instructional critique will be

conducted, as appropriate, throughout each block of instruction. For documentation purposes, Instructor Upgrade is coded "IPUG."

(5) ***Recurrent Training.*** Consists of one block of instruction that includes a safety/ORM review, one hour of academics developed by the instructor or at the request of the pilot receiving recurrent training and a minimum of one hour of flight training. The recurrent training block of instruction is designed to be completed within 4 hours, including breaks. For documentation purposes, recurrent training is coded "RECUR."

Guidance. Applicable pilot certification and currency guidance is provided in 14 CFR Part 61. Operational guidance is provided in 14 CFR Part 91. Current versions of these Federal Aviation Regulations (FARs) should be consulted. Current regulations and other publications may be obtained on-line at www.faa.gov. Additional techniques applicable to operation of aircraft may be obtained from the Airman's Information Manual (AIM) and the FAA Flight Training Handbook. In some cases, this Guide is more restrictive than FARs (e.g., Training Rules, currency requirements, etc.).

Using this Guide. This manual has been prepared using numerous sources. It is designed for instructor use in preparing briefings and lesson plans as well as providing standardization guidance to ensure continuity of effort. Part 1 contains a course description for each track, objective standards, grading criteria and recommended training rules to support the different tracks of instruction. Part 2 includes academics in the form of briefing guides and lesson plans. Part 3 includes additional academic/background information, generic pilot guidance (in the form of techniques and procedures that can be adapted to the different tracks of instruction after critical review) and RV-type handling characteristics. Generic expanded checklists are included in the NORMAL and EMERGENCY procedures section in Part 3 if specific guidance for the RV-type to be operated for or after training is not available.

Experimental Amateur-Built (EAB) Aircraft. RV-type aircraft are designed and constructed as an Experimental amateur-built aircraft. ***They are not designed or built to meet any standards of airworthiness as with a standard certificated aircraft.*** 14 CFR Section 21.191(g) defines an amateur-built aircraft as an aircraft in which the major portion of the aircraft has been fabricated and assembled by persons who undertook the construction project solely for their own education or recreation. RV-type aircraft do not have an FAA Form 8130-9 "Statement of Conformity" on file with the FAA, since there is no FAA Approval data to which they conform. The builder and/or owner of this aircraft were and are experimenters and the aircraft were not built in permanent jigs and parts are not necessarily interchangeable with any other aircraft. The registered owner is free make modifications as he or she wishes. EAB aircraft must possess an unlimited duration special airworthiness certificate and operating limitations issued by the FAA. The operating limitations are set forth under guidance prescribed in Order 8130.2 and established to maintain compliance with 14 CFR 91.319. ***Maintenance and operation of EAB aircraft must be in accordance with the operating limitations.***

(1) EAB aircraft used in the conduct of RV-Type transition training must be in Phase 2 operations (i.e., initial test period complete). ***All maneuvers flown in the conduct of training must have been previously tested under similar load conditions and in accordance with Operating Limitations issued for that airplane.***
(2) EAB aircraft may not be operated for hire unless an appropriate Letter of Deviation Authority (LODA) has been issued by the appropriate FAA Flight Standards District Office.
(3) Instructors may receive remuneration for conduct of training in an upgrading pilot's aircraft.

Note
LODA restrictions may prohibit the conduct of some tracks of training as included in these syllabi.

Operational Risk Management. A continuing cycle of risk assessment, aircrew decision making, and applying control measures to: a) avoid risk; b) mitigate risk or c) consciously accept risk. The core principles to successful risk management are to anticipate/manage risk by planning (i.e., thinking); accept no unnecessary risk; and consciously accept risk when the benefits outweigh the potential cost. Risk management is a continual process and must be taught and/or emphasized to upgrading pilots. 80% of all mishaps involve human factors, with the majority of these mishaps occurring during takeoff and landing phase of flight. For Experimental/Amateur Built (EAB) types, maneuvering flight carries increased risk. The initial period of transition to operation of EAB types (the first 5-8 hours of initial operating experience) has also proven to be a moderate to high risk phase of operation as well. To manage risk during the conduct of training, and establish a basic framework to assist upgrading pilot decision making, a set of recommended training rules is contained in this Guide. These rules may be more restrictive than guidance contained in the FARs or aircraft Operating Limitations.

(1) Upgrading pilots should complete the King School's "Practical Risk Management for Pilots" course prior to the conduct of training. The appropriate course completion certificate shall be maintained in the upgrading pilot's grade book. This course may be obtained on-line at www.kingschools.com or by calling (800) 854-1001.

> **Note**
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> At the instructor's discretion, appropriate airline, FAA/Industry-sanctioned or military training in risk management/aircrew decision making may be substituted for this requirement.

Aircraft Documentation. Documentation must be reviewed and verified by the instructor prior to utilizing an RV-type aircraft for training purposes. The airworthiness certificate and operating limitations must be maintained aboard the aircraft during operation. The airworthiness certificate shall be displayed in a manner so that it is visible to either the passengers or crew. Additionally, a current registration form and weight and balance data shall be maintained on board. The registration form must not be expired and have a current address on it for the registered owner(s). Documentation that the aircraft has completed appropriate flight test requirements is maintained in the airframe logbook. The operating limitations, weight and balance data and airframe logbook must be reviewed prior to flight.

Weight and Balance Considerations. Accurate weight and balance data must be available for the airplane operated during the conduct of training. Like all light planes, RV-types are sensitive to loading and accurate assessment of performance and handling characteristics cannot be achieved without current weight and balance data. One of the primary limitations likely to be encountered is G-allowable or the ability to perform advanced maneuvers (if appropriate) during the conduct of training. Longitudinal stick force gradient and post-stall handling characteristics are highly dependent upon CG location. Depending on the airplane and crew weight, it may not be practical to carry full fuel for the conduct of dual instruction.

> **Note**
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> Maximum allowable gross weight is contained in the Operating Limitations specific to the airplane utilized for training. However, for the conduct of these tracks of instruction, designer's weight and balance limits should be utilized unless the Operating Limitations are more restrictive. Designer's limits are contained in Table 1-1.

Transition Training Track(s) Objective. The upgrading pilot will obtain the aeronautical skill and knowledge necessary to operate an RV-Type airplane commensurate with private pilot certification standards. If flown (as appropriate), advanced maneuvers need only be demonstrated to a safe ("practice") level for course completion. See Table 1-3.

Instructor Upgrade Track Objective. The upgrading instructor will obtain the high level of aeronautical skill and knowledge necessary to instruct in RV-type aircraft (including briefing, in-flight instruction and flight reconstruction/debriefing). All flying and instructional tasks will be demonstrated to proficiency level (commensurate with commercial pilot certification standards) for course completion. See Table 1-4.

Recurrent Training Track Objective. Completion of a flight review IAW 14 CFR 61.65, as amended.

Table 1-1: RV-Type Basic Weight and Balance Design Limits

Type	Max Allowable Gross Weight	Max Aerobatic Gross Weight	Forward CG Limit[2]	Aerobatic CG Limit[2]	Aft CG Limit[2]
RV-4	1500 LBS	1375 LBS	68.7	75.9	77.4
RV-6	1600 LBS	1375 LBS	68.7	75.3	76.8
RV-6A	1650 LBS	1375 LBS	68.7	75.3	76.8
RV-7	1800 LBS	1600 LBS	78.7	84.5	86.82
RV-7A	1800 LBS	1600 LBS	78.7	84.5	86.82
RV-8*	1800 LBS	1600 LBS*	78.7	85.3	86.82
RV-8A*	1800 LBS	1600 LBS*	78.7	85.3	86.82
		Max Utility Gross Weight		Utility CG Limit[2]	
RV-9/A[1]	1750 LBS	1600 LBS	77.95	82.72	84.84

*1550 LBS if not equipped with the -1 wing.
[1]Not designed for aerobatic flight
[2]Inches aft of datum. Datum for RV-4/6(A) is 60" ahead of the leading edge of the wing, and 70" ahead of the LE for RV-7(A)/8(A)/9(A).

Certificate Requirements. Upgrading pilots will possess a minimum of a private pilot's certificate with airplane, single-engine, land ratings and a valid 3rd Class Medical Certificate. For Instructor upgrade, the upgrading instructor will possess a minimum of a commercial pilot's certificate with instrument airplane, single-engine, land ratings, and current Flight Instructor's Certificate, or an expired Flight Instructor's Certificate, or a Ground Instructor Certificate, or a valid teaching certificate issued by a recognized licensing organization, or a valid/prior military instructor rating and a valid 3nd Class medical certificate.

> **Note**
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> A valid medical certificate is required if the upgrading pilot/instructor is operating as pilot-in-command.

Basic Course Experience Requirements. Upgrading pilots will have completed a Flight Review in accordance with 14 CFR 61.57, or other qualifying flight check/examination within the preceding 24 months prior to the beginning of transition training. For transition training in tail wheel equipped RV-type aircraft, the upgrading pilot will possess a tail wheel endorsement or have tail wheel experience logged prior to 15 April, 1991. Upgrading pilots will have logged a minimum of 3 hours of pilot-in-command time in an airplane in the 30 days prior to the beginning of training. Pilots upgrading to tail wheel equipped RV-types will have completed a minimum of 3 takeoffs and full stop landings in a tail wheel equipped aircraft within the 30 days preceding the beginning of transition training. Pilots upgrading to a nose wheel equipped RV-type aircraft will have completed a minimum of 3 takeoffs and landings in a nose wheel equipped aircraft within the 60 days preceding the beginning of transition training. Appropriate log book/flight record entries documenting experience must be presented prior to the conduct of training.

Advanced Course Experience Requirements. In addition to the requirements in the paragraph above (Basic Course Experience Requirements), pilots upgrading to tail wheel equipped RV-types will have completed a minimum of 10 takeoffs and full stop landings in a tail wheel equipped aircraft with 150 or more horsepower within the 30 days preceding the beginning of transition training. Pilots upgrading to a nose wheel equipped RV-type aircraft will have completed a minimum of 3 takeoffs and landings in a nose wheel equipped aircraft with 150 or more horse power within the 30 days preceding the beginning of transition training. Upgrading pilots will have completed an aircraft handling sortie within the preceding 30 days prior to the start of training in a single-engine, propeller driven aircraft with a MGTOW of less than 4000 lbs that includes: at least one short-field takeoff and landing to a full stop; at least one soft-field takeoff and landing to a full stop; power off stalls; power on stalls and slow flight. Upgrading pilots completing the advanced maneuvers portion of this syllabus will have prior aerobatic experience. Appropriate log book/flight record entries documenting experience must be presented prior to the conduct of training.

Advanced Top-Off Course Experience Requirements. Prior qualification in a RV type(s). 3 takeoffs and landings and 3 hours of pilot in command time in a RV type(s) within 30 days preceding the beginning of training. Appropriate log book/flight record entries documenting experience must be presented prior to the conduct of training.

Instructor Upgrade Course Experience Requirements. Prior qualification in a RV type(s): For initial instructor upgrade (i.e., not a previously qualified instructor), the upgrading instructor will have a minimum of 300 hours of pilot-in-command time logged in RV-type(s) aircraft. For upgrading instructors with previous instructor qualification in other aircraft or possessing a Certified Flight Instructor certificate, a minimum of 100 hours of pilot-in-command time in RV type(s) aircraft is required. 3 takeoffs and landings and 3 hours of pilot in command time in a RV type(s) aircraft within 30 days preceding the beginning of training. Appropriate log book/flight record entries documenting experience must be presented prior to the conduct of training.

Recurrent Course Experience Requirements. Prior qualification in an RV type(s).

> **Note**
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> Experience requirements for any track of instruction may be modified at the instructor's discretion. They have been established to provide a reasonable expectation that the appropriate track can be completed within time allotted. Variation in experience and currency is to be expected and will affect the amount of time required to complete training.

Average Flight Duration. The basic and advanced transition courses are designed for four flights of 1.25 hours average duration. The advanced top-off course is designed for two flights of 1.25 hours average duration. The instructor upgrade course uses the flow of the advanced transition course and is designed for four flights of 1.25 hours average duration. The recurrent course is designed for one flight of a minimum of 1.0 hours average duration. The instructor may adjust flight duration to accommodate local constraints and ensure completion of all required training events. Flights may be broken up into shorter segments and flight elements may be deferred at instructor discretion. A minimum of 5 hours of in-flight instruction is required for course completion of Basic, Advanced Transition and Instructor Upgrade tracks, a minimum of 2.5 hours of in-flight instruction is required for Advanced Top-Off, and a minimum of 1.0 hours of in-flight instruction is required for Reccurent training.

Training Days. The basic, advanced transition and instructor upgrade courses are designed to be completed in four training days, with one block of instruction completed per training day. The advanced top-off course is designed to be completed in two training days, and the recurrent course is designed to be completed in one training day. At the instructor's discretion, up to two blocks may be completed in one day.

> **Note**
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> Formal risk management training must be complete prior to beginning Block 1 training in the Basic, Advanced Transition and Instructor Upgrade tracks. If this student has not completed risk management training, an additional half training day is required prior to beginning Block 1 instruction.

Continuity of Training. One of the most important facets of effective training is ensuring adequate continuity. No more than seven calendar days should elapse between training flights. If a break exceeding seven days occurs, the previous flight should be re-flown for proficiency prior to moving on to the next flight in the track. If more than two days has elapsed between flights, the instructor should expect that the upgrading pilot may require additional review. Briefing, flight tasks and flight duration may need to be adjusted to accommodate.

Proficiency Flights. Additional proficiency (practice) flights may be added to the syllabus at the instructor's discretion. Grade sheets will be annotated with a "P" to indicate a proficiency flight (e.g., TR-3P). A proficiency flight may be generated due to break in training, upgrading pilot non-progression, upgrading pilot confidence/request, or for any reason at the instructor's discretion.

Incomplete Flights. If a flight is non-effective for weather, mechanical breakdown, etc., it will be considered incomplete and an additional flight will be generated to complete task requirements. The grade sheet should clearly state the flight is incomplete and an overall flight grade should not be assigned for the incomplete portion (individual elements/tasks that were completed should be graded, however).

Testing. The upgrading pilot/instructor will complete open-book written testing when required by the syllabus track. The minimum passing score for a written examination is 70%, and all examinations will be de-briefed with an instructor and corrected to 100%. In the event the minimum passing score is not achieved, the upgrading pilot will continue to re-take the test until a minimum passing grade is achieved. See WRITTEN EXAMINATION AND REVIEW.

Use of Chase Aircraft. RV-type aircraft are load-sensitive and not all are fitted with dual flight controls. In some cases (e.g., RV-4), lack of RCP load capacity and dual controls may make it impractical to conduct training in a specific aircraft. It may, however, be practical to conduct two-ship training if an appropriately qualified instructor and equivalent airplane are available for use. Chase flying is an instructor pilot using a suitable equivalent airplane to accompany a solo upgrading pilot and supervise in-flight training. ***The instructor pilot must be familiar with this type of formation flying and flight instruction technique prior to conducting chase operations.*** For the purpose of these syllabi, flying with a chase aircraft is not considered formation flying, and the upgrading pilot need not be proficient in formation operations. The chase aircraft/instructor pilot maintains responsibility for ensuring inter-flight deconfliction at all times.

Spin Training. Spin training will be conducted in accordance with AC61-67C, as amended. Spin training, when conducted, will be limited to incipient spin phase only. The incipient phase is defined as the portion of the spin from the time the airplane stalls and rotation starts until the spin becomes fully developed. When conducted for the purpose of these tracks of instruction, spin training will be limited to incipient spins of one turn duration, or less.

Use of Parachutes. Appropriately inspected parachutes will be worn any time planned maneuvering will exceed ± 30° of pitch or ± 60° of bank. Parachute weight must be factored into weight and balance calculations. A weight of 14 lbs per parachute will be used for weight and balance purposes if exact weight of parachute is not known.

Note
In accordance with AC61-67C Paragraph 301(b), parachutes are not required for spin training.

Training Documentation. Individual upgrading pilot/instructor grade books should be prepared to document transition training. Grade books should contain a training log, unaccomplished task log and individual grade sheets for each flight.

(1) ***Grade Books.*** Completed original grade books are the property of the flight instructor and will be retained for record. A copy will be provided to the upgrading pilot at the completion of training at the upgrading pilot's request.
(2) ***Grade Sheets.*** The instructor will prepare a grade sheet for each training flight flown. Individual maneuver elements/tasks will be objectively graded, and when proficiency is required, a "P" will be pre-printed at the appropriate level to aid the instructor in making a determination. Objective grading criteria, flight completion standards and specific maneuvering limitations will be printed on the back of each grade sheet. An overall subjective grade will be assigned for each flight.
(3) ***Log Book Endorsement.*** The instructor will annotate and endorse the upgrading pilot's log, as appropriate.

Note
Individual maneuvers and flight elements may be graded below required proficiency level and the upgrading pilot/instructor may progress to the next flight at the instructor's discretion, however all required maneuvers will be complete to the appropriate grade level prior to course completion. Flight elements graded below standard and unaccomplished tasks should be recorded and tracked in the unaccomplished task log in the student grade book.

Grading. Individual flight elements and maneuvers will be assigned a numeric grade in accordance with the standards in Table 1-2. Specific criteria are established for individual elements to allow for objective grading. An overall (average) numeric grade using the same scale should be assigned to the flight by the instructor. The instructor will also make a subjective progress assessment at the conclusion of each flight. Progress assessment levels are BELOW AVERAGE; AVERAGE; or ABOVE AVERAGE.

Table 1-2: Grading Criteria	
UNKOWN	Performance not observed or element not performed
DANGEROUS	Performance unsafe (requires overall grade of 0)
0	Performance indicates lack of ability or knowledge
1	Performance is safe, but indicates limited proficiency, makes errors of omission or commission. Minimum grade required to meet syllabus definition of "practice."
2	Performance is essentially correct. Recognizes and corrects errors. Minimum grade required to meet syllabus definition of "proficient."
3	Performance is correct, efficient, skillful and without hesitation
4	Performance reflects unusually high degree of ability

Flight Element Objectives/Standards of Behavior. Standards for proficiency of individual flight elements are listed in Tables 1-3 and 1-4. Table 1-3 is to be used for upgrading pilots completing the Basic, Advanced, Advanced Top-Off or Recurrent track(s). Table 1-4 is to be used for instructor upgrade track.

Table 1-3: Objectives/Standards of Behavior for Individual Flight Elements For Upgrading Pilots in the Basic Transition, Advanced Transition, Advanced Top-Off and Recurrent Tracks		
Element	***Min Grade Req***	***Objectives/Standards of Behavior***
GROUND OPERATIONS		
Weather / NOTAM Information	2	-Able to obtain sufficient information from an FAA approved source to make Go / No-Go decision for conduct of flight -Understands airspace requirements/limitations and temporary flight restrictions
TOLD (Takeoff and Landing Data)	2	-Able to compute or estimate takeoff and landing performance; able to determine runway requirements for safe operation under existing conditions; able to compute decision points -Understands factors affecting performance and able to apply appropriate takeoff and landing safety factors -Understands Koch Chart for density altitude effects

		-Understands Designer's Performance Specifications; understands difference between those specifications and specific RV-Type to be operated
EAB Airworthiness Determination	2	-Understands EAB airworthiness requirements and is able to make a determination as to the airworthiness of the airplane to be operated -Understands requirements documents and placards to be maintained on board -Understands Operating Limitations for airplane to be operated, including Phase 1 and Phase 2 operations -Understands requirement for annual condition check, able to reference appropriate airframe and engine log books to determine compliance -Familiar with EAB maintenance practice, including airframe look book entries and AD compliance (when appropriate) -Familiar with Van's Service Bulletins for RV-type to be operated -Familiar with procedures for completing minor and major modifications, including requirements to notify FSDO (when appropriate) -Familiar with procedure for ensuring current avionics data bases are maintained (when appropriate)
Weight and Balance	2	-Understands designer's weight and balance limits for RV-type to be operated -Able to locate and understand specific empty weight and balance data for RV-type to be operated; knows maximum allowable gross weight specified in the Operating Limitations for the RV-type to be operated -Able to compute weight and balance condition for takeoff, planned landing weight and low-fuel landing weight; able to apply computation and make determination as to whether or not the computed CG is within the envelope and maximum gross weight is not exceeded -Understands weight effects on performance; familiar with weight and balance effects on handling characteristics for RV-type operated
Operations of Systems	2	-Understands fuel system of RV-type to be operated: able to operate fuel selector valve; able to determine quantity of fuel on board -Understands electrical system of RV-type to be operated: understands sources of power; familiar with buss design; understands location and operation of critical circuit breakers; understands normal and abnormal system instrument indications; able to load-shed; familiar with time limits for

		back-up power systems -Flight control systems: understands how primary and secondary flight controls are activated; understands airspeed limitation for flap actuation -Understands airspeed limitations for the RV-type to be operated including airspeed indicator markings, calculation of symmetric and asymmetric maneuvering speed appropriate for gross weight and determining V_{NE} -Canopy system: understands how to actuate canopy; understands how to determine “locked” status of canopy; familiar with in-flight jettison procedures (when appropriate) -Brakes and steering: understands ground steering and braking systems for RV-type to be operated -Engine: understands how to start, operate and secure power plant for the RV-Type to be operated; able to interpret instrument indications for normal and abnormal conditions -Blindfold Cockpit Check: Able to locate all cockpit switches and controls by feel; able to operate critical systems by feel
Preflight Inspection	2	-Exhibits developed flow plan for the conduct of pre-flight inspection -Inspects the airplane utilizing appropriate check-list -Understands what items should be inspected, the reason for inspection and is able to detect defects -Develops methodology for inspection of wheels and brakes -Understands how to fuel the aircraft, exhibits ability to properly ground the airplane during refueling operations; understands how to remove, adjust and secure gas caps; exhibits methodology for determining fuel load for less than full tanks; knows location of all fuel drains and is able to drain and inspect fuel from all points -Understands the proper type/weight and how to service oil to the engine sump; able to determine oil level
Cockpit Management	2	-Understands preflight inspection requirements for egress equipment (parachutes) -Ensures loose items are secure; organizes equipment, publications and other material in an efficient manner to insure in-flight accessibility -Able to conduct effective passenger briefing to include experimental nature of the airplane, use of safety belts/harness, canopy operation, control interference, transfer of aircraft control (if appropriate), emergency procedures and use of safety equipment (if appropriate) -Familiar with technique to secure unoccupied cockpit for solo operations

		-Understands location and operation of all cockpit switches, circuit breakers and controls -Understands canopy operation; familiar with limitations for operating with canopy open or partially open; understands how to secure and verify security of canopy
Engine Start	2	-Positions aircraft properly with regard to safety of personnel on the ground, structures and surface conditions; demonstrates awareness of prop blast effects at all times -Understands engine manufacturer's or builder's recommended engine start procedures for starting, utilizing appropriate checklist -Familiar with cold weather starting procedures; familiar with manufacturer's recommendations for pre-heating -Familiar with hot starting procedure -Familiar with flooded start procedure -Familiar with ground leaning technique -Understands engine operating limits for ground operations -Familiar with starting and ground operation emergency procedures
Taxi	2	-Demonstrates awareness of prop blast at all times -Performs a brake check prior to taxi -Maneuvers the aircraft with regard to safety of personnel on the ground, structures and surface conditions; taxis to avoid other aircraft and hazards -Understands wind effects; allows for surface conditions and steering effectiveness; properly positions flight controls for taxi operations -Controls taxi direction and speed without excessive use of brakes -Divides attention inside/outside of cockpit; prioritizes and uses techniques to minimize pilot distraction -Understands how to ventilate the cockpit during taxi operations -Complies with markings, signals, clearances and instructions -Utilizes appropriate checklist -Avoids runway incursions
Before Takeoff Check/Run-up Operations	2	-Demonstrates awareness of prop blast at all times -Positions the airplane with regard to other planes, vehicles, obstacles/structures, wind and surface conditions -Understands engine manufacturer's or builder's recommended engine run-up procedure; understands engine operating limits; understands temperature requirements for run-up and is able to detect malfunctions -Divides attention inside/outside of cockpit

		-Utilizes appropriate checklist; able to ensure the airplane is in a safe operating condition -Understands use of flaps for takeoff; sets trim for computed CG/gross weight condition -Reviews TOLD, departure and emergency procedures; notes wind direction/speed -Ensures no conflict with traffic prior to taxiing into takeoff position
TAKEOFF		
Normal Takeoff	2	-Clears area, obtains clearance, properly positions aircraft for takeoff -Determines wind direction, crosswind component and properly positions flight controls -Utilizes appropriate checklist and applies pre-takeoff flow check to determine that aircraft is properly configured and ready for takeoff -Applies power smoothly; cross-checks engine instruments to determine normal operation -Maintains directional control, applies proper wind drift correction -Rotates and accelerates to V_Y +10/-5 KTS/MPH CAS; maintains V_Y to 1500 feet AGL; maintains coordinated flight; retracts flaps (when appropriate) prior to exceeding V_{FE}; transitions to desired cruise climb commensurate with engine cooling requirements/desired performance -Complies with clearance/departure procedure
Short-Field Takeoff	2	-Understands short-field operations; accommodates surface conditions -Clears area, obtains clearance, utilizes all available takeoff area, properly positions aircraft for takeoff -Utilizes appropriate checklist and applies pre-takeoff flow check to determine that aircraft is properly configured and ready for takeoff -Applies brakes while smoothly advancing power to specified run-up RPM; cross checks engine instruments to determine normal operation prior to brake release -Applies remaining power smoothly; maintains directional control, applies proper wind drift correction -Lifts off and accelerates to V_X +10/-5 KTS/MPH CAS; establishes proper pitch attitude to maintain speed until obstacles are cleared -Transitions to V_Y +10/-5 KTS/MPH CAS or cruise climb (as appropriate); retracts flaps (as appropriate) by V_{FE}

Soft-Field Takeoff	2	-Understands soft-field operations; accommodates surface conditions -Determines wind direction and properly positions flight controls to accommodate and to maximize lift as quickly as possible -Clears area, obtains clearance, properly positions aircraft for takeoff without stopping; smoothly applies power; cross-checks engine instruments to determine normal operation -Utilizes appropriate checklist and applies pre-takeoff flow check to determine that aircraft is properly configured and ready for takeoff -Establishes/maintains attitude that will transfer weight from wheels to wings as rapidly as practical; maintains directional control; properly applies wind drift correction -Lifts off at lowest practical airspeed and maintains ground effect while accelerating to V_X or $V_{Y,}$ as appropriate; maintains V_X or V_Y +10/-5 KTS/MPH CAS; maintains V_X or V_Y to 1500 feet AGL; retracts flaps (when appropriate) prior to exceeding V_{FE}; transitions to desired cruise climb commensurate with engine cooling requirements/desired performance -Complies with clearance/departure procedure
BASIC AIRCRAFT CONTROL		
Climb	2	-Understands climb performance for RV-Type to be operated -Understands handling qualities (including pitch stability) for best angle, best rate and cruise climbs -Understands proper application of rudder to maintain coordinated flight during all climb operations -Familiar with visibility restrictions during maximum performance climb -Understands engine temperature limits and adjusts climb (when appropriate) to ensure proper cooling air flow -Maintains desired heading ± 10^o -Maintains desired speed ± 10 KTS/MPH CAS -Familiar with techniques for cruise climb altitude adjustment; applies appropriate power/mixture adjustment
Straight and Level Flight	2	-Level-off: applies appropriate lead point, levels at specified altitude ± 100 feet; maintains altitude ± 100 feet; properly adjusts trim; maintains desired speed ± 10 KTS/MPH CAS -Establishing cruise condition: understands power settings; trims for desired airspeed; leans mixture for best power or economy; computes fuel flow ± 1 GPH; knows engine manufacturer's maximum recommended cruise power setting -Recognizes turbulent conditions; adjusts speed appropriately

Descent	2	-Descent point: able to compute cruise descent point ± 1 NM; plans descent with sufficient VVI to meet crossing restriction ± 1 NM; understands speed limitations; monitors engine condition; conducts descent check -Actively manages mixture control during descent -Level-off: applies appropriate lead point, levels at specified altitude ± 100 feet -Familiar with techniques for cruise descent altitude adjustment; applies appropriate power/mixture adjustment -Familiar with high descent rates at low speed -Glide: Understands glide performance; able to establish max endurance glide ± 10 KTS/MPH CAS; able to establish max range glide ± 10 KTS/MPH CAS; knows nominal sink rate for RV-Type to be operated; knows glide ratio for RV-type to be operated; knows power-off glide angle for RV-type to be operated; familiar with prop-stopped glide
Standard Rate Turns	2	-Understands instrument indications for establishing a 3^{o} per second turn
Medium Banked Turns	2	-Smoothly establishes 30^{o} bank ± 5^{o}; applies appropriate rudder to coordinate turn with no more than ½ ball-width error; establishes appropriate back pressure to maintain altitude ± 100 feet; computes lead-point for roll out and rolls out ± 10^{o} of specified heading; maintains airspeed ± 10 KTS/MPH CAS throughout -Divides attention between aircraft control, orientation, and clearing
Steep Turns	2	-Smoothly establishes 45^{o} or 60^{o} bank ± 5^{o}; applies appropriate rudder to coordinate turn with no more than ½ ball-width error; establishes appropriate back pressure and power; maintains altitude ± 100 feet; computes lead-point for roll out and rolls out ± 10^{o} of specified heading; maintains airspeed ± 10 KTS/MPH CAS when appropriate; -Divides attention between aircraft control, orientation, and clearing
SLOW FLIGHT AND STALLS		
Slow Flight	2	-Selects appropriate altitude for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 1500 feet AGL) -Properly configures the aircraft -Establishes/maintains airspeed at which any further increase in AOA or load factor would result in a stall; maintains speed +10/-0 KTS/MPH CAS -Accomplishes coordinated straight and level flight, turns,

		climbs and descents -When appropriate: Maintains specified altitude ± 100 feet; heading ± 10^{o}; specified bank angle ± 10^{o} -Divides attention between aircraft control, orientation, clearing and maintains minimum maneuvering altitude
Power-off Stall	2	-Selects appropriate altitude for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 1500 feet AGL) -Maintains coordinated flight and makes smooth control inputs -Recognizes aerodynamic warning/recovers promptly after a fully developed stall occurs by reducing AOA, increasing power and recovering to straight and level condition; makes appropriate control movements and attitude changes during recovery; does not exceed operating limitations for configuration -Divides attention between aircraft control, orientation, clearing and maintains minimum maneuvering altitude
Power-on Stall	2	-Selects appropriate altitude for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 1500 feet AGL) -Sets power to 65% or greater NLT stall break -Maintains coordinated flight and makes smooth control inputs -Recognizes aerodynamic warning/recovers promptly after a fully developed stall occurs by reducing AOA, adjusting power (as appropriate) and recovering to straight and level condition; makes appropriate control movements and attitude changes during recovery; does not exceed operating limitations for configuration -Divides attention between aircraft control, orientation, clearing and maintains minimum maneuvering altitude
Accelerated Stall	2	-Selects appropriate altitude for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 1500 feet AGL) -Establishes cruise condition at 55-65% power -Smoothly applies coordinated controls to establish 60^{o} bank angle; smooth application of G to cause deceleration while maintaining constant altitude -Recognizes/recovers promptly after stall occurs by reducing AOA, adjusting power (as appropriate) and recovering to straight and level condition; does not exceed operating limitations for configuration -Divides attention between aircraft control, orientation, clearing and maintains minimum maneuvering altitude

UNUSUAL ATTITUDES		
Nose-High Unusual Attitude	2	-Recognizes and confirms an unusual attitude exists -Applies smooth control inputs; maintain awareness of airspeed -Neutralizes aileron and rudder inputs; establishes 0 to ½ G condition -Adjusts power and bank as necessary to assist pitch and airspeed control; avoids negative G -As the nose approaches the horizon with adequate airspeed, adjusts pitch, bank and power to re-establish straight and level flight
Nose-Low Unusual Attitude	2	-Recognizes and confirms an unusual attitude exists -Applies smooth control inputs; maintains awareness of airspeed and adjusts power appropriately; avoids over G
CONFIDENCE MANEUVERS (Advanced Tracks)		
Lazy-Eight / Wing-over	1	-Establishes 55-65% cruise condition -Maintains constant pitch and roll rates throughout maneuver using smooth control inputs -Coordinates control inputs -Heading ± 15^{o} from entry reference at 180^{o} points -Airspeed ± 25 KTS/MPH CAS (not to exceed V_{NO}) from entry reference speed For maximum performance maneuvering: degrees of roll approximately equal to degrees of heading change (i.e., nose slicing through the horizon with 90^{o} bank at 90^{o} turn point). -With instructor assistance, divides attention between aircraft control, orientation, clearing and maintains minimum maneuvering altitude
Chandelle	1	-Establishes 55-65% cruise condition -Simultaneous application of power and smooth pitch and roll inputs to establish 45-60^{o} bank by 45^{o}turn point; maintains bank until 135^{o} point -Coordinates control inputs -Completes roll out at 180^{o} point ± 15^{o} at speed slightly above stall -With instructor assistance, divides attention between aircraft control, orientation, clearing and maintains minimum maneuvering altitude
AOA Recovery	2	-Understands "Unload for Control" concept -Smoothly retards the throttle to Idle-1500 RPM -Smoothly establishes and maintains 0 to ½ G condition with neutral controls -Coordinates recovery inputs

		-Avoids excessive airspeed build-up -Reestablishes straight and level flight -Divides attention between aircraft control, orientation, clearing and maintains minimum maneuvering altitude
Low AOA Aileron Roll	1	-Smoothly establishes 45-60^o pitch to 90 KTS/100 MPH CAS -Smoothly establishes and maintains 0 to ½ G condition and rolls the aircraft through 360^o as the nose tracks down -Coordinates recovery inputs -Avoids excessive airspeed build-up -Reestablishes straight and level flight -With instructor assistance, divides attention between aircraft control, orientation, clearing and maintains minimum maneuvering altitude
Inverted Recovery	1	-Smoothly establishes 60^o pitch to 70 KTS/80 MPH CAS -Smoothly establishes and maintains 0 to ½ G condition and rolls the aircraft through 180^o to inverted; -Maintains inverted 0 to ½ G condition as the nose drops -Performs low AOA roll to upright as airspeed increases -Avoids excessive airspeed build-up -Reestablishes straight and level flight -With instructor assistance, divides attention between aircraft control, orientation, clearing and maintains minimum maneuvering altitude
Deep Stall	1	-Selects appropriate altitude for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 5000 feet AGL) -Makes smooth control inputs -Decelerates power off to a stalled condition, recognizes aerodynamic warning -Maintains sufficient AOA to sustain stalled condition -Recognizes yaw and applies appropriate rudder to counter wing drop/nose slice -Recovers to a glide without use of power from nose-low condition without excessive airspeed build-up -With instructor assistance, divides attention between aircraft control, orientation, clearing, and maintains minimum maneuvering altitude
Incipient Upright Spin	1	-Selects appropriate altitude for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 3500 feet AGL) -Makes smooth control inputs -Decelerates power off to a stalled condition, recognizes aerodynamic warning and applies pro-spin controls after the stall is encountered

		-Maintains pro-spin controls until applying recovery controls -Recovers from nose-low condition without excessive airspeed build-up or engine over-speed
Cross-control Stall A. Skid B. Slip	1	-Selects appropriate altitude for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 5000 feet AGL) -Makes smooth control inputs A. Initiates skidding turn with rudder during deceleration (airspeed decreasing through 80 MPH/70 KTS CAS); applies appropriate outside aileron to maintain bank in direction of skid B. Initiates slipping turn with aileron during deceleration (airspeed decreasing through 90 MPH/80 KTS CAS); Applies sufficient top rudder to establish slip in direction of turn -Recognizes departure warning cues -Applies appropriate recovery controls -Notes altitude lost in recovery to straight/level flight -Understands a stall/spin at or below pattern altitude is generally non-recoverable
ADVANCED HANDLING (Advanced Tracks)		
G Warm-up	1	-Selects appropriate altitude for maneuvering in accordance with training rules and/or local restrictions -Establishes 130-140 KTS/150-160 MPH CAS / 65% Power condition -Over-banks and smoothly applies 3 G's for approximately 90^{o} of heading change -Reverses turn direction with an unloaded roll while establishing 130-150 KTS/150-170 MPH CAS -Smoothly applies 4 G's for approximately 90^{o} of heading change -Manages velocity vector throughout maneuver; avoids excessive speed build-up or accelerated stall -With instructor assistance, divides attention between aircraft control, orientation, clearing and maintains minimum maneuvering altitude
Acceleration maneuver	1	-Selects appropriate altitude for maneuvering in accordance with training rules and/or local restrictions -Smoothly establishes 0 to ½ G condition -Avoids negative G, unintentional engine interruption -Manages velocity vector throughout maneuver; avoids excessive speed build-up -With instructor assistance, divides attention between aircraft control, orientation, clearing and maintains minimum

		maneuvering altitude
Basic Roll	1	-Selects appropriate altitude for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 1500 feet AGL) -Establishes 125-150 KTS/140-170 MPH CAS / 65-75% Power condition -Smoothly applies back stick to establish 20-30^o nose up -Unloads to neutralize elevator input then applies smooth aileron input in desired direction of roll; maintains sufficient roll rate to ensure return to upright attitude no later than 20-30^o nose low --With instructor assistance, divides attention between aircraft control, orientation, clearing and maintains minimum maneuvering altitude
Loop	1	-Selects appropriate altitude for maneuvering in accordance with training rules and/or local restrictions -Establishes 150-160 KTS/170-180 MPH CAS / FULL power condition; does not exceed V_{NO} or engine red line RPM -Smoothly applies 3-4 G's -Eases back pressure as pitch exceeds 90^o nose up, but maintains sufficient pressure to ensure nose continues to track -Apexes inverted at ½ to 1 (positive) G at 60-80 KTS/70-90 MPH CAS -Reduces power (when appropriate) and smoothly increases G through backside of loop to rate nose; avoids excessive speed build-up; avoids accelerated stall -With instructor assistance, divides attention between aircraft control, orientation, clearing and maintains minimum maneuvering altitude
Split-S	1	-Selects appropriate altitude for maneuvering in accordance with training rules and/or local restrictions -Manages energy to establish a 10-30^o nose up entry condition at 60-80 KTS/70-90 MPH CAS -Reduces power to idle and smoothly increases G; avoids excessive speed build-up; avoids accelerated stall -With instructor assistance, divides attention between aircraft control, orientation, clearing and maintains minimum maneuvering altitude
Barrel Roll	1	-Selects appropriate altitude for maneuvering in accordance with training rules and/or local restrictions -Establishes 130-160 KTS/150-180 MPH CAS (not to exceed V_{NO}) / 65-75% condition -Selects suitable reference point; offsets 20-30^o using a coordinated turn

		-Smoothly applies simultaneous back pressure and aileron to establish a 2-3G roll -Maintains adequate roll rate and G to control airspeed throughout the maneuver; adjusts power as necessary -With instructor assistance, divides attention between aircraft control, orientation, clearing and maintains minimum maneuvering altitude
Immelman	1	-Selects appropriate altitude for maneuvering in accordance with training rules and/or local restrictions -Establishes 150-160 KTS/170-180 MPH CAS (not to exceed V_{NO}) / FULL power condition; does not exceed engine red line RPM -Smoothly applies 3-4 G's -Eases back pressure to arrive approximately 20-30^o nose up, inverted; unloads and smoothly applies aileron to roll back to upright; coordinates roll -With instructor assistance, divides attention between aircraft control, orientation, clearing and maintains minimum maneuvering altitude
Cuban 8	1	-Selects appropriate altitude for maneuvering in accordance with training rules and/or local restrictions -Establishes 150-160 KTS/170-180 MPH CAS (not to exceed V_{NO}) / FULL power condition; does not exceed engine red line RPM -Smoothly applies 3-4 G's -Eases back pressure as pitch exceeds 90^o nose up, but maintains sufficient pressure to ensure nose continues to track -Apexes inverted at ½ to 1 (positive) G at 60-80 KTS/70-90 MPH CAS -Reduces power and smoothly increases G through backside of loop to rate nose to 30-45^o below the horizon (inverted) -Unloaded roll to maintain 30-45^o down line -Initiates smooth pull-out to arrive at initial entry altitude/airspeed -Avoids excessive airspeed build-up; accelerated stall -With instructor assistance, divides attention between aircraft control, orientation, clearing and maintains minimum maneuvering altitude
Cloverleaf	1	-Selects appropriate altitude for maneuvering in accordance with training rules and/or local restrictions -Establishes 130-160 KTS/150-180 MPH CAS (not to exceed V_{NO}) / 65-75% condition -Smoothly applies 2-3 G's to achieve 70^o pitch -Applies aileron to roll to inverted as nose passes down

		through horizon 90^{o} from original entry heading -Smooth back pressure to re-establish entry conditions; adjusts power as required -Avoids excessive airspeed build-up; accelerated stall -With instructor assistance, divides attention between aircraft control, orientation, clearing and maintains minimum maneuvering altitude
PATTERN AND LANDING		
Emergency Landing	2	-Selects appropriate Glide Speed -Selects suitable site for emergency landing -Completes appropriate emergency procedures to effect re-start and/or secure; notifies ATC; squawks 7700 -Arrives at High Key position aligned with landing direction +500 / -0 feet of 1500’ AGL at a speed ≥ 105 MPH /95 KTS CAS -Establishes low key 1000’ AGL ± 200’ at 80 MPH / 70 KTS ± 10 KTS/MPH CAS -Arrives at selected landing site with sufficient energy to land
Descent Check	2	-Understands induction system and how to prevent icing/operate alternate air -Utilizes appropriate checklist: basic “GUMPS” flow prior to all descents and landings
Pattern Operations/ Perch Management	2	-Maintains pattern altitude ± 100 feet -Arrives at perch +10/-5 KTS/MPH of desired airspeed; maintains throughout base turn -Applies appropriate wind correction to maintain desired ground track -Adjusts perch point for wind conditions
Low-Approach / Go-Around	2	-Makes timely decision -Smoothly applies takeoff power; maintains directional control; adjusts pitch for V_X or V_Y climb (as appropriate) +10/-5 KTS/MPH CAS to safe altitude; maintains coordinated flight -Adjusts trim; retracts flaps no later than V_{FE} -Maneuvers as required to clear traffic/hazards -Applies appropriate wind drift correction -Utilizes appropriate checklist
Slip	2	-Understands proper control inputs to establish a forward and side slip; maintains AOA/airspeed awareness -For the purpose of glide path adjustment during approach to landing: Makes smooth, timely and correct control application during recovery from the slip -For the purpose of cross-wind landing: establishes a forward slip in a timely manner during the transition to landing; maintains desired ground track with longitudinal axis aligned

		with the landing surface to touchdown
Normal Landing	2	-Considers wind conditions, landing surface, obstructions and selects suitable TDZ -Establishes stabilized final approach; maintains speed of 1.3-1.4 V_{S0} +10/-5 KTS/MPH CAS (or L/D_{MAX} if equipped with AOA); applies gust correction -Makes smooth, timely and correct control applications during round out and touchdown -Touches down within first 500 feet of usable surface with no drift/longitudinal axis aligned with landing surface -Maintains cross-wind correction and directional control throughout approach and landing -Complies with approach/clearance procedure -Utilizes appropriate checklist
180^o Power-off Landing	2	-Familiar with energy management techniques to accomplish a 180^o power-off approach from a 1000 foot AGL low key through touchdown on a suitable landing surface - Considers wind conditions, landing surface, obstructions and selects suitable TDZ -Utilizes appropriate glide speed to transition to final approach speed no slower than 1.3-1.4 V_{S0} +10/-5 KTS/MPH CAS (or L/D_{MAX} if equipped with AOA) -Touches down in normal landing attitude within the first 1/2 of usable surface or at a suitable touchdown point that would allow a full stop landing without application of abnormal braking on the landing surface available with no drift/longitudinal axis aligned with landing surface -Maintains cross-wind correction and directional control throughout approach and landing Complies with approach/clearance procedure -Utilizes appropriate checklist
Short-Field Landing	2	-Considers wind conditions, landing surface, obstructions and selects suitable TDZ -Maintains stabilized approach speed not greater than 11.3-1.4 V_{S0} +10/-5 KTS/MPH CAS (or L/D_{MAX} if equipped with AOA) -Makes smooth, timely and correct control application during the round out and touchdown -Touches down smoothly at minimum control airspeed at or within 200 feet of planned TDZ with no side drift, minimum float and longitudinal axis aligned with landing path -Maintains cross-wind correction and directional control throughout the approach and landing sequence -Applies brakes and flight controls as necessary to stop in the shortest distance consistent with safety

		-Utilizes appropriate checklist
Soft-Field Landing	2	-Considers wind conditions, landing surface, obstructions and selects suitable TDZ -Maintains stabilized approach speed not greater than 1.3-1.4 V_{S0} +10/-5 KTS/MPH CAS (or L/D_{MAX} if equipped with AOA) -Makes smooth, timely and correct control application during the round out and touchdown -Touches down softly with no drift and longitudinal axis aligned with landing path -Maintains cross-wind correction and directional control throughout the approach and landing sequence -Utilizes proper flight controls, speed and power to taxi on the soft surface -Utilizes appropriate checklist
AFTER LANDING		
After landing, parking and securing	2	-Maintains directional control -Observes markings/procedures/clearance(s) -Parks in appropriate area; considers safety of airplane, persons and property on the ground -Utilizes appropriate checklist -Familiar with techniques for moving the airplane after shutdown -Conducts post-flight inspection; secures the aircraft
Servicing	2	-Understands how to fuel the aircraft, exhibits ability to properly ground the airplane during refueling operations; understands how to remove, adjust and secure gas caps; exhibits methodology for determining fuel load for less than full tanks; knows location of all fuel drains and is able to drain and inspect fuel from all points -Understands the proper type/weight and how to service oil to the engine sump; able to determine oil level
AIRMANSHIP		
Clearing / Visual Look-out	2	-Utilizes proper scanning techniques -Maneuvers as required to ensure flight path is clear of traffic -Maintains situational awareness of other aircraft operating on frequency/sharing the traffic pattern -Understands and applies right of way rules
Fuel Management	2	-Determines fuel requirements and ensures proper fuel load for the conduct of the flight; ensures sufficient fuel reserve at all times -Monitors fuel level throughout the flight -Computes appropriate BINGO fuel -Maintains fuel levels sufficient for lateral balance

Airmanship	2	-Understands aircraft capabilities and limitations -Able to navigate; maintains orientation - Adheres to training rules, procedures and regulations -Utilizes resources effectively -Recognizes fatigue and degraded performance -Manages cockpit workload effectively; prioritizes
Judgment (ORM/ADM)	2	- Identifies risks/hazards, analyzes controls, makes control decisions and monitors results -Understands pilot capabilities: establishes and adheres to personal limitations -Applies appropriate prioritization to ensure safety

Table 1-4: Objectives/Standards of Behavior for Individual Flight Elements For Instructor Upgrade

Element	***Min Grade Req***	***Objectives/Standards of Behavior***
GROUND OPERATIONS		
Weather / NOTAM Information	2	-Able to instruct an upgrading pilot how to obtain sufficient information from an FAA approved source to make Go / No-Go decision for conduct of flight -Understands and is able to instruct airspace requirements/limitations and temporary flight restrictions
TOLD (Takeoff and Landing Data)	2	-Able to compute or estimate takeoff and landing performance; able to determine runway requirements for safe operation under existing conditions; able to compute decision points and able to offer performance estimation techniques to upgrading pilots with limited performance information available -Understands and is able to instruct factors affecting performance and able to apply appropriate takeoff and landing safety factors -Understands and is able to instruct Koch Chart for density altitude effects -Understands and is able to instruct Designer's Performance Specifications; understands difference between those specifications and specific RV-Type to be operated
EAB Airworthiness Determination	2	-Understands and is able to instruct EAB airworthiness requirements and is able to make a determination as to the airworthiness of the airplane to be operated -Understands and is able to instruct requirements documents and placards to be maintained on board

		-Understands and is able to instruct Operating Limitations for airplane to be operated, including Phase 1 and Phase 2 operations -Understands and is able to instruct requirement for annual condition check, able to reference appropriate airframe and engine log books to determine compliance -Understands and is able to instruct EAB maintenance practice, including airframe look book entries and AD compliance (when appropriate) - Understands and is able to instruct Van's Service Bulletins for RV-type to be operated - Understands and is able to instruct procedures for completing minor and major modifications, including requirements to notify FSDO (when appropriate) - Understands and is able to instruct procedure for ensuring current avionics data bases are maintained (when appropriate)
Weight and Balance	2	-Understands and is able to instruct designer's weight and balance limits for RV-type to be operated -Locates, understands and is able to instruct specific empty weight and balance data for RV-type to be operated; knows maximum allowable gross weight specified in the Operating Limitations for the RV-type to be operated -Able to compute and instruct weight and balance condition for takeoff, planned landing weight and low-fuel landing weight; able to apply computation and make determination as to whether or not the computed CG is within the envelope and maximum gross weight is not exceeded -Understands and is able to instruct weight effects on performance; familiar with and able to instruct weight and balance effects on handling characteristics for RV-type operated
Operations of Systems	2	-Understands and is able to instruct fuel system of RV-type to be operated: able to operate fuel selector valve; able to determine quantity of fuel on board -Understands and is able to instruct electrical system of RV-type to be operated: understands sources of power; familiar with buss design; understands location and operation of critical circuit breakers; understands normal and abnormal system instrument indications; able to load-shed; familiar with time limits for back-up power systems -Flight control systems: understands and is able to instruct how primary and secondary flight controls are activated; understands airspeed limitation for flap actuation -Understands and is able to instruct airspeed limitations for the

		RV-type to be operated including airspeed indicator markings, calculation of symmetric and asymmetric maneuvering speed appropriate for gross weight and determining V_{NE} -Canopy system: understands and is able to instruct how to actuate canopy; understands how to determine "locked" status of canopy; familiar with in-flight jettison procedures (when appropriate) -Brakes and steering: understands and is able to instruct ground steering and braking systems for RV-type to be operated -Engine: understands and is able to instruct how to start, operate and secure power plant for the RV-Type to be operated; able to interpret instrument indications for normal and abnormal conditions -Blindfold Cockpit Check: Able to locate all cockpit switches and controls by feel; able to operate critical systems by feel
Preflight Inspection	2	-Exhibits developed flow plan for and is able to instruct the conduct of pre-flight inspection; demonstrates and simultaneously explains a visual inspection -Inspects the airplane utilizing appropriate check-list -Understands and is able to instruct what items should be inspected, the reason for inspection and is able to detect defects -Develops methodology for and is able to instruct inspection of wheels and brakes -Understands and is able to instruct how to fuel the aircraft: exhibits ability to properly ground the airplane during refueling operations; understands how to remove, adjust and secure gas caps; exhibits methodology for determining fuel load for less than full tanks; knows location of all fuel drains and is able to drain and inspect fuel from all points -Understands the proper type/weight and is able to instruct how to service oil to the engine sump; able to determine oil level
Cockpit Management	2	-Understands and is able to instruct preflight inspection requirements for egress equipment (parachutes) -Ensures loose items are secure; organizes equipment, publications and other material in an efficient manner to insure in-flight accessibility -Able to conduct effective passenger briefing to include experimental nature of the airplane, use of safety belts/harness, canopy operation, control interference, transfer of aircraft control (if appropriate), emergency procedures and use of safety equipment (if appropriate)

		-Able to secure unoccupied cockpit for solo operations -Understands and is able to instruct location and operation of all cockpit switches, circuit breakers and controls -Understands and is able to instruct canopy operation; understands limitations for operating with canopy open or partially open; understands how to secure and verify security of canopy
Engine Start	2	-Positions aircraft properly with regard to safety of personnel on the ground, structures and surface conditions; demonstrates awareness of prop blast effects at all times -Understands and is able to instruct engine manufacturer's or builder's recommended engine start procedures for starting, utilizing appropriate checklist -Understands and is able to instruct cold weather starting procedures; understands manufacturer's recommendations for pre-heating -Understands and is able to instruct hot starting procedure -Understands and is able to instruct flooded start procedure -Understands and is able to instruct ground leaning -Understands engine operating limits for ground operations -Understands and is able to instruct starting and ground operation emergency procedures; able to assist upgrading pilot with developing procedures and techniques if no builder's information is available
Taxi	2	-Demonstrates awareness of prop blast at all times -Performs a brake check prior to taxi -Maneuvers the aircraft with regard to safety of personnel on the ground, structures and surface conditions; taxis to avoid other aircraft and hazards -Understands and is able to instruct how to compensate for wind effects; allows for surface conditions and steering effectiveness; properly positions flight controls for taxi operations -Controls taxi direction and speed without excessive use of brakes -Divides attention inside/outside of cockpit; prioritizes and uses techniques to minimize pilot distraction -Understands how to ventilate the cockpit during taxi operations -Complies with markings, signals, clearances and instructions -Utilizes appropriate checklist -Avoids runway incursions
Before Takeoff Check/Run-up	2	-Demonstrates awareness of prop blast at all times -Positions the airplane with regard to other planes, vehicles,

Operations		obstacles/structures, wind and surface conditions -Understands and is able to instruct engine manufacturer's or builder's recommended engine run-up procedure: understands engine operating limits; understands temperature requirements for run-up and is able to detect malfunctions -Divides attention inside/outside of cockpit -Utilizes appropriate checklist; able to ensure the airplane is in a safe operating condition -Understands and is able to instruct use of flaps and trim for takeoff -Reviews TOLD, departure and emergency procedures; notes wind direction/speed -Ensures no conflict with traffic prior to taxiing into takeoff position
TAKEOFF		
Normal Takeoff	2	-Understands and is able to instruct techniques and procedures for a normal and crosswind takeoff and rejected (aborted) takeoff -Clears area, obtains clearance, properly positions aircraft for takeoff -Determines wind direction, crosswind component and properly positions flight controls -Utilizes appropriate checklist and applies pre-takeoff flow check to determine that aircraft is properly configured and ready for takeoff -Applies power smoothly; cross-checks engine instruments to determine normal operation -Maintains directional control, applies proper wind drift correction -Rotates and accelerates to $V_Y \pm$ 5 KTS/MPH CAS; maintains $V_Y \pm$ 5 KTS/MPH CAS to 1500 feet AGL; maintains coordinated flight; retracts flaps (when appropriate) prior to exceeding V_{FE}; transitions to desired cruise climb commensurate with engine cooling requirements/desired performance -Complies with clearance/departure procedure
Short-Field Takeoff	2	-Understands and is able to instruct short-field operations; accommodates surface conditions -Clears area, obtains clearance, utilizes all available takeoff area, properly positions aircraft for takeoff -Utilizes appropriate checklist and applies pre-takeoff flow check to determine that aircraft is properly configured and ready for takeoff -Applies brakes while smoothly advancing power to specified

		run-up RPM; cross checks engine instruments to determine normal operation prior to brake release -Applies remaining power smoothly; maintains directional control, applies proper wind drift correction -Lifts off and accelerates to V_X +5/-0 KTS/MPH CAS; establishes proper pitch attitude to maintain speed until obstacles are cleared -Transitions to V_Y ± 5 KTS/MPH CAS or cruise climb (as appropriate); retracts flaps (as appropriate) by V_{FE}
Soft-Field Takeoff	2	-Understands and is able to instruct soft-field operations; accommodates surface conditions -Determines wind direction and properly positions flight controls to accommodate and to maximize lift as quickly as possible -Clears area, obtains clearance, properly positions aircraft for takeoff without stopping; smoothly applies power; cross-checks engine instruments to determine normal operation -Utilizes appropriate checklist and applies pre-takeoff flow check to determine that aircraft is properly configured and ready for takeoff -Establishes/maintains attitude that will transfer weight from wheels to wings as rapidly as practical; maintains directional control; properly applies wind drift correction -Lifts off at lowest practical airspeed and maintains ground effect while accelerating to V_X or $V_{Y,}$ as appropriate; maintains V_X or V_Y ± 5 KTS/MPH CAS; maintains V_X or V_Y to 1500 feet AGL; retracts flaps (when appropriate) prior to exceeding V_{FE}; transitions to desired cruise climb commensurate with engine cooling requirements/desired performance -Complies with clearance/departure procedure
BASIC AIRCRAFT CONTROL		
Climb	2	-Understands and is able to instruct climb performance for RV-Type to be operated -Understands and is able to instruct handling qualities (including pitch stability) for best angle, best rate and cruise climbs -Understands and is able to instruct proper application of rudder to maintain coordinated flight during all climb operations -Understands visibility restrictions during maximum performance climb -Understands and is able to instruct engine temperature limits and adjusts climb (when appropriate) to ensure proper cooling

		air flow -Maintains desired heading ± 10^{o} -Maintains desired speed ± 5 KTS/MPH CAS -Understands and is able to instruct techniques for cruise climb altitude adjustment; applies appropriate power/mixture adjustment
Straight and Level Flight	2	-Level-off: applies appropriate lead point, levels at specified altitude ± 50 feet; maintains altitude ± 50 feet; properly adjusts trim; maintains airspeed ± 5 KTS/MPH CAS -Establishing cruise condition: understands and is able to instruct power settings; trims for desired airspeed; leans mixture for best power or economy; computes fuel flow ± 1 GPH; knows engine manufacturer's maximum recommended cruise power setting -Recognizes turbulent conditions; adjusts speed appropriately
Descent	2	-Descent point: able to compute and instruct cruise descent point ± 1 NM; plans descent with sufficient VVI to meet crossing restriction ± 1 NM; understands and instructs speed limitations; monitors engine condition; conducts descent check -Actively manages mixture control during descent -Level-off: applies appropriate lead point, levels at specified altitude ± 50 feet -Understands and is able to instruct techniques for cruise descent altitude adjustment; applies appropriate power/mixture adjustment -Understands high descent rates at low speed -Glide: Understands glide performance; able to establish and instruct max endurance glide ± 5 KTS/MPH CAS; able to establish and instruct max rang glide ± 5 KTS/MPH CAS; understands and is able to instruct nominal sink rate for RV-Type to be operated; understands glide ratio for RV-type to be operated; understands power-off glide angle for RV-type to be operated; understands and is able to instruct prop-stopped glide
Standard Rate Turns	2	-Understands and is able to instruct instrument indications for establishing a 3^{o} per second turn
Medium Banked Turns	2	-Smoothly establishes 30^{o} bank ± 5^{o}; applies appropriate rudder to coordinate turn with no more than ½ ball-width error; establishes appropriate back pressure to maintain altitude ± 50 feet; computes lead-point for roll out and rolls out ± 10^{o} of specified heading; maintains airspeed ± 5 KTS/MPH CAS throughout -Divides attention between aircraft control, orientation and clearing and in-flight instruction

Steep Turns	2	-Smoothly establishes 45^{o} or 60^{o} bank ± 5^{o}; applies appropriate rudder to coordinate turn with no more than ½ ball-width error; establishes appropriate back pressure and power; maintains altitude ± 100 feet; computes lead-point for roll out and rolls out ± 10^{o} of specified heading; maintains airspeed ± 10 KTS/MPH CAS when appropriate; -Divides attention between aircraft control, orientation and clearing and in-flight instruction
<u>SLOW FLIGHT AND STALLS</u>		
Slow Flight	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 1500 feet AGL) in a manner which optimizes task accomplishment and/or flow -Properly configures the aircraft -Establishes/maintains airspeed 5 KTS/MPH CAS above stall buffet; maintains speed +5/-0 KTS/MPH CAS -Accomplishes coordinated straight and level flight, turns, climbs and descents -When appropriate: Maintains specified altitude ± 50 feet; heading ± 10^{o}; specified bank angle ± 5^{o} -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
Power-off Stall	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 1500 feet AGL) in a manner which optimizes task accomplishment and/or flow -Maintains coordinated flight and makes smooth control inputs -Recognizes aerodynamic warning/recovers promptly after stall occurs by reducing AOA, increasing power and recovering to straight and level condition; makes appropriate control movements and attitude changes during recovery; does not exceed operating limitations for configuration -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
Power-on Stall	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 1500 feet AGL) in a manner which optimizes task accomplishment and/or flow -Sets power to 65% or greater NLT stall break -Maintains coordinated flight and makes smooth control inputs -Recognizes aerodynamic warning/recovers promptly after stall

		occurs by reducing AOA, adjusting power (as appropriate) and recovering to straight and level condition; makes appropriate control movements and attitude changes during recovery; does not exceed operating limitations for configuration -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
Accelerated Stall	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 1500 feet AGL) in a manner which optimizes task accomplishment and/or flow -Establishes cruise condition at 55-65% power -Smoothly applies coordinated controls to establish 60^{o} bank angle; smooth application of G to cause deceleration while maintaining constant altitude -Recognizes/recovers promptly after stall occurs by reducing AOA, adjusting power (as appropriate) and recovering to straight and level condition; does not exceed operating limitations for configuration -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
UNUSUAL ATTITUDES		
Nose-High Unusual Attitude	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 1500 feet AGL) in a manner which optimizes task accomplishment and/or flow -Recognizes and confirms an unusual attitude exists -Applies smooth control inputs; maintain awareness of airspeed -Neutralizes aileron and rudder inputs; establishes 0 to ½ G condition -Adjusts power and bank as necessary to assist pitch and airspeed control; avoids negative G -As the nose approaches the horizon with adequate airspeed, adjusts pitch, bank and power to re-establish straight and level flight
Nose-Low Unusual Attitude	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 1500 feet AGL) in a manner which optimizes task accomplishment and/or flow -Recognizes and confirms an unusual attitude exists -Applies smooth control inputs; maintains awareness of

		airspeed and adjusts power appropriately; avoids over G
<u>CONFIDENCE MANEUVERS</u>		
Lazy-Eight / Wing-over	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 1500 feet AGL) in a manner which optimizes task accomplishment and/or flow -Establishes 55-65% cruise condition -Maintains constant pitch and roll rate throughout maneuver using smooth control inputs -Coordinates control inputs -Heading ± 15^{o} from entry reference at 180^{o} points -Airspeed ± 20 KTS/MPH CAS (not to exceed V_{NO}) from entry reference speed For maximum performance maneuvering: degrees of roll approximately equal to degrees of heading change (i.e., nose slicing through the horizon with 90^{o} bank at 90^{o} turn point). -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
Chandelle	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 1500 feet AGL) in a manner which optimizes task accomplishment and/or flow -Establishes 55-65% cruise condition -Simultaneous application of power and smooth pitch and roll inputs to establish 45-60^{o} bank by 45^{o}turn point; maintains bank until 135^{o} point -Coordinates control inputs -Completes roll out at 180^{o} point ± 15^{o} at speed slightly above stall -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
AOA Recovery	2	-Understands and effectively instructs “Unload for Control” concept -Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 1500 feet AGL) in a manner which optimizes task accomplishment and/or flow -Smoothly retards the throttle to Idle-1500 RPM -Smoothly establishes and maintains 0 to ½ G condition with neutral controls -Coordinates recovery inputs

		-Avoids excessive airspeed build-up -Reestablishes straight and level flight -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
Low AOA Aileron Roll	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 1500 feet AGL) in a manner which optimizes task accomplishment and/or flow -Smoothly establishes 45-60^{o} pitch to 90 KTS/100 MPH CAS -Smoothly establishes and maintains 0 to ½ G condition and rolls the aircraft through 360^{o} as the nose tracks down -Coordinates recovery inputs -Avoids excessive airspeed build-up -Reestablishes straight and level flight -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
Inverted Recovery	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 1500 feet AGL) in a manner which optimizes task accomplishment and/or flow -Smoothly establishes 60^{o} pitch to 70 KTS/80 MPH CAS -Smoothly establishes and maintains 0 to ½ G condition and rolls the aircraft through 180^{o} to inverted; -Maintains inverted 0 to ½ G condition as the nose drops -Performs low AOA roll to upright as airspeed increases -Avoids excessive airspeed build-up -Reestablishes straight and level flight -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
Deep Stall	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 3500 feet AGL) -Smoothly decelerates to a power off to a stalled condition, recognizes aerodynamic warning -Maintains sufficient AOA to sustain stalled condition -Recognizes yaw and smoothly and efficiently applies appropriate rudder to counter nose slice/wing drop -Recovers to a glide without use of power from nose-low condition without excessive airspeed build-up -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-

		flight instruction
Incipient Upright Spin	2	--Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 3500 feet AGL) in a manner which optimizes task accomplishment and/or flow -Makes smooth control inputs -Decelerates power off to a stalled condition, recognizes aerodynamic warning and applies pro-spin controls after the stall is encountered -Maintains pro-spin controls until applying recovery controls -Recovers from nose-low condition without excessive airspeed build-up or engine over-speed -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
Cross-control Stall C. Skid D. Slip	1	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules and/or local restrictions (in no case lower than 5000 feet AGL) -Makes smooth control inputs A. Initiates skidding turn with rudder during deceleration (airspeed decreasing through 80 MPH/70 KTS CAS); applies appropriate outside aileron to maintain bank in direction of skid B. Initiates slipping turn with aileron during deceleration (airspeed decreasing through 90 MPH/80 KTS CAS); applies sufficient top rudder to establish slip in direction of turn -Recognizes departure warning cues -Applies appropriate recovery controls -Demonstrates the difference between rolling underneath and recovering from nose low unusual attitude following skidding departure in terms of altitude lost during recovery -Emphasizes altitude lost during recovery; emphasizes need for proper control application in the landing pattern; emphasizes that a stall/spin encountered at/below pattern altitude is generally unrecoverable -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
ADVANCED HANDLING		
G Warm-up	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules FARs and/or local restrictions in a manner which optimizes task accomplishment and/or flow

		-Establishes 130-140 KTS/150-160 MPH CAS / 65% Power condition -Over-banks and smoothly applies 3 G's for approximately 90^{o} of heading change -Reverses turn direction with an unloaded roll while establishing 130-150 KTS/150-170 MPH CAS -Smoothly applies 4 G's for approximately 90^{o} of heading change -Manages velocity vector throughout maneuver; avoids excessive speed build-up or accelerated stall -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
Acceleration maneuver	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules FARs and/or local restrictions in a manner which optimizes task accomplishment and/or flow -Smoothly establishes 0 to ½ G condition -Avoids negative G, unintentional engine interruption -Manages velocity vector throughout maneuver; avoids excessive speed build-up -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
Basic Roll	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules FARs and/or local restrictions in a manner which optimizes task accomplishment and/or flow -Establishes 125-150 KTS/140-170 MPH CAS / 65-75% Power condition -Smoothly applies back stick to establish 20-30^{o} nose up -Unloads to neutralize elevator input then applies smooth aileron input in desired direction of roll; maintains sufficient roll rate to ensure return to upright attitude no later than 20-30^{o} nose low -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
Loop	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules FARs and/or local restrictions in a manner which optimizes task accomplishment and/or flow -Establishes 150-160 KTS/170-180 MPH CAS / FULL power condition; does not exceed V_{NO} or engine red line RPM

		-Smoothly applies 3-4 G's -Eases back pressure as pitch exceeds 90^{o} nose up, but maintains sufficient pressure to ensure nose continues to track -Apexes inverted at ½ to 1 (positive) G at 60-80 KTS/70-90 MPH CAS -Reduces power (when appropriate) and smoothly increases G through backside of loop to rate nose; avoids excessive speed build-up; avoids accelerated stall -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
Split-S	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules FARs and/or local restrictions in a manner which optimizes task accomplishment and/or flow -Manages energy to establish a $10\text{-}30^{o}$ nose up entry condition at 60-80 KTS/70-90 MPH CAS -Reduces power to idle and smoothly increases G; avoids excessive speed build-up; avoids accelerated stall -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
Barrel Roll	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules FARs and/or local restrictions in a manner which optimizes task accomplishment and/or flow -Establishes 130-160 KTS/150-180 MPH CAS (not to exceed V_{NO}) / 65-75% condition -Selects suitable reference point; offsets $20\text{-}30^{o}$ using a coordinated turn -Smoothly applies simultaneous back pressure and aileron to establish a 2-3G roll -Maintains adequate roll rate and G to control airspeed throughout the maneuver; adjusts power as necessary -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
Immelman	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules FARs and/or local restrictions in a manner which optimizes task accomplishment and/or flow -Establishes 150-160 KTS/170-180 MPH CAS (not to exceed V_{NO}) / FULL power condition; does not exceed engine red line RPM

		-Smoothly applies 3-4 G's -Eases back pressure to arrive approximately 20-30^{o} nose up, inverted; unloads and smoothly applies aileron to roll back to upright; coordinates roll -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
Cuban 8	2	-Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules FARs and/or local restrictions in a manner which optimizes task accomplishment and/or flow -Establishes 150-160 KTS/170-180 MPH CAS (not to exceed V_{NO}) / FULL power condition; does not exceed engine red line RPM -Smoothly applies 3-4 G's -Eases back pressure as pitch exceeds 90^{o} nose up, but maintains sufficient pressure to ensure nose continues to track -Apexes inverted at ½ to 1 (positive) G at 60-80 KTS/70-90 MPH CAS -Reduces power and smoothly increases G through backside of loop to rate nose to 30-45^{o} below the horizon (inverted) -Unloaded roll to maintain 30-45^{o} down line -Initiates smooth pull-out to arrive at initial entry altitude/airspeed -Avoids excessive airspeed build-up; accelerated stall -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction
Cloverleaf	2	--Selects appropriate altitude; safely and efficiently positions the aircraft for maneuvering in accordance with training rules FARs and/or local restrictions in a manner which optimizes task accomplishment and/or flow -Establishes 130-160 KTS/150-180 MPH CAS (not to exceed V_{NO}) / 65-75% condition -Smoothly applies 2-3 G's to achieve 70^{o} pitch -Applies aileron to roll to inverted as nose passes down through horizon 90^{o} from original entry heading -Smooth back pressure to re-establish entry conditions; adjusts power as required -Avoids excessive airspeed build-up; accelerated stall -Divides attention between aircraft control, orientation, clearing, maintaining minimum maneuvering altitude, and in-flight instruction

PATTERN AND LANDING		
Emergency Landing	2	-Understands and demonstrates the ability to instruct emergency and precautionary landing; -Understands and selects appropriate Glide Speed -Selects suitable site for emergency landing -Completes appropriate emergency procedures to effect re-start and/or secure; notifies ATC; squawks 7700 -Arrives at High Key position aligned with landing direction +500 / -0 feet of 1500' AGL at a speed ≥ 105 MPH /95 KTS CAS -Establishes low key 1000' AGL ± 200' at 80 MPH / 70 KTS ± 10 KTS/MPH CAS -Arrives at selected landing site with sufficient energy to land
Descent Check	2	-Understands induction system and how to prevent icing/operate alternate air -Utilizes appropriate checklist: basic "GUMPS" flow prior to all descents and landings
Pattern Operations/ Perch Management	2	-Maintains pattern altitude ± 50 feet -Arrives at perch ± 5 KTS/MPH CAS of desired airspeed; maintains throughout base turn -Understands and is able to instruct application of appropriate wind correction to maintain desired ground track -Understands and is able to instruct how to adjust the perch point for wind conditions
Low-Approach / Go-Around	2	-Understands and is able to instruct appropriate techniques and procedures to accomplish a balked landing/go-around; -Makes timely decision -Smoothly applies takeoff power; maintains directional control; adjusts pitch for V_X or V_Y climb (as appropriate) ± 5 KTS/MPH CAS to safe altitude; maintains coordinated flight -Adjusts trim; retracts flaps no later than V_{FE} -Maneuvers as required to clear traffic/hazards -Applies appropriate wind drift correction -Utilizes appropriate checklist
Slip	2	-Understands and is able to instruct proper control inputs to establish a forward and side slip; maintains AOA/airspeed awareness -For the purpose of glide path adjustment during approach to landing: Makes smooth, timely and correct control application during recovery from the slip -For the purpose of cross-wind landing: establishes a forward slip in a timely manner during the transition to landing; maintains desired ground track with longitudinal axis aligned with the landing surface to touchdown

Normal Landing	2	-Understands and is able to instruct appropriate techniques and procedures to accomplish a normal landing: -Considers wind conditions, landing surface, obstructions and selects suitable TDZ -Establishes stabilized final approach; maintains speed of 1.3-1.4 V_{S0} ± 5 KTS/MPH CAS (or L/D_{MAX} if equipped with AOA) ; applies gust correction -Makes smooth, timely and correct control applications during round out and touchdown -Touches down within 200 feet of the specified point (within first 500 feet of usable surface) with no drift/longitudinal axis aligned with landing surface -Maintains cross-wind correction and directional control throughout approach and landing -Complies with approach/clearance procedure -Utilizes appropriate checklist
180^{o} Power-off Landing	2	-Understands and is able to instruct energy management techniques to accomplish a 180^{o} power-off approach from a 1000 foot AGL low key through touchdown on a suitable landing surface -Considers wind conditions, landing surface, obstructions and selects suitable TDZ -Utilizes appropriate glide speed to transition to final approach; speed no slower than 1.3-1.4 V_{S0} KTS/MPH CAS (or L/D_{MAX} if equipped with AOA) until landing is assured -Touches down in normal landing attitude within the first 1/2 of usable surface or at a suitable touchdown point that would allow a full stop landing without application of abnormal braking on the landing surface available with no drift/longitudinal axis aligned with landing surface -Maintains cross-wind correction and directional control throughout approach and landing -Complies with approach/clearance procedure -Utilizes appropriate checklist
Short-Field Landing	2	-Understands and is able to instruct appropriate techniques and procedures to accomplish a short-field landing: -Considers wind conditions, landing surface, obstructions and selects suitable TDZ -Maintains stabilized approach speed not greater than 1.3-1.4 V_{S0} ± 5 KTS/MPH CAS (or L/D_{MAX} if equipped with AOA) until landing is assured -Makes smooth, timely and correct control application during the round out and touchdown -Touches down smoothly at minimum control airspeed at or

		within 200 feet of planned TDZ with no side drift, minimum float and longitudinal axis aligned with landing path -Maintains cross-wind correction and directional control throughout the approach and landing sequence -Applies brakes and flight controls as necessary to stop in the shortest distance consistent with safety -Utilizes appropriate checklist
Soft-Field Landing	2	-Understands and is able to instruct appropriate techniques and procedures to accomplish a soft-field landing: -Considers wind conditions, landing surface, obstructions and selects suitable TDZ -Maintains stabilized approach speed not greater than 1.3-1.4 V_{S0} ± 5 KTS/MPH CAS (or L/D_{MAX} if equipped with AOA) until landing is assured -Makes smooth, timely and correct control application during the round out and touchdown -Touches down softly with no drift and longitudinal axis aligned with landing path -Maintains cross-wind correction and directional control throughout the approach and landing sequence -Utilizes proper flight controls, speed and power to taxi on the soft surface -Utilizes appropriate checklist
AFTER LANDING		
After landing, parking and securing	2	-Maintains directional control -Observes markings/procedures/clearance(s) -Parks in appropriate area; considers safety of airplane, persons and property on the ground -Utilizes appropriate checklist -Understands and is able to instruct techniques for moving the airplane after shutdown -Able to instruct proper conduct of post-flight inspection and offer techniques to properly secure the aircraft
Servicing	2	-Understands and is able to instruct how to fuel the aircraft: -Properly ground the airplane during refueling operations; understands how to remove, adjust and secure gas caps; exhibits methodology for determining fuel load for less than full tanks; knows location of all fuel drains and is able to drain and inspect fuel from all points -Understands the proper type/weight and how to service oil to the engine sump; able to determine oil level
AIRMANSHIP		
Clearing / Visual	2	-Utilizes proper scanning techniques

Look-out		-Maneuvers as required to ensure flight path is clear of traffic -Maintains situational awareness of other aircraft operating on frequency/sharing the traffic pattern -Understands and applies right of way rules
Fuel Management	2	-Determines fuel requirements and ensures proper fuel load for the conduct of the flight; ensures sufficient fuel reserve at all times -Monitors fuel level throughout the flight -Computes appropriate BINGO fuel -Maintains fuel levels sufficient for lateral balance
Airmanship	2	-Understands aircraft capabilities and limitations -Able to navigate; maintains orientation -Adheres to training rules, procedures and regulations, safely positions the aircraft for maneuvering -Utilizes resources effectively -Recognizes fatigue and degraded performance -Manages cockpit workload effectively; prioritizes; does not rush
Judgment (ORM/ADM)	2	-Identifies and is able to instruct how to identify potential risks/hazards, analyzes or develop controls, and making control decisions and monitors results -Understands pilot capabilities: assists the upgrading pilot with establishing and adhering to appropriate personal limitations -Applies and is able to instruct how to apply appropriate prioritization to ensure safety -Familiar with EAB safety considerations and mishap statistics
INSTRUCTIONAL ABILITY		
Ground Instruction	2	-Able to develop and conduct effective briefing; offers suitable techniques for accomplishment of various tasks -Effectively utilizes time available for the conduct of briefing and debriefing -Effectively utilizes visual aids during the conduct of brief and debrief -Familiar with the learning process and barriers to learning; recognizes student saturation -Able to accurately reconstruct flight during debrief and effectively assist upgrading pilot with proper understanding or familiarity with various tasks; evaluate and critique performance; develop upgrading pilot potential -Able to effectively answer questions and utilize appropriate reference material; demonstrates thorough understanding of EAB operations
In-flight Instruction	2	-Analyzes and corrects errors

		-Recognizes upgrading pilot task saturation and/or channelized attention, stress/anxiety; adjusts appropriately -Communicates effectively; utilizes appropriate brevity; recognizes when non-effective communication occurs, adjusts appropriately -Maintains SA, or regains SA after recognizing loss of SA -Correctly prioritizes and manages tasks -Effectively manages flow to ensure effective learning and utilization of time

Situational Emergency Procedures Training (SEPT). Each Block of instruction contains a section of emergency procedures training. A list of possible malfunctions and considerations for discussion are contained in the lesson plans. If specific builder's guidance or checklists are not available, the expanded checklists in Part 3 EMERGENCY PROCEDURES can be referenced. Each SEPT session should last 45 minutes and cover all items listed for discussion. The time required for SEPT may be increased at the instructor's discretion. The cockpit of the airplane utilized for training should be used to the maximum extent practical for the conduct of situational emergency procedures training.

Course Completion Standards. A minimum of five hours of in-flight instruction for Basic Upgrade, Advanced Upgrade and Instructor Upgrade is required. For Advanced Top-Off, a minimum of 2.5 hours of in-flight instruction is required. For Recurrent Training, a minimum of 1.0 hours of in-flight instruction is required. Additional hours and/or experience requirements may be established by the insurance carrier or the instructor. There is no maximum time limit as training will be conducted to "practice" or "proficiency" as applicable with objective standards established in Tables 1-3 and 1-4. All flight elements/tasks requiring proficiency require a minimum grade of 2 as defined in Table 1-2. Flight elements for which lesson plans specify "practice" or "for purposes of familiarization" require a minimum grade of 1 as defined in Table 1-2. For Basic Upgrade, Advanced Upgrade and Instructor Upgrade, 3 hours of academic instruction is required. Three .75 hour sessions of Situational Emergency Procedures Training (SEPT) are required: all ground, takeoff, in-flight and landing emergencies will be covered. Formal risk management training, a blindfold cockpit check and an open-book written exam (corrected to 100%) will be completed. For Advanced Top-Off, 1.5 hours of academic instruction and an emergency procedures review is required. For Recurrent Training, 1 hour of academic instruction and an emergency procedures review is required. For Instructor Upgrade, "proficiency" and instructional knowledge will be demonstrated for all tasks.

Note

All tracks of instruction meet requirements for completion of a flight review in accordance with FAR 61.57.

RV-Type Fuel Considerations

-Fuel consumption can vary widely from data in the engine operator's manual. Due to variance in construction and power plant size and configurations, it is difficult to establish a baseline ROT that would apply to all RV-type airplanes. Furthermore, even airplanes with nearly identical characteristics can vary in consumption (e.g., carburetor out of adjustment, etc.). It is imperative to obtain accurate fuel consumption data for the airplane flown. If this has not been provided by the builder, it must be obtained through research and flight test. Fuel flow devices must be properly calibrated to provide accurate information. Calibration must be confirmed by flight test.

-Failure to know fuel consumption rates for the airplane operated is just as dangerous as not checking fuel on-board before flight. The exact amount of fuel on board must be known and confirmed prior to engine start.

-For certified airplanes, the fuel gauges are required to read accurately only when the tanks are completely full OR empty. Although a sound practice for calibrating gauges, keep in mind that certification standards do not apply to EAB aircraft, so even this basic assumption cannot be made. Fuel gauge accuracy must be confirmed by proper calibration and test.

-For a normally aspirated 320 cubic inch engine with a compression ratio of 8.5:1 or less equipped with an aviation carburetor, fuel flow can exceed 13 GPH at high power, with a significant increase in fuel flow at power settings greater than 75% power. For a normally aspirated 360 cubic inch engine with a compression ratio of 8.5:1 or less equipped with an aviation carburetor, fuel flow can exceed 17 GPH at high power, with a significant increase in fuel flow at power settings greater than 75% power. For leaned operation below 70% power, aircraft test and engine manufacturer's data should be consulted to determine nominal fuel flow rates.

- For best power leaned operation ≤ 65% power, a nominal fuel flow of approximately 10 GPH should be anticipated (i.e., 1 gallon per 1/10 hour of engine operation), unless specific information regarding power setting and fuel consumption is available for the airplane operated.

-Unusable Fuel. Each RV-type airplane will have a certain amount of unusable fuel. The exact amount can only be determined by testing. If test data is not available for the airplane being operated, it is recommended that it be ASSUMED that a MINUMUM of 1 gallon per side is unusable.

-Fuel Reserve. A minimum 45 minute reserve should be utilized during training operations. Assuming a 1 gallon unusable fuel quantity, O-320 powered airplanes should land with a minimum of 7 gallons on board, and O-360 powered airplanes should land with a minimum of 9 gallons on board (assuming a nominal cruise fuel flow rate of 8 GPH for an O-320 equipped airplane and 10 GPH for an O-360 equipped airplane). Specific values should be computed based on manufacturer's/builder's data (confirmed by flight test) for the airplane operated.

TRAINING RULES

> **Note**
>
> Training Rules may be modified or amended at the instructor’s discretion.

Weather

- Pattern Only Operations: 1500/3 ± 1 Hour of intended operation.
- Area/Cross-Country Operations: 3000/5 ± 2 Hour of intended operation (along route of flight as well as intended destinations):
  - An alternate will be specified for each stop, regardless of weather forecast.
  - Note: for outer landing field operations during the conduct of local training, the departure/RTB airport is a suitable alternate.
- For Solo/Chase Operations or aircraft not equipped with a gyroscopic artificial horizon (or suitable EFIS): Clearly Defined Horizon.
- For Solo/Chase Operations: Maximum cross-wind component 10 KTS.
- For Solo/Chase Operations: Maximum surface wind 15 KTS; maximum gust factor 5 KTS.
  - Instructor may increase maximum allowable surface wind to 20 KTS and gust factor to 10 KTS based on upgrading pilot proficiency.
- For Day Operations: Land NLT Official Sunset + 15 minutes.
- For Solo/Chase Operations: Avoid takeoff and landing on runways within 20° of azimuth of sunrise or sunset within 1 hour of sunrise or sunset (15° elevation). Adjust times to takeoff prior to sunrise or land immediately after sunset, if necessary.

Deep Stalls, Spins and Confidence Maneuvers

- Aircraft loaded within Designer’s limits.
- Phase I testing for configuration complete and properly annotated in aircraft log book; and/or spins approved in Operating Limitations.
- Stability Check Complete
- Loose Items Stowed.
- Planned spins limited to one turn or less.
- Fuel imbalance 6 gallons or less.

Takeoff and Landing

- Minimum runway width: 50’ paved; 75’ unpaved (N/A for Dual operations).

- Minimum runway length: 2000’ (2500’ for Solo/Chase Operations).
- Takeoff and Landing Data will be computed; Takeoff Abort and Land NLT points will be Established:
    - Koch Chart will be consulted for DA Effects. A basic Takeoff Safety Factor of 1.33 and Landing Safety Factor of 1.43 will be applied to all operations.
- For operation from turf runways, grass height will not exceed 1/3 wheel diameter.
    - Assume turf runways are wet with dew ± 1 hour of sunrise.
- For Solo/Chase Operations: No touch and goes on turf runways or any runway shorter than 3000’.
- Touchdown prior to computed Land NLT point for all full-stop landings.
- Initial touchdown must be within 1/3 of usable landing surface for any touch and go.

Area

- Minimum maneuvering altitude: 3000’ AGL (may be reduced to 1500’ AGL with instructor on board).
- Minimum airspeed (unless performing stalls, slow flight, or aerobatics [including spins]): 80 MPH /70 KTS CAS .
- Maneuvering limits with more than one on-board (unless parachutes are worn): ± 30° Pitch, ± 60° Bank (N/A for spins)
- Smooth control application.
- Minimum G: 0.
    - Negative G excursion, no inverted systems: knock-it-off if oil loss is suspected, land as soon as practical and check servicing
- Maximum G: Aircraft limits (4-G’s desired).
    - Note: assume asymmetric maneuvering reduces G-allowable by 33%.
- Not on a Victor Airway, or within the confines of an active VR, IR training route or MOA.
- Minimum planned spin entry altitude: 6000’ AGL.
- Ground reference maneuvers: Minimum altitude 800’ AGL (1000’ AGL desired); Maximum bank angle 60°.
- Minimum altitude: 500’ AGL (or higher as required by Regulation).
- Monitor appropriate ATC Frequency.
- For Solo/chase Operations: Recover from stalls and/or slow flight at first sign of buffet, or uncommanded yaw regardless of airspeed.

Advanced Handling Maneuvers

- IAW Operating Limitations

- Aircraft loaded IAW designer's limitations for aerobatic flight
- 3000' AGL maneuvering floor
- Parachutes will be worn
- Stability Check Complete

Prohibited Maneuvers

- Intentional tail slide
- Snap maneuvers performed at speeds greater than asymmetric V_A
- Negative G maneuvering, including inverted spins

Out-of-Control

- Unless planned, initiate recovery (Unload for Control) at first sign of departure: Buffet; wing rock/drop; nose slice or nose rise.
- Recovery: Ailerons neutral; Unload for Control (0 – 1/2G); Rudder (as required) Opposite Yaw
- Aircraft is no longer out-of-control when unloaded and airspeed is passing 100 MPH / 90 KTS CAS

Pattern Operations

- A cockpit takeoff flow check will be completed before beginning all takeoff rolls.
- A cockpit landing ("GUMPS") flow check will be completed prior to all landings.
- Minimum pattern speed: ON SPEED and/or 80 MPH/75 KTS CAS (or 1.4 V_S, whichever is greater) until in a landing configuration on final approach.
- Add 5 KTS/MPH to approach speeds for gusty conditions (or ½ reported gust velocity, whichever is less).
- For non-towered airports, minimum over-flight altitude 500' above specified pattern altitude or 1500' AGL, whichever is less.

Fuel

- Minimum fuel required for takeoff at the beginning of any flight: 2 hours (unless precluded by weight and balance requirements).
- Minimum fuel: 45 Minutes.
- Planning FF and flight time limits based on actual fuel on board: calculated and understood.

Equipment

- Dual flashlights required for night operations.
- Spare batteries on board for all battery operated equipment.
- For Solo/Chase Operations: Upgrading pilot will carry a cell phone.
- For Solo/Chase Operations: Upgrading pilot will carry a GPS for all non-local (cross-country) operations.
  - Note: For the purposes of this section, outer landing field pattern work does not constitute cross-country operation.

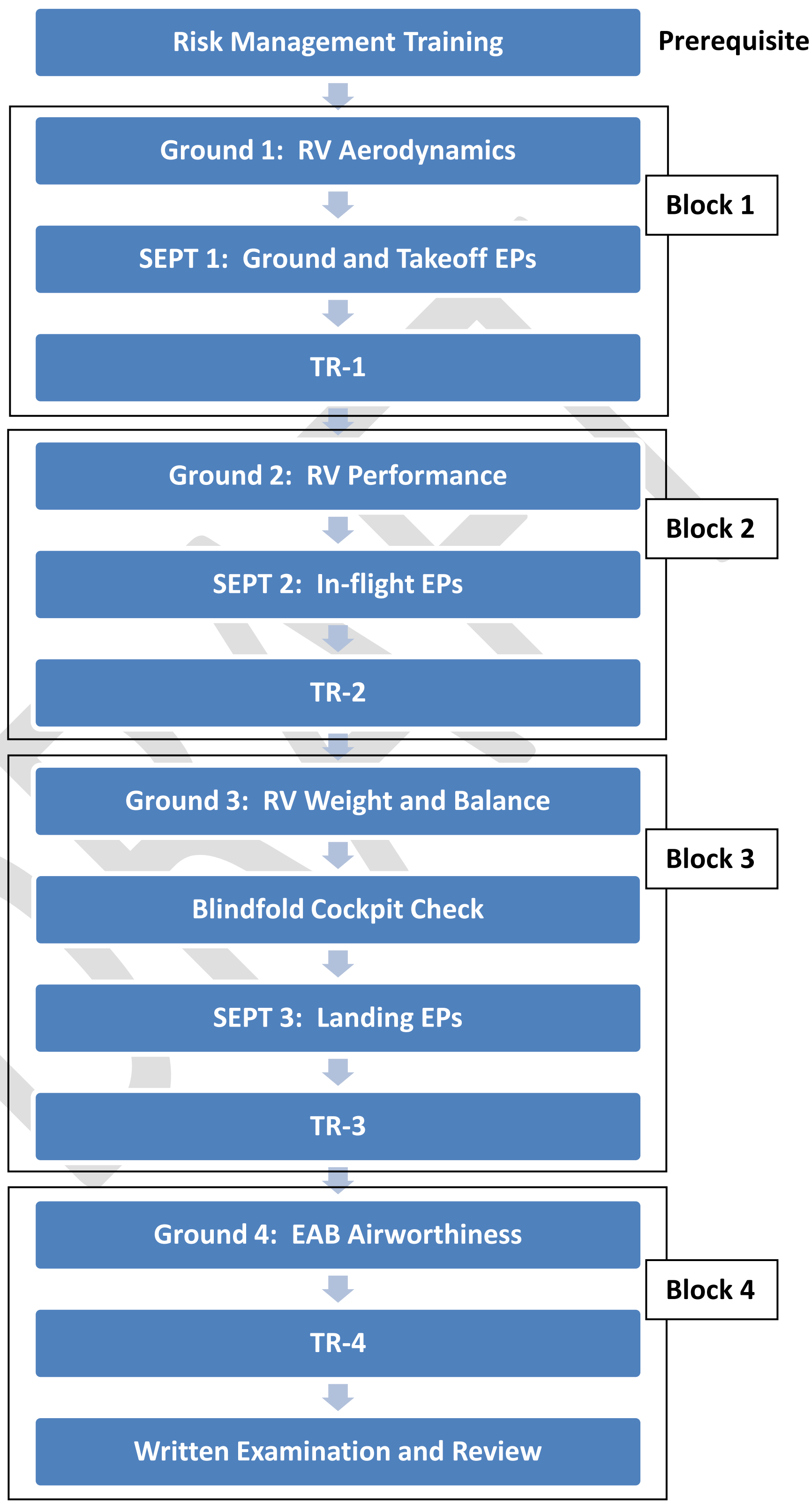
Minimum Bail-out Altitude

- Controlled: NLT 1500 feet AGL
- Out-of-Control: NLT 2500 feet AGL

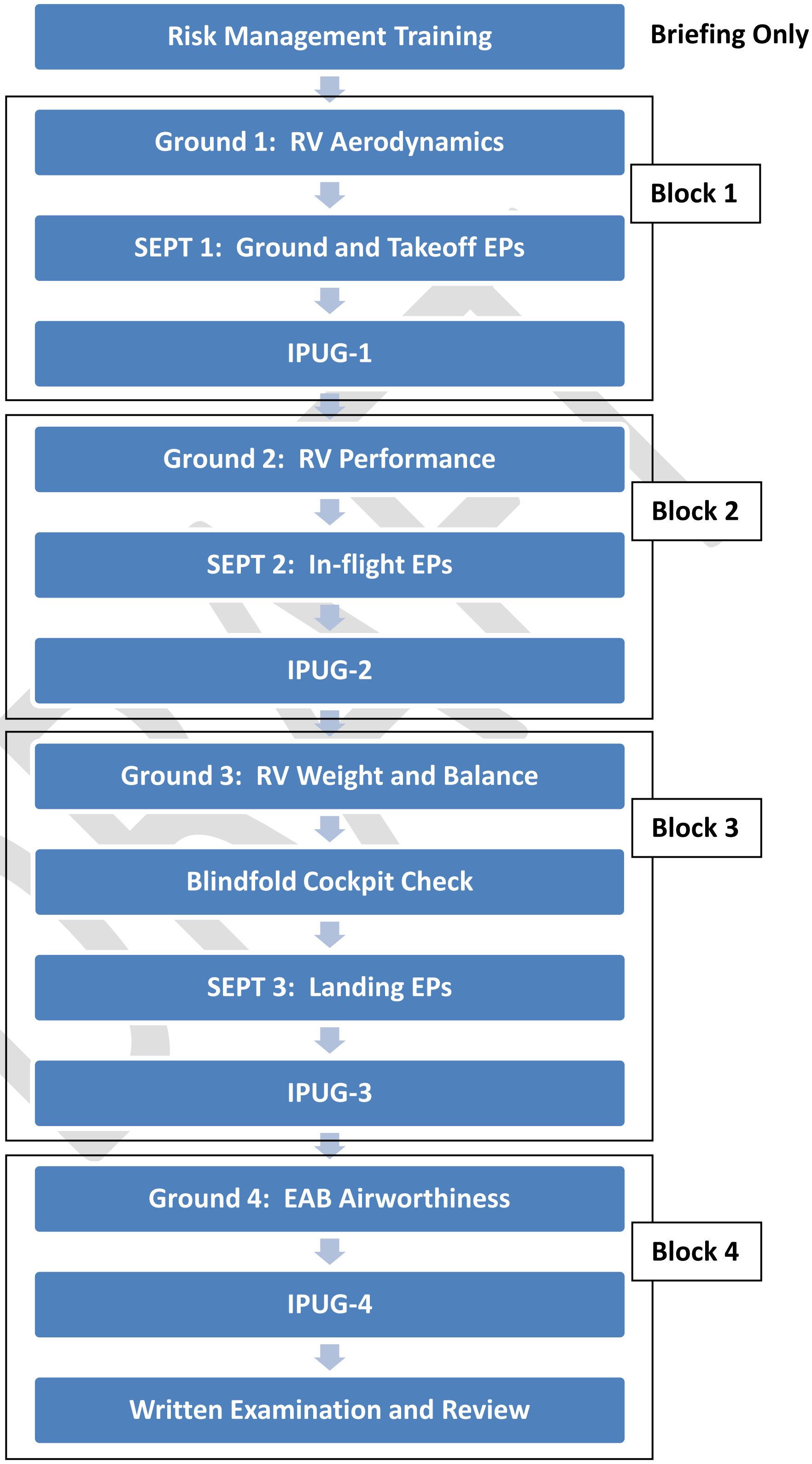
Human Factors

- Task saturation / Prioritization
- Channelized attention
- Fatigue
- Time pressure
- One-way decision gates
- Bad communication

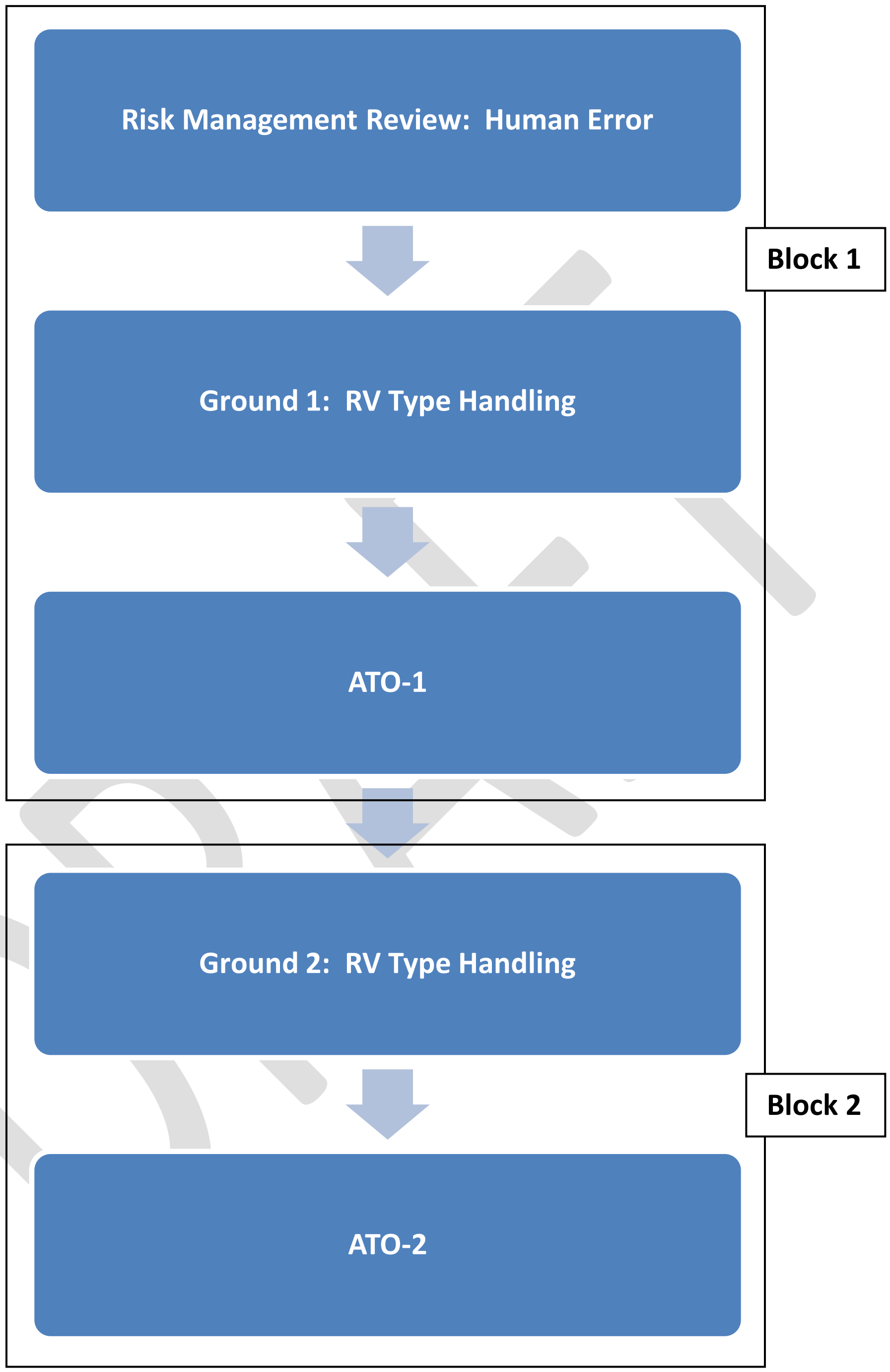
BASIC/ADVANCED TRACK FLOW



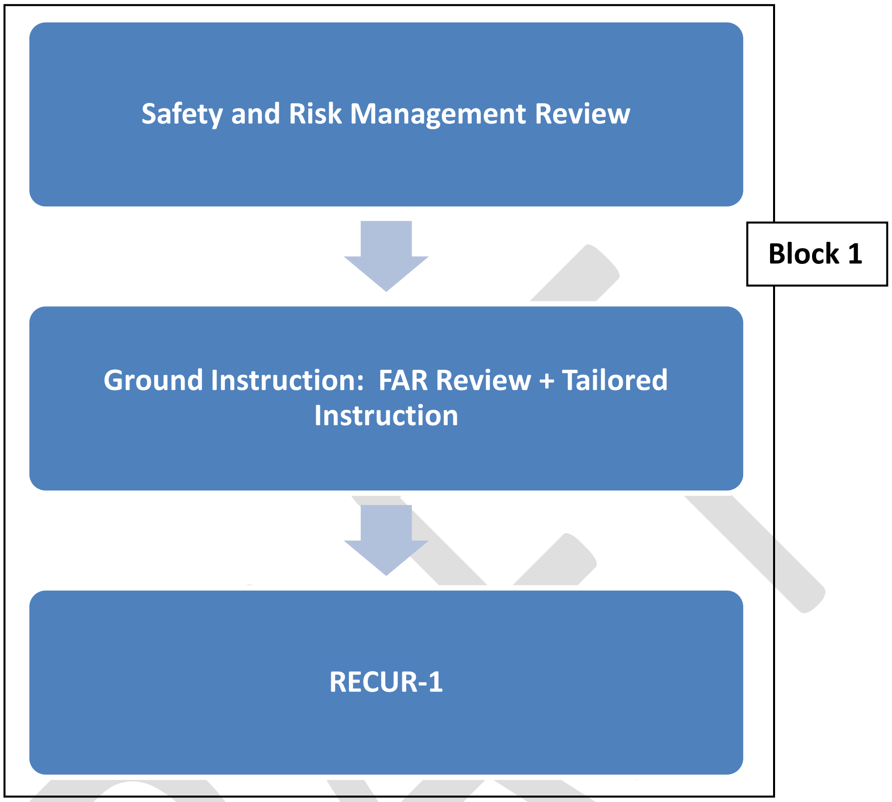
INSTRUCTOR UPGRADE TRACK FLOW



ADVANCED TOP-OFF TRACK FLOW



RECURRENT TRAINING TRACK FLOW



Part 2: Lesson Plans and Briefing Guides

OPERATIONAL RISK MANAGMENT

Note

- The information in this briefing outline has been adopted from the King Aviation School's "Practical Risk Management" Course and is provided for reference. It is based on discussion contained in Chapter 17 (Aeronautical Decision Making) of the Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25A). Course requirements include formal risk management training if the upgrading pilot has not already completed such training (e.g., military, airlines, etc.). This outline is intended to provide a review for guided discussion, when required. The instructor will review basic risk management principles with the upgrading pilot prior to beginning Block 1 training.
- The information in this briefing supports all tracks of training.

Risk 101

-Risk is insidious

-Unmanaged risk becomes unacceptable

-SURVEILLANCE is the key

-***Look for risk:*** doesn't jump out at you; but once identified, do something!

-***Manage*** those ***Risks***

-Usually something simple: get an updated weather brief, service fuel, etc.

80-85% of all mishaps are result of risk management failure

-Flying training emphasizes physical skill

-We don't really teach risk management

-We tell stories

-Establish rules; some are "written in blood"

-Make up sayings: "3 most useless things in aviation are altitude above you, runway behind you and air in your fuel tanks, etc."

-We learn two ways: from experience or mistakes/situations of others

-Bottom line: we haven't done a good job of teaching risk management as a skill

We learn mostly through trial and error

-We are exposed to risk; if we make it, we evaluate after the fact

-Not too bad? Risk becomes acceptable BUT IT COULD HAVE JUST BEEN LUCK!

-Can lead to “normalization of deviance” if you “get away with it”

-Bottom line: ***you get the test first, then the lesson***

Ugly Facts

-EXPERIENCE CAN’T PREPARE YOU FOR UNANTICIPATED RISK

-As a rule, ***pilot’s underestimate consequences***

-Risk is vague/indefinite

-We do a poor job of estimating odds

-Benefits are specific/tangible…e.g., we get there, we land, etc.

-Bottom line: the human animal doesn’t do a good job of making decisions when the risks are vague and the benefit is specific

We are the enemy

-Pilot psychology works against us

-Goal oriented

-Self-confident

-Sense of invulnerability

-Achiever

-Meets a challenge; effort as required to get the job done; commitment and competence

-This behavior becomes self-reinforcing! The more successful we are, the more we believe that we really ARE that good. This leads to sense of invulnerability.

-Smart people do dumb things

-Fact: ***EVERYONE makes mistakes (regularly),*** even dumb ones, exacerbated by fatigue

-We get impatient when things don’t go as planned

-Low tolerance for mistakes of others: e.g., ATC, other aircraft in the pattern, etc.

-You can’t control buffoonery, but you CAN CONTROL THE WAY YOU REACT TO IT!

-Rule #1: ***It does no good to get angry in the cockpit***

-If you’re in a hurry, it’s probably a good time to slow down

-Discipline required

-You need gas as well; it’s hard to be patient if the fuel gauge is bumping up against the “E”

More Ugly Facts

-Goal oriented = Risk tolerant

-Question: Do you HAVE to do this NOW (this hour, today, etc.)?

-Experienced MIGHT = Risk tolerant

-"I've got 1000 hours of high performance time, I can handle this light plane…even though I've only got three hours of tail wheel time"

-Risk tolerance

-Distorts risk evaluation

-Mission accomplishment over risk management

-Working alone? Much easier to risk your own life; but remember, your family is ALWAYS flying with you!

-WE are the risk, it's how we REACT to external factors that manages risk.

-Experts make as many mistakes as novices; the difference is that experts catch their mistakes.

Risk Mitigation

-Rules and Regulations help: establish a simple decision matrix

-How do you get help with go / no-go decision?

-Online resources (Weather/NOTAMs/Flight Planning Tools)

-Fellow pilots

-Do you have a mentor?

-Basic risk mitigation checklist: ***PAVE*** mnemonic

-Pilot: Are you ready?

-Aircraft: Is the airplane ready?

-enVironment: Is the environment suitable?

-External pressure

-Application: look for risks in each area—if risks pop up in two or more areas, time to think about Plan B…

Psychology

-Easy to critique others, especially ex post facto

-Reviewing mishaps helps us "learn from the mistakes of others"

-Key error/omission/malfunction tends to jump out of a review of a mishap chain, yet a competent aviator failed to note this real-time…

-It's difficult to pick out risk factors real-time for ourselves

-Need to identify risk and manage

-Minimums for each category

-Regulations don't cover every contingency—they are designed to be flexible

-Personal skill sets/readiness varies from day to day

-On any given day, every pilot has to establish their own personal minimums

<u>Pilot: I'M SAFE Checklist</u>

-Illness

-How "under the weather" are you?

-Under pressure to not be the weak link?

-Medication

-If there is a doubt, there is no doubt: consult AME

-Stress

-For some pilots, flying is stress relief; if you can't decouple stress, don't strap in

-Alcohol

-8-hour rule vs. reality

-Fatigue/Food

-Motor/cognitive skills critically affected by fatigue

-Emotion

-Rule #1: It does no good to get angry in the cockpit

<u>Aircraft</u>

-Basic Airworthiness and servicing

-Required inspections complied with

-Non-scheduled maintenance status?

-Are you "ramp check" proof?

-EXACT amount of CLEAN fuel on board

-EXACT amount of oil in the engine sump

-Preflight inspection

-"RVism" Wheel and brake condition: what can you see with the wheel pants installed?

-Unoccupied cockpit/seat: everything secure?

-Minimum equipment

-"Old Man" disease: tendency to do more with less, i.e., comfortable accepting a less than perfect airplane

-That's O.K. and a benefit of experience--JUST KNOW THAT BY ACCEPTING MINIMUM EQUIPMENT, YOU'VE FLAGED ANOTHER RISK CATEGORY

-Situation dependent

-Day VFR vs. Night IFR

-Configuration: ***it's experimental man!***

-Has something been changed? Has it been tested?

-Sanity check: 43-13 compliant?

-Mentor? A&P familiar with EAB

Environment

-Biggest factor: WEATHER

-Different than forecast

-Unanticipated winds aloft/sheer affecting pattern operations

-Airfield

-Runway status/condition

-Cross-wind

-Approach aids?

-Airspace

-TFR?

-Terrain

-Off-station (out base) operations

-Away from the home 'drome! Have you done your homework?

External Pressure

-Always there in the background: ***affects EVERYTHING we do***

-Causes you to ignore other risk factors: clouds your judgment

-Time pressure

-Pilots are their own worst enemy; good ones know when it's time to slow down and get their faster

-Build yourself some room: you can usually recover from "too early"

-Peer pressure

-Mission Accomplishment

Pre-flight Decision Time

-Risk factors are cumulative

-Insidious

-If you have issues in two or more areas, flex to Plan B or consider an abort

-PAVE Categories: Pilot; Aircraft; environment; External Pressure

-Bottom line: This is the math part. Use the "accident chain" analogy, changing one or two things will make a critical difference.

Real-time Risk Management: How to monitor risk during flight

-Utilize all available resources

-FSS

-ATC

-Avionics: ADS-B in, XM Weather, etc.

-Warning: Latency of display! Need to be able to know what you're looking at. ***View out the window ALWAYS trumps the internet version of reality…LOOK OUTSIDE!***

-Unicom

-FBO? Someone with a radio on the ground?

-Wingman: anyone airborne that can help?

-Stick to the plan

-Planning and preparation are KEY

-Adding flight elements/tasks without malice of forethought and planning is a foul!

-KISS (keep it simple, stupid) works

-Always ask: "Is this the simplest way to accomplish this?" If the answer is "no," time for a simpler plan…

-Monitor "bailout option(s)": what can you do if/***when*** conditions change?

- Give yourself an out, always! e.g., land short and wait out weather…

<u>"Attention Scan"</u>

-Is the way you pay attention to consequences, alternatives, reality and external pressure throughout the flight. Analogy: just like a solid instrument cross-check.

-Mnemonic: ***CARE***

-Consequences

-Dynamic: what's about to happen?

-Pilot

-Fatigue/stress increase

-The pilot that lands is not the same pilot that took off!

-Aircraft

-Fuel/mechanical state

-Environment

-Weather

-External pressure

-"Goal oriented behavior intensifies" means the closer the human animal gets to achieving a mission objective, the greater the tendency to press becomes. Warning sign "I'm almost there…"

-Alternatives

-What if…runway becomes unusable; weather rolls in; airplane breaks, etc?

-Here's where contingency planning/thinking pays off

-No rule says you can't change the game plan; new plan should always be simpler than the old plan

-Number of alternatives decreases as the flight progresses

-Reality

-Deal with things as they are, not as you planned

-Are you as flexible as you think?

-Does your solution pass the KISS test?

-Are you pushing too hard NOT to bust a rule?

-E.g., be on the deck before sundown, etc.

-Getting upset because someone else's mistake is making your life hard?

-Good time to apply the "FIDO" principle: forget it and drive on…

-External Pressure

-Mission accomplishment becomes the over-riding goal: "I gotta' get there…"

-Tom just landed—the cross-wind can't be that bad…

-Showing off…are you doing this to impress yourself or someone else?

<u>Summary</u>

-If risk factors affect two groups in PAVE model, consider Plan B or abort

-PAVE = Pilot; Airplane; environment; External Pressure

-Acid test: Would you do this with the FAA (or your family!) on board?

-Why risk your own butt?

-Make the effort to understand the consequences of the actions you take

-Bottom Line: If there is a doubt, there is no doubt (i.e., some mitigating action is required!)—listen to that little voice…

BLOCK 1: Basic Transition/Advanced Transition/Instructor Upgrade

Ground 1: RV-Type Aerodynamics (.75 Hours)

-**NO TWO AIRPLANES ARE IDENTICAL /** ***Handling Characteristics Vary***

- -Prototype testing less rigorous than standard category factory flight test
- -Construction
  - -Rigging / Fairings
- -Configuration / Weight
- -Loading
  - -Different airplane with passenger and/or baggage aboard
- -Performance and handling characteristics must be validated by flight test of individual aircraft

-**Static Margin (Pitch Stability)**

- -More pronounced variation with tandem versions: Pitch stability trends towards neutral as RCP and baggage load increases; side-by-side types, less CG range/effect
- -All RV's: CG moves aft (decreasing margin) as fuel is burned
  - -Tandem: Movement proportional to initial load—if RCP is occupied/baggage carried, shift will be GREATER than if solo
  - -Review Weight and Balance information, and determine maximum loads to: A) operate within aerobatic envelope; and B) operate within basic envelope.
- -Pilot needs to anticipate neutral control response
  - -Pilot needs to be ready to move the stick as required to establish desired attitude and AOA; anticipate over-shoot tendency (e.g., high climb angle and landing flare)
  - -The key is to monitor pitch RATE when maneuvering and move the stick appropriately; control pressure AS REQUIRED to achieve desired pitch
    - -Can be critical during landing and IMC climb
    - -As CG moves aft, stick controls pitch rate more so than AOA: control forces become lighter
    - -At neutral stability nose stays where you put it vs. aircraft self-correcting to trim condition
- -Stall/spin resistance reduced as CG moves aft
- **-*<u>DO NOT EXCEED AFT LIMIT</u>***
  - -Airplane does not become suddenly uncontrollable, however designer's limits ARE NOT CONSERVATIVE—i.e., no margin at aft limit

-At maximum aft limit, most RV's exhibit neutral stability. Aft of the limit, stability trends to negative

-Aerobatics: *observing design limits critical to ensure adequate spin recovery characteristics*

-Aerobatic limit established to provide positive static margin

--Farthest aft point tested in prototype by designer

-Aerobatics with passengers? Problematic for most airplanes due to weight restrictions (as well as CG)

-Stick Force Lightening: Gradient linear for a given TAS / CG combination, but:

-Stick length or geometry may be adjusted by builder

-Stability / margin affected by ATTITUDE

-Nose-up, low airspeed, high power (V_X climb) = reduced margin

-Acrobatics: longitudinal axis nearly vertical = reduced margin

-Landing: ground effect/low aspect ratio = pitch adjustment required

-Handling improves as speed decreases

-Heavy stick with forward CG / high speed

-***Biggest impact on stick force gradient: CG location***

-Larger variability in Tandem versions

-Maximum Allowable Gross Weight

-Operation Limitations/Builder specifications vs. designer's limits

-***Structural margin UNKNOWN when operating beyond design limits***

-Operating near/at aft CG limits:

-Little or no trim change required over wide speed band

-Light stick forces; *easy to over-control*

-Nose does not readily drop when aircraft is stalled

-Tendency for pitch control reversal just prior to stall

-Neutral/negative phugoid at low airspeed

-Yaw

-Positive stability throughout the envelope

-Excursions (fish tailing) likely in turbulence

-Rudder NOT effective for singular roll control (lift vector placement)

-Limited dihedral effect to generate roll

-Sufficient authority to be effective post-stall

-Slips: full deflection slips with or without flaps practical

-Limited effect on IAS (wing mounted pitot)

-Effect of gear fairings

-Destabilizing when installed (vertical area ahead of aerodynamic center)

-Reduce airframe drag by approximately 15% (Van's)

-Roll

-Tending to neutral stability throughout the envelope

-Aileron primary means of controlling roll / lift vector (rudder marginally effective at high AOA)

-***Overall Control Harmony: very light ailerons, light rudder, heavier elevator***

-Stalls: *straight wing, Frise-type ailerons, no wash-in or wash-out, no stall strips (most airplanes)*

-Power-off: non-event (e.g., 60 MPH / 52 KTS CAS)

-Notable engine power effects at all throttle settings (including idle)

-Use rudder to keep the ball centered

-May have to sacrifice desired attitude or heading control

-If aileron is used to counter engine power effects at idle, sufficient cross-control will exist at stall to cause a (left) wing drop

-Nose may or may not drop if full aft stick is held

-Distinct buffet

-CG Dependent (proportional to static margin): with forward CG, airplane "nods" and remains controllable post stall; with aft CG airplane remains in stalled condition and may depart (spin) with little warning

-May recover quickly, ¼ to ½ turn with neutral controls

-Aircraft will tend to depart in yaw if deep stall is held

-First indication of breakdown in directional stability: nose slice or wing drop

-Rudder effective post-stall; precise heading control not practical

-More distinct wing drop with flaps extended: left roll tendency

-Less buffet than clean stall/Limited aerodynamic warning

-Sustained deep stalls ("falling leaf") have the potential to cause horizontal stabilizer buffet

-Most horizontal tail buffet ("wet dog shake") occurs if a deep stall is induced/maintained with inside slip control inputs

-Accelerated: Any attitude/any airspeed

-AERODYNAMIC WARNING PROPORTIONAL TO G-LOAD OR SPEED AT WHICH FLIGHT CONTROLS ARE APPLIED

-Minimal buffet at low G

-Rapid application of flight controls? Can "beat" aerodynamic warning (i.e., stall without observed warning cues)

-2.1 G stall @ ≈ 80 MPH / 70 KTS CAS (Pattern speed); 60^{o} bank?

-3G @ ≈ 95 MPH / 83 KTS

-4G @ ≈ 110 MPH / 96 KTS

-5G @ ≈ 123 MPH / 107 KTS

-6G @ ≈ 135 (nominal V_A) MPH / 117 KTS

-Power on: Same except (much) higher pitch attitude; more pronounced engine power effects

-AOA or Stall Warning System?

-Manual Trim

-Pitch: Lever type (tandem aircraft)--sensitivity proportional to airspeed

-Cruise: Careful! "Squeeze" the "ball" (lever type) / twist Vernier type

-Good redundant pitch authority at approach/landing speeds

-Back-up elevator control system?

-Pattern/low speed: considerable nose-up trim can be required (considerable lever movement / "pull" Vernier types)

-Position of elevator counterweight tip (non RV-3) trimmed for landing

-Solo: front of counterweight well down (more so for tandem aircraft)

-Pax/load: front of counterweight closer to neutral

-Roll: No brainer—deflect lever in desired direction of roll to bias stick

-6-8 gallon delta before it becomes a factor

-Can run out of manual trim authority (spring bias system) as fuel delta ≥ 10 gal

-Yaw

-Generally, fixed tab optimized for 55-75% cruise

-Only time your feet are on the floor

-All other conditions: "Step on the ball"

-Rules of Thumb (no built-in rudder offset/bias):

-Left Rudder most conditions (high speed, low-speed power-off)

-Right Rudder power-on, high AOA/low speed

-Maneuvering Speed

-Definition: Speed below which you can ***move a single flight control, <u>one time</u>, to full deflection for one axis of airplane rotation only*** (pitch, roll or yaw), in smooth air, without risk of damage to the airplane.

-Below maneuvering speed, airplane will stall before hitting structural limits

-Flaps UP

-Minimum turn radius, maximum turn rate occurs at this speed

-Generally SLOWER than most folks realize

-***NOT a static value***: changes as a function of gross weight

-V_A is really the stall speed that corresponds to design limit G ("G Allowable)

-$V_A = V_S \times \sqrt{(\text{G-limit})}$

-Aerobatic (6 G's allowable) Example: V_S = 55 MPH CAS

-V_A = 134 MPH CAS

-Utility (4.4 G's allowable) Example: V_S = 48 KCAS

-V_A = 101 KCAS

-Normal (3.8 G's allowable) Example: V_S = 45 KCAS

-V_A = 88 KCAS

-***V_A increases with gross weight up to maximum allowable aerobatic gross weight (or 1600 lbs for RV-9/9A) and then DECREASES up to maximum allowable gross weight***

-Above Van's specified max allowable aerobatic gross weight (or 1600 lbs for RV-9/9A), g limits are reduced: $V_A = V_S \times \sqrt{G_{LIMIT}}$ therefore V_A decreases

-V_A will also decrease slightly throughout the flight as fuel is burned and gross weight is reduced

-Actual IAS for V_A for the RV-type operated ***must*** be determined by flight test

-Aerobatic Considerations

-***Asymmetric G-limits not specified by Van's Aircraft***

-Allowable G reduced when applying flight controls about more than one axis simultaneously

-MILSPEC: 20% reduction in allowable G

-Example: 6 G symmetric limit; 4.8 G asymmetric limit

-FAR 23: 33% reduction in allowable G

-Example: 6 G symmetric limit; 4 G asymmetric limit

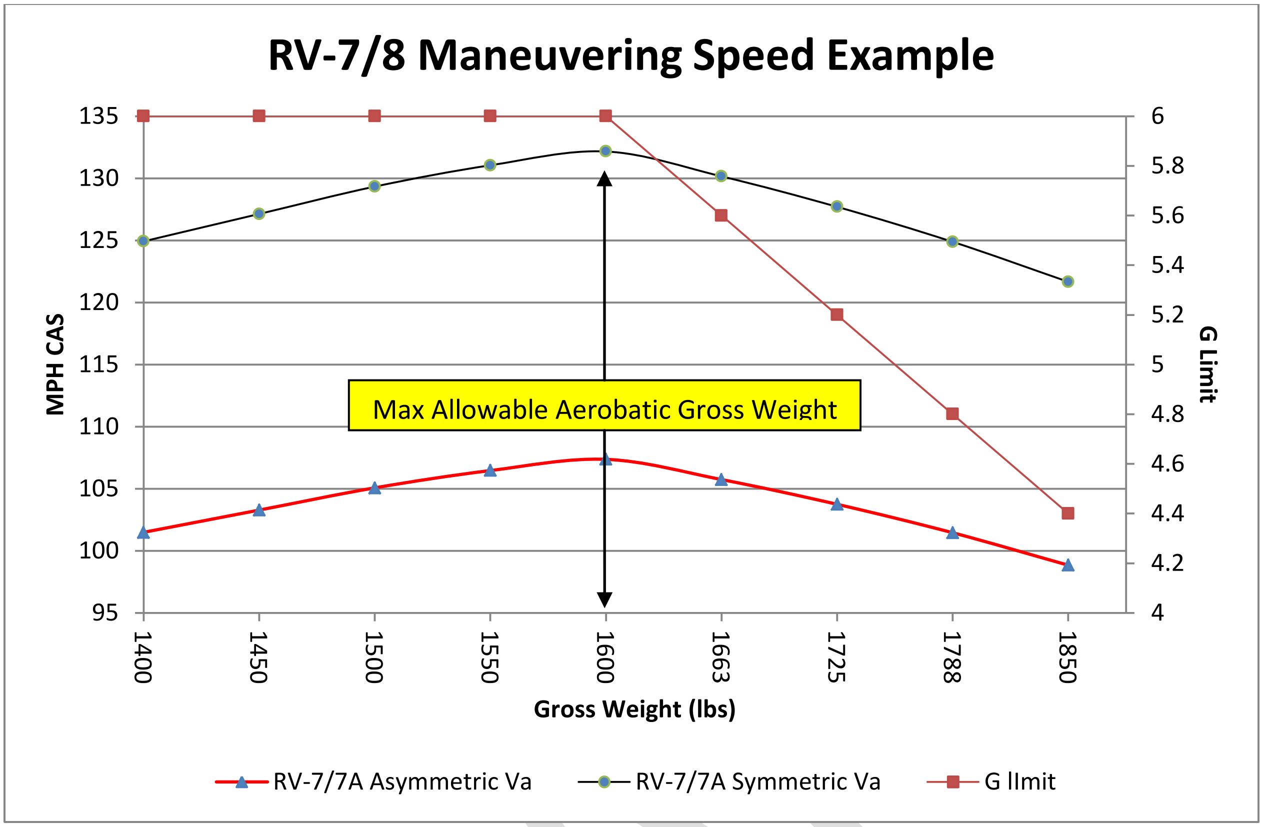
-ROT: V_A decreases to 2 x V_S

-"Snap" maneuvering (cross-control stalls/spins) should be limited to asymmetric V_A (i.e., 2 x V_S)

-Example, 4 G asymmetric limit, 55 MPH CAS $V_S \rightarrow V_A$ 110 MPH CAS *maximum* entry speed

-Designer's viewpoint: RV-types not conducive to "snap" maneuvers

-Bottom line: Below maneuvering speed, lift is limiting factor; above maneuvering speed, ***the pilot*** is the limiting factor



-Design Speed Range/Acceleration Characteristics

-V_S to V_{NE} ≈ 4:1 ratio stall speed to V_{MAX} = "Wide speed band"

-What this aerodynamic efficiency also means: ***ANY TIME THE VELOCITY VECTOR IS BELOW THE HORIZON SMOOTH AIRSPEED/G CONTROL IS CRITICAL***

-RV-types accelerate rapidly

-Gravity + low drag = rapid acceleration

-ROT: Nose down = throttle back (more critical with fixed-pitch prop)

-***WEIGHT IS ADDED TO THRUST WHEN THE NOSE IS DOWN*** (proportional do dive angle)

-E.g., 1800 lb airplane at 90° dive angle can produce over 2000 lbs of "thrust" towards terra firma

-Need to check airspeed before pull-through when inverted

-"Bail out" (recover to wing's level) if out of parameters

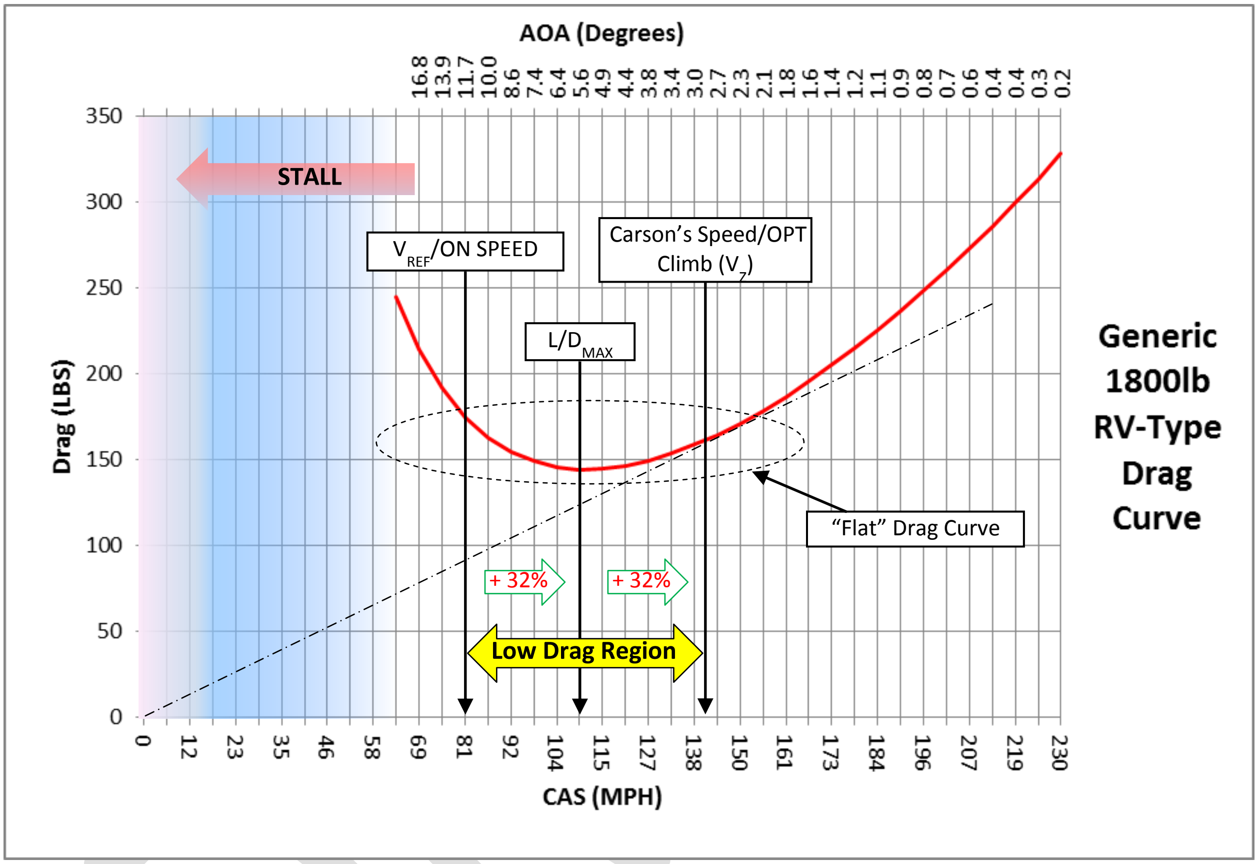
-Entry parameters and G-onset/buffet management critical for keeping speed under control during maneuvering flight

-E.g., back side of a loop/split S; unusual attitude or dive recovery

-Improper control during aerobatics can result in dangerous airspeed build-up

-E.g., falling out of a barrel roll, attempting high speed Split-S, etc.
-Nose low, high speed unusual attitude recovery critical skill set (including emergency dive recovery)

-Flying the "Flat Drag Curve"

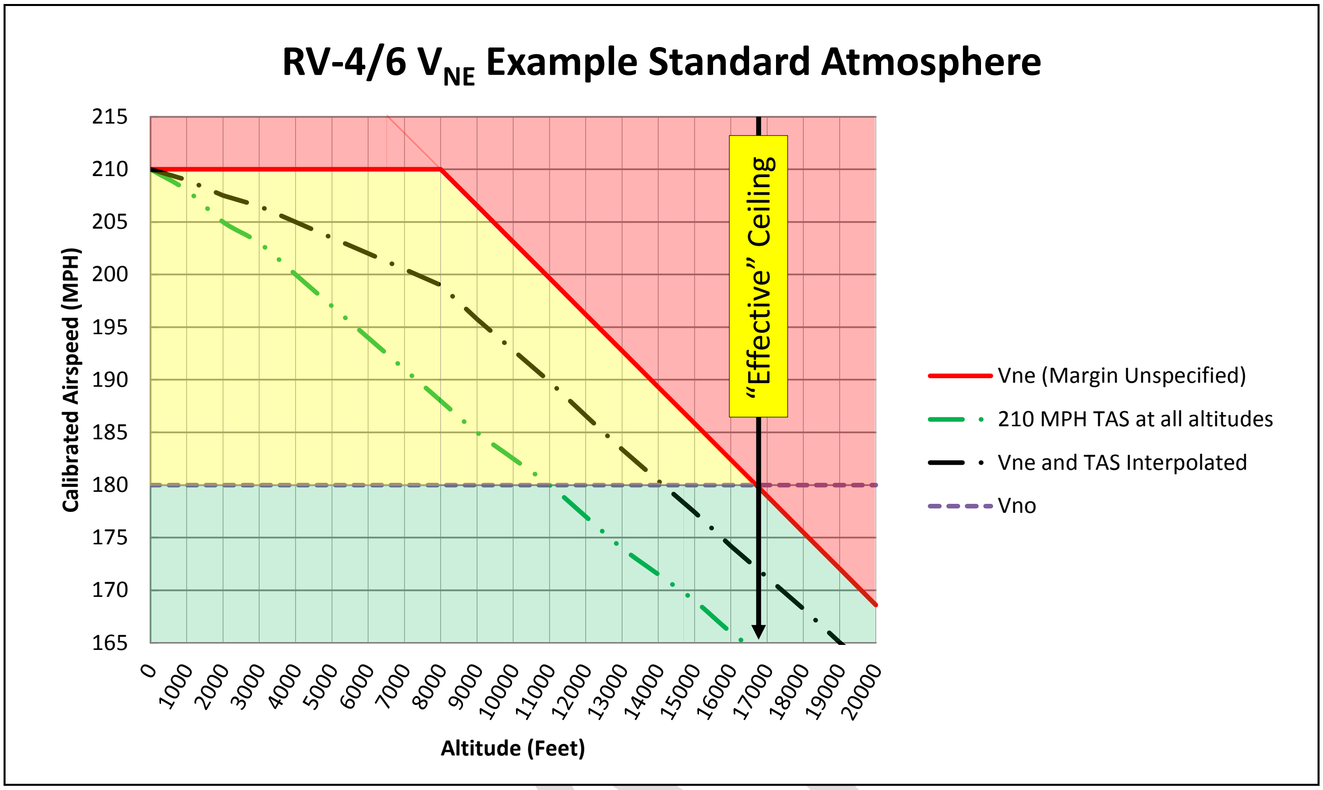


-"Snap shot in time:" Shows basic relationships, not specific performance/precise AOA
-Low drag = excess thrust = excellent performance in climb / level flight = wide speed band
-Flat drag curve = wide climb speed band
    -Consistent performance over wide speed range
    -ROT: after initial climb segment, engine cooling can take priority over precise speed control
-Also means you've generally got plenty of power available
    -Takeoff/Go-around throttle control: engine power effects and yaw…bottom line: smooth, deliberate throttle control required; keep the ball centered

-High Speed/High Altitude Operation

- -Important concepts:
  - -V_{NE} (red line) based on EAS (effectively TAS), <u>not</u> IAS
    - -Velocity/Flutter limit
    - -**<u>Flutter depends on *velocity*</u>** (TAS) not *magnitude* (IAS)
      - -**<u>Flutter does NOT depend on dynamic pressure/IAS</u>**
      - -Requires a disturbance to start; so you may have already exceeded flutter speed and gotten lucky!
    - -***This is different than certified types where the red line on the airspeed indicator provides a known/tested flutter margin at approved operating altitudes in smooth air***
      - -Normally aspirated engine: power decreases with altitude
      - -RV-types: large operating envelope/diverse powerplant configurations
  - -***<u>ONLY EXCEED V_{NO} WITH CAUTION AT ANY ALTITUDE</u>***
    - -CAS/Structural/"Q" limit: can read directly from ASI
    - -**RV-types capable of exceeding V_{NO} in LEVEL flight**
    - -Provides 50 FPS gust protection
  - -Advanced instrumentation that displays TAS? Use it!
  - -"Classic" instrumentation? Develop tab data / ROT / Adjustable ASI / Whiz Wheel (See Table 2-1)

WARNING Aerodynamic flutter, if encountered, can occur without warning and cause nearly instantaneous catastrophic airframe damage.



-Red line **(Requires flight test to validate)**

-Assumes 3 KT (3.45 MPH) change in TAS per 1K' altitude above 8000'

-Flutter margin decreases from surface to 8000' (nominal 75% power V_C)

-Difference between V_{NE} and ultimate limit remains reduced but proportional above 8000 feet

-Green line is V_{NE} expressed as TAS

-Green shaded area provides adequate gust <u>and</u> flutter margin to altitude

-Yellow shaded area provides flutter margin only to altitude

-Note: Above "effective ceiling," Vne is less than Vno. Size of yellow shaded area/"effective" ceiling depends on which V_{NE} line is applied

-Van's recommended solution?

-Current version of Builder's manual references V_{NE} as IAS

-Recommends operating within specified limits

-Flutter flight test not recommended

-"Flying High and Fast" and "All the Pretty Horses" required reading…available at Van's Web Site

-In-depth discussion of V_{NE} and consideration of RV-types

-**Bottom Line:** *conservative solution to maintain flutter margin is to treat V_{NE} as TAS unless flutter analysis and flight test has been performed to validate alternate technique*

-V_{NO} = 180 MPH / 156 KTS CAS (RV-4/6/9) or 193 MPH / 168 KTS CAS (RV-7/8): blue dashed line in graphic/top of green arc on ASI

- -"Q" limit (read directly from ASI)
- -50 FPS vertical gust imposes maximum allowable structural limit
  - -Note: Limiting factor for RV-9 in cruise flight due to structural limits
    - -Van's recommendation: largest RV-9 engine 160 HP
- -Can only be exceed in smooth air

Table 2-1: Example RV-4/6 210 MPH CAS to TAS Look-up Table

Pressure Altitude	ROT 3 KTS (3.45 MPH)/1000'[2]		"Summer" (ROT: Std - 5 MPH)[3]		"Winter" (ROT: Std + 5 MPH)[4]	
	Std Temp (15° C)	TAS[1]	Std Temp +15°C	TAS[1]	Std Temp -15°C	TAS[1]
SL	15°	210	30°	206	0°	217
1000	13°	208	28°	203	-2°	214
2000	11°	205	26°	200	-4°	211
3000	9°	203	24°	197	-6°	208
4000	7°	200	22°	194	-8°	205
5000	5°	197	20°	192	-10°	202
6000	3°	194	18°	189	-12°	199
7000	1°	191	16°	186	-14°	197
8000	-1°	188	14°	183	-16°	194
9000	-3°	185	12°	180	-18°	191
10,000	-5°	183	10°	178	-20°	188
11,000	-7°	180	8°	175	-22°	185
12,000	-9°	177	6°	172	-24°	182
13,000	-11°	174	4°	169	-26°	180
14,000	-13°	172	2°	167	-28°	177
15,000	-15°	169	0°	164	-30°	174
16,000	-17°	166	-2°	161	-32°	171
17,000	-19°	164	-4°	159	-34°	169
18,000	-21°	161	-6°	156	-36°	166
19,000	-23°	158	-8°	154	-38°	163
20,000	-25°	156	-10°	151	-40°	161

[1]TAS derived using E6B flight computer
[2]Rule of thumb for estimating TAS change with altitude: 3 KTS (3.45 MPH) per 1000'
[3]"Summer" defined as standard temp +15°C. Rule of thumb: adjust standard temperature speed by subtracting 5 MPH. Note: If temperature exceeds STD + 15°C, actual TAS must be computed.
[4]"Winter" defined as standard temp -15°C. Rule of thumb: adjust standard temperature by adding 5 MPH. Note: If temperature is less than STD – 15°C, actual TAS must be computed.

-Lots of “G available:” ***smooth flight control application critical***

-E.g., at typical cruise speed, rapid application of aft stick can generate 9+ instantaneous G’s

Table 2-2: RV-4 Aerodynamic G-Available at 1375 Lbs Gross Weight

CAS MPH	G	CAS MPH	G	CAS MPH	G	CAS MPH	G
55	1.0	100	3.3	145	7.0	190	11.3
60	1.2	105	3.6	150	7.4	195	12.6
65	1.4	110	4.0[1]	155	8.0	200	13.2
70	1.6	115	4.4	160	8.5	205	13.9
75	1.9	120	4.8	165	9.0[3]	210	14.6
80	2.1	125	5.2	170	9.6	215	15.3
85	2.4	130	5.6	175	10.1	220	16.0
90	2.7	135	6.0[2]	180	10.7	225	16.7
95	3.0	140	6.5	185	11.3	230	17.5

[1] Recommended asymmetric load limit. Asymmetric maneuvering is defined as simultaneous control inputs in two-axis simultaneously. **Van’s Aircraft does not specify asymmetric load limits.**
[2] Maximum G Limit @ 1375 lb Gross Weight. Structural damage can occur at loadings in excess of maximum limit. Aerodynamic limit and G-available coincident at V_A/Corner Velocity.
[3] Ultimate design load limit. Structure designed to withstand 9 G’s for 3 seconds assuming no corrosion, fatigue, material defects or construction flaws.

-Structural (fatigue) damage can occur any time design limits are exceeded or if there is a construction or material flaw

-Cumulative over time

-***May result in structural damage or failure at loads less than limit***

-**Loss of Control**

-Indications:

-Buffet; and/or

-Nose stops tracking; and/or

-Wing drop/rock; and/or

-Nose Slice (yaw); and/or

-Nose Rise (stick force lightening)

-Power Effects

-*Tends* to cause left yaw/nose slice

-Mitigated with IDLE power but present at ALL throttle settings

-***Uncontrolled yaw is what will get you into trouble post-stall***

-You can “beat” aerodynamic warning: rapid control input can cause a departure without aerodynamic warning

-*“UNLOAD FOR CONTROL”* Concept: AOA recovery (stall)

- -***Ailerons neutral***
- -***Establish 0 to 1/2 G condition***
  - -Engine (oil) limitations / fuel starvation (carb)
    - -Carb float is poor man’s aural G-meter!
    - -Does an inverted oil system work at zero G?
  - - Stall speed dramatically reduced (zero G = zero V_S)
- ***-Prioritize:*** maintaining aircraft control is more important than engine parameters
- -***Rudder (as required) to counter yaw*** (nose slice/wing drop)
- -Airplane is ballistic
  - -Unloaded; airspeed increasing
  - -Velocity vector on/below horizon
  - -Roll to recover
  - -ROT for nose high recovery: Degrees nose up (start) = degrees nose low (finish)
  - -Fuel odor in the cockpit? Normal
  - -Nose low? Airspeed build-up is primary concern
- -***Power: As required***
  - -Idle to reduce power effects
  - -Carbureted engine? Don’t be surprised if it quits
    - -Prop likely to stop if it’s light weight (wood)
    - -Be ready for air-start post recovery
      - -Starter vs. dive to windmill

-Recovery: ***AIRCRAFT IS NO LONGER OUT-OF-CONTROL WHEN UNLOADED TO 0 – ½ G AND AIRSPEED IS INCREASING PAST 100 MPH / 90 KTS CAS***

-***Unintentional Spins***

- -Airplane resistant to spins unless pro-spin controls are input/held (i.e., uncoordinated flight is maintained post-stall)
  - -Spin resistance proportional to CG location…airplanes more spin prone, less warning with AFT CG (Tandem)
  - -Nose slice is best yaw cue; if you see it post-stall, you are set up for an incipient spin
- -Neutralizing the controls will ***always*** help
  - -Auto recovery in less than one turn/snap roll likely if controls neutralized immediately

-Inertial coupling can occur if you apply anti-yaw rudder with simultaneous forward stick (auto roll).

-Think of “stick forward” as “ease” or “release back pressure”

-Low Altitude

-***<u>Unintentional spins that occur in the traffic pattern should be considered non-recoverable</u>***

-AOA/Airspeed awareness is critical in the pattern

-Observe min airspeed / Max AOA limits

-A 2-G accelerated stall occurs at approximately 80 MPH CAS

-Skidding turns higher risk than slipping turns: A skid will cause an immediate departure as Critical AOA is exceeded; it’s very difficult to get an airplane to depart in a slip (it will rudder roll “over-the-top” before autorotation)

-Below 2000’ AGL, uncontrolled bailout is not practical.

-No man’s land: Anti-spin controls NLT 1500’ AGL with PERFECT dive recovery technique: you MIGHT make it; but you are below minimum out-of-control bail-out altitude

-RECOVERY BOLDFACE (Boldface = memory item)

-POWER IDLE

-CONTROLS NEUTRAL

-“Idilize and Neutralize”

-Recovery within 1 to 1 ½ turns no other action

-RUDDER OPPOSITE YAW (IF REQUIRED)

-Stick motion: center laterally, then longitudinally

-May need to look at stick (consider using two hands)

-Tandem/forward CG: Inertial coupling possible

-Auto roll tendency if rudder deflected

-Nose tuck past vertical if spin is result of “normal” attitude stall

-If rotation increases, use “other” opposite rudder

-ELEVATOR PAST NEUTRAL (IF REQUIRED)

-What does it take to break the stall?

-Upright = forward

-Inverted = aft

-Target zero G

-How to move the stick: smooth/aggressive

-Altimeter/bail-out cross-check? Must be OUT of the plane NLT 2500 AGL for out-of-control

-Intentional Spin Characteristics

-Designer's viewpoint: not a recreational maneuver

-Tandem vs. side-by-side configurations: different auto-rotation characteristics

-Tandem rear cockpit occupied? Different auto-rotation characteristics than solo…

-CG considerations: margin aft of aerobatic limit? Belongs to the *DESIGNER/ENGINEER,* not the *PILOT/BUILDER*

-CG at non-aerobatic aft limit? Assume NO margin

-Hesitant to spin: pro spin controls must be maintained throughout incipient phase (≈ 1 ½ turns)

-Expect nose tuck past vertical

-Some airplanes may enter a spiral dive vs. spin at forward CG locations

-If speed increasing above 100 MPH/KTS, recover immediately

-Power above idle may improve elevator effectiveness and help force spin entry

-Nose low, high rotation rate: 180-270 deg/sec

-Full aft stick SLOWS rotation rate

-If stick is allowed to float, expect outside aileron to float up; drive stick off center (opposite spin direction)

-Maintain pro-spin controls until it's time to recover!

-Zero CAS, VVI pegged, 1 G, ball opposite spin (EFIS indications?)

-300-500 ft/turn, 2 sec/turn

-3000 AGL 6 turns and 12 seconds from impact

-1500 AGL 3 turns and 6 seconds from impact

-Recovery requires 1.5 turns and 1000' of altitude (including dive recovery)

-Initiate recovery NLT Floor + 1000'

-More than 7 turns? Disorientation more likely

-Gee Whiz

-Power on spins = higher nose attitude / slower rotation rate (spin flattens)

-Aileron applied opposite direction of spin also helps flatten

-10 turn spin + recovery requires ≈ 3500' of altitude

-Engine-out Glide Performance: function of propeller type fitted

-Excellent with light weight, fixed pitch propeller

-Good with constant speed propeller, low RPM (course pitch) set (assuming sufficient oil pressure for prop control, non-aerobatic/counterweight type)

-Max Range glide speed faster than max endurance

-E_M: absolute max performance vs. maneuverability…use the "flat" climb curve, i.e., give yourself room for error

-ROT @ 105 MPH / 90 KTS CAS:

-Alt x 2 – 1 NM = no wind estimate (6K' and below)

-Alt x 2 – 2 NM = no wind estimate (6K' and above)

-500 FPM rate of descent

-3.5 G's available, 45-60^{o} banked turns practical

-Tab data in Emergency Checklist?

-Visual estimate: ellipse from wing tips around spinner (pilot's view point)—any point in that arc should be obtainable

-Advanced flight instrumentation or GPS? VNAV Mode (Garmin example)

-MENU>MENU>SETUP>VNAV

-Nominal 500-700 feet lost per 180^{o} of turn

-30-40^{o} banks at 105

-Standard rate turn at 80-85

-Flight test: ROT for altitude lost in 180^{o} descending turn; assists with spiral glide planning

-Numbers to understand and know by heart

- V_{FE} < Half Flaps:

-RV-4/6/7/8: 110 MPH / 95 KTS CAS

-RV-9: 100 MPH / 87 KTS CAS

- V_{FE} > Half Flaps:

-RV-4/6/7/8: 100 MPH / 87 KTS CAS

-RV-9: 90 MPH / 78 KTS CAS

-Self-limiting if manual!

-Maneuvering Speed (V_A, symmetric) = Vs x √G limit

-Asymmetric ≈ Symmetric V_A reduced by 33%

-***<u>Actual IAS for V_A must be determined by flight test</u>***

-Max L/D: Approximately V_Y (Quick Reference: top of the white arc)

-Max Endurance Glide: Approximately V_X (ON SPEED)

-Max Cruise (V_{NO}) except smooth air:

-RV-4/6: 180 MPH / 156 KTS CAS

-RV-7/8: 193 MPH / 168 KTS CAS

-RV-9: 180 MPH / 156 KTS CAS

-Rough air? Slow down to reduce vertical gust effects (smoother ride); V_A if necessary

-Never exceed (V_{NE}) :

-RV-4/6: 210 MPH / 182 KTS

-RV-7/8: 230 MPH / 200 KTS

-RV-9: 210 MPH / 182 KTS

-Really a function TAS: easily exceeded in cruise descent or maneuvering flight; safety margin reduced as altitude increases.

-Over-speed? Power back and ***smoothly*** transition velocity vector above the horizon. Reduce airspeed, resume descent at reduced speed.

-TAS display (advanced instrumentation)? Use it!

-V_{REF} (final approach speed)/ON SPEED: 1.3-1.4 V_{S1} (V_{S1} = stall speed, landing configuration)

-$V_{APP} = V_{REF} + 5$

-Properly tested/calibrated AOA system? ON SPEED AOA primary reference for approach and landing, CAS back-up

-Aircraft specific, variation in pitot/static calibration; but indicated V_{S1} is V_{S1} for that airplane, 1.3-1.4 ratio will work with whatever number is displayed on the ASI

<u>TR/ATR-1: Basic/Advanced Transition Flight 1 (1.25 Hour Flight + .75 Hour Brief + .5 Hour Debrief)</u>

<u>IPUG-1: Instructor Upgrade Flight 1 (1.25 Hour Flight + .75 Hour Brief + .5 Hour Debrief + Instructional Critique)</u>

Prerequisites

1. Risk Management Training
2. Ground 1
3. SEPT 1

Briefing

-Limitations
-Weight and Balance
-Takeoff and Landing Data Computations (TOLD): Safety Factors
-Airworthiness Determination
-Crew Coordination: Emergencies

Ground Operations

-Basic Servicing (May be deferred to post-flight):
 -Fuel
 -Oil
 -Air (Tires)
 -Brake Fluid
-Pre-flight Inspection
 -Use of Checklist/Flow
-Cockpit Management
 -Securing Baggage
 -Securing the unoccupied cockpit for solo operations
 -Strap In / Ergonomics: Use of Cushions; rudder pedal adjustment; design eye height
 -Cockpit Control Familiarization
 -Canopy Operation
 -Emergency Egress: Ground/Bail Out
-Engine Start
 -Use of Checklist/Flow
 -Normal Start
 -Hot Start
 -Flooded Start

- Leaning Mixture for Ground Operation

-Taxi

- Brake check
- Tail / Nose Wheel Steering
- Prop Blast and Power Control
- Proper position of Flight Controls
- S-Turns (when appropriate)

-Run-up

- Use of Checklist/Flow
- Positioning Aircraft: Hazards/Cooling
- Confirming Canopy Security
- Trim and Flap Setting

Takeoff and Departure

-Normal/Cross-Wind Takeoff

- Line-up Check
- Directional Control:
  - Power Application/Engine Power Effects
  - Raising the Tail/Rotation
- Engine Power/Pressure Checks During Roll
- Rotation/Lift Off

-Climb

- Acceleration: Flap Retraction
- V_Y / Cruise Climb
- Power Adjustment / Temperature Monitoring

-Traffic Pattern Departure

-Level-Off

- Use of Trim
- Engine Management

Basic Aircraft Control

-Straight and Level Flight

- Visual References

-Pitch Stability Exercise

-Yaw Stability Exercise

-Roll Stability Exercise

-Acceleration/Deceleration

- Use of Rudder

-Trim Adjustment

-Standard Rate Turns

-30^{o} Banked Turns

-Roll-out Lead Point / Heading Control

-Altitude Control

-Cruise Altitude Climb/Descent Adjustment

-1 Inch MAP Per 1000 foot

-Descents

-Low Speed

-High Speed: Acceleration Demonstration

-Computing Descent Point(s) / VVI Required

Steep Turns

-Steep Turns: 45 and 60^{o} Bank

-Constant Power (Airspeed Bleed)

-Constant Airspeed (FULL Power)

-Roll-out Lead Point / Heading Control

-Altitude Control

Slow Flight and Stalls

-Slow Flight

-No-Flap (V_{S1} + 5)

-Full-flap (V_{S0} + 5)

-Power-Off Stall

-AOA Recovery

-Cross-control Demonstration

-Power-On Stall

-AOA Recovery

-Go-around Exercise: Power-up/V_{MC} Yaw Drill

Unusual Attitudes (Visual Reference)

-Nose High; Airspeed Decreasing

-Nose Low; Airspeed Increasing

Confidence Maneuvers (Advanced/Instructor Upgrade Only)

-Lazy 8/Wingover

-AOA Recovery

-Deep Stall

Descent/RTB

-Computing Descent Point / Descent path control (Angle/VVI)
-Engine / Airspeed Management

Pattern and Landing

-Use of Checklist/Flow
-Pattern Entry
-Perch Management
-Base Turn
-Stabilized Final
-Slip
-Low-Approach and Go-Around
-Closed Pattern
-Runway Drag (Low Flight) Exercise
-Full-Stop Landings (TW: 3 point; wheel: tail-low)
    -Normal
    -Touchdown
    -Roll-out Directional Control
    -Brake Use

After Landing

-Use of Checklist/Flow
-Parking and Securing
    -Post-flight Inspection
    -Tie Down
    -Control Locks and Covers
    -Servicing

SEPT 1: Ground and Takeoff Emergency Procedures (.75 Hours)

Emergency Procedures (EP) Basics

-Maintain aircraft control, analyze the situation, take appropriate action. **Don't Rush.**
-Safer to fly into the ground (crash under control) than to lose control under low energy conditions close to the ground.
-Emergency ground and in-flight egress should be practiced using a static airplane as a training aid.
-The time to determine when bailing out is appropriate is ON THE GROUND. Minimum bail-out altitudes must be established and adhered to. Based on typical parachute performance, the minimum controlled bailout altitude is 1500 feet AGL, and minimum out-of-control bailout altitude is 2000 feet AGL. These are NO LATER THAN altitudes, occupants must be egressing the airplane by this point. Parachute opening must occur by 1000 feet AGL. Bailout below 1500 feet is not recommended. Provide a thorough briefing on emergency parachute use and parachute flying and landing techniques for upgrading pilots who do not have prior experience.
-When operating on the ground and during takeoff and landing, the pilot must maintain positive directional control at all times and make allowance for prevailing wind conditions.

Ground Emergencies

-Emergency Ground Egress
-Induction Fire During Start
-No Oil Pressure After Start
-Flooded Engine During Start
-Brake Malfunction
-Fire During Ground Operations
-Loss of Directional Control

Takeoff Emergencies

-Loss of Directional Control
-Rejected takeoff (Abort)
-Engine Failure During or Immediately After Takeoff
    -During Takeoff Roll
    -Immediately After Lift-off
    -Below 1500 Feet AGL

Block 2: Basic Transition/Advanced Transition/Instructor Upgrade

Ground Lesson 2: RV-Type Performance (.75 Hours)

-NO TWO AIRPLANES ARE IDENTICAL / Performance Varies

- -Engine / Prop / Weight / Empty CG
  - -"Light Nose" = O-320 + light-weight prop
  - -"Heavy Nose" = O-360 (or more) + constant speed prop
- -Primary difference in take-off and landing performance
  - -Climb to lesser degree
  - -Cruise is cruise, regardless
    - -Apples to apples requires ***accurate*** calibrated airspeed data
    - -Van's factory numbers accurate for properly "propped" airplanes at similar gross weight
  - -Little or no difference on top end with cruise / constant speed prop
  - -Glide: Depends on propeller type/pitch fitted
    - -Large variation
      - -Light weight (e.g., wood) fixed pitch "cruise" prop tend to have lowest rotating drag, i.e., best glide performance (ROT 10:1)
      - -Typical non-aerobatic controllable pitch propeller best glide/lowest drag in **LOW RPM** (course pitch)
    - -Prop stopped: pays above 3000-4000 AGL--below that, limited benefit
      - -Problematic for controllable pitch propellers
      - -***Never sacrifice control to stop prop***

-Different airplane with passenger / cargo / density altitude Δ

-Quality of flight test and data varies

- -Good takeoff and landing data is difficult to measure without proper equipment and test procedures
- -Accurate cruise data requires proper pitot/static testing
- ***-Outstanding general performance CAN FOSTER COMPLACENCY***

-Example: Van's Numbers (160 HP RV-4)

- -Prototype / standard conditions / fixed-pitch, wood prop / measured
  - -Solo weight data: 1160
    - -Real world example 985 lb empty weight + 170 lb pilot: 1335 lbs takeoff weight with full fuel (115% of prototype #'s)

-RV-4 max allowable gross weight: 1500

-Gross Weight Takeoff

-Van's Ground roll distance: 450 feet (measured)

-AC90-89A estimate: 850 feet (estimate based on wing loading)

-Minimum Recommended runway: 2000 feet (1:20 climb to 50')

-Accelerate/Stop: 1750 feet

-Take-off/Fly 5 Sec/Land/Stop: 3100 feet

-"Koch Chart" non-standard density ratio

-Florida example: Pressure Altitude 300' MSL / 90^{o}F

-30% increase in takeoff distance:

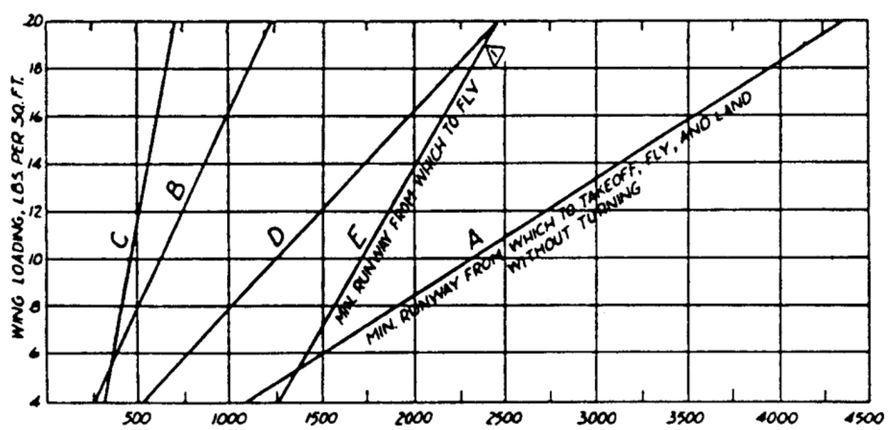
-Van's ≈ 585 foot ground run

-AC90-89A ≈ 1105 foot ground run

-Your airplane? Somewhere in that range

-Throttle technique?

-Flap setting?



A – Distance to takeoff at minimum smooth lift-off speed, fly for 5 seconds at that speed without climbing, land and stop straight ahead.

B – Distance to reach minimum smooth lift-off speed.

C – Distance covered in 5 seconds of flight at minimum smooth lift-off speed.

D – Distance to stop from minimum smooth lift-off speed (includes air and ground distance).

E – Distance to takeoff at slow approach speed and climb thereafter at an angle of 1 in 20 to 50 ft. altitude —this distance will allow most airplanes to accelerate to normal climb speed before crossing end of runway.

Figure 2-1: AC90-89A Minimum Recommended Runway Length Chart

-Climb:

-V_X largely a function of weight: decreases with weight (ball park 80-85 MPH / 70-75 KTS)

-V_Y largely a function of altitude: decreases with altitude (ball park 100-120 MPH / 90-105 KTS)

-"Flat" RV climb curve data = fairly consistent performance across a large speed band…limiting factor at lower speeds? Engine cooling. Adjusting CHT (if equipped) can take priority over precise airspeed control

-"Light nose" Cruise Prop (fixed pitch) ROT at 105-120 MPH / 90-105 KTS CAS (nominal V_Y):

-Solo / Standard Winter: 1800-2000 FPM

-Solo / Summer: 1200-1500 FPM

-Gross / Standard: 1500-1700 FPM

-Gross / Summer: 1000-1200 FPM

-Bottom line: Airspeed as required to keep hottest cylinder at 380°F or less and oil temperature within limits

-Constant speed prop: positive effect on takeoff and climb performance

-Cruise

-Is what it is! ***Only way to know for sure is to collect data***

-Key: being able to ***establish a known power setting***

-Tach/MAP required

-Review charts

-Manufacturer's Charts/Power Curves (Engine Handbook?)

-Airplane charts (if available)

-No appreciable performance advantage for a constant speed prop over a properly pitched fixed propeller in cruise flight

-Pick a power setting (55-65% sweet spot)

-Stock O-320 ROT: 7-8 GPH (properly leaned) at altitude (6-10K MSL)

-Stock O-360 ROT: 8-10 GPH (properly leaned) at altitude (6-10K MSL)

-Lycoming recommendation: 65% or less for max engine life

-LOP if you can get there

-***Fuel flow vs. actual ground speed is all that matters***

-No wind planning numbers?

-RV-4 Example: 150KCAS / 172MPH

-3+30 with 30 minute reserve (450 NM range)

-TAS ROT: add 4 (or 2%) KTS / 1000' to CAS

-Power Setting ROT: MP + RPM/100 ≈ % Power

"45" ≈ 65% (±3 for each 10% up or down)

-Example: 22.5" MP + 22(50) RPM ≈ 45 (65% power)

-Can also pull MP/RPM combination off of Lycoming graphic data

-Cruise Climb/Descent: Airplane is extremely efficient…make 1” MAP per 1000’ power adjustments for 300-500 FPM ROC or descent for changing cruise altitude

-Descent

-Descents take planning; Observe V_{NO} (CAS) and V_{NE} (TAS)

-Be alert for induction icing at reduced power settings

-Adjust pitch, set airspeed (trim) THEN adjust MP

-Smooth air ground speed: 3 NM/Min (180 KTS)

-3^{o} = 3 NM per 1K’ to lose; “DME X 3”

-“Normal” 15-17” MAP/1800-2000 RPM

-Rough air ground speed: 2 — 2.5 NM/Min (120-150 KTS)

-Turn radius (NM) ≈ 1% ground speed

-ROT: 1NM to decel from cruise descent to holding speed; 2NM to decel to approach speed

-Holding

-L/D_{MAX} for max endurance (≈1.4 V_S)

-Else, 120 MPH / 105 KTS CAS (≈ Carson’s speed)

-Power: 40-45% 16-17” MAP 1900-2000 RPM

-Pitch: +2.5^{o}

-Fuel Flow: Lycoming ≈ .1 Gal/minute (e.g., 25 min hold ≈ 2.5 Gal burned)

-Instrument Approach: GS x 5 = VVI for 3^{o} approach path (400-500 FPM)

-3^{o} VDP @ HAT/300 in miles from TDZ

-3^{o} VDP by timing: 10% HAT subtracted from FAF to MAP timing

-90 MPH / KTS CAS, Flaps UP works well for approach speed, low to ON SPEED/V_{REF} when transitioning visually; maintain glide path depicted on approach plate for final approach/transition to landing (e.g., 3^{o})

-Dive/drive (non-precision): 10” MAP; 800-1000 FPM at MDA NLT computed/published VDP

-CDA (constant descent approach) in lieu of dive/drive?

-Visual Stabilized Final: 300’ AGL 3K’ from TDZ; 6^{o} (or ON SPEED/V_{REF} glide angle)

-Sufficient energy to reach TDZ power off

-Shallower descent angles (e.g., standard 3^{o}) require power

-Landing

-Normal landing distance ≈ 95% of takeoff distance

-Short field landing = back side of the power curve

-EXPECT float if flying standard 75-80 CAS (1.4 V_S) power-off approach to three-point

-Flaps UP to transition weight to the gear

-Constant speed prop? Whole different animal

-Bottom Line: 2000 foot minimum runway until you're proficient

-Proficient? Operating off a short runway still carries increased risk factor…

TR/ATR-2: Basic/Advanced Transition Flight 2 (1.25 Hour Flight + .75 Hour Brief + .5 Hour Debrief)

IPUG-2: Instructor Upgrade Flight 2 (1.25 Hour Flight + .75 Hour Brief + .5 Hour Debrief + Instructional Critique)

Prerequisites

1. Block 1
2. Ground 2
3. SEPT 2

Briefing

-Limitations
-Weight and Balance
-Takeoff and Landing Data Computations (TOLD): Safety Factors
-Airworthiness Determination
-Crew Coordination: Emergencies

Ground Operations

-Review Basic Servicing (May be deferred to post-flight):
    -Fuel
    -Oil
    -Air (Tires)
    -Brake Fluid
-Pre-flight Inspection
    -Flow
-Cockpit Management
    -Canopy Operation
    -Emergency Egress: Ground/Bail Out
-Engine Start
    -Use of Checklist/Flow
    -Normal Start
    -Hot Start
    -Flooded Start
    -Leaning Mixture for Ground Operation
-Taxi
    -Brake check
    -Tail / Nose Wheel Steering

-Prop Blast and Power Control
-Proper position of Flight Controls
-S-Turns
-Run-up
-Use of Checklist/Flow
-Positioning Aircraft: Hazards/Cooling
-Confirming Canopy Security
-Trim and Flap Setting

Takeoff and Departure

-Maximum Performance Takeoff (V_X)
-Line-up Check
-Directional Control:
-Power Application/Engine Power Effects
-Raising the Tail/Rotation
-Engine Power/Pressure Checks During Roll
-Rotation/Lift Off
-Climb
-Acceleration: Flap Retraction
-V_X / High Power Climb
-Pitch Stability Exercise
-Engine Monitoring and mixture control
-Traffic Pattern Departure
-Level-Off
-Use of Trim
-Engine Management

Basic Aircraft Control

-Straight and Level Flight
-Visual References
-Pitch Stability Exercise
-Yaw Stability Exercise
-Roll Stability Exercise
-Acceleration/Deceleration
-Use of Rudder
-Trim Adjustment
-30° Banked Turns
-Roll-out Lead Point / Heading Control

-Altitude Control
-Climbs and Descents

Steep Turns

-Steep Turns: 45 and 60^{o} Bank
-Constant Power (Airspeed Bleed)
-Constant Airspeed (FULL Power)
-Roll-out Lead Point / Heading Control
-Altitude Control

Slow Flight and Stalls

-Slow Flight
-No-Flap (V_{S1} + 5)
-Full-flap (V_{S0} + 5)
-Power-Off Stall
-Unusual attitude + AOA Recovery
-Power-On Stall
-Unusual attitude + AOA Recovery
-Go-around Exercise: Power-up/V_{MC} Yaw Drill

Unusual Attitudes (Visual Reference)

-Nose High; Airspeed Decreasing
-Nose Low; Airspeed Increasing

Confidence Maneuvers (Advanced/Instructor Upgrade Only)

-Lazy- 8/Wingover
-AOA Recovery
-Incipient Spin

Advanced Handling (Advanced/Instructor Upgrade Only)

-G Warm-up
-Basic Roll
-Loop
-Cloverleaf

Descent/RTB

-Use of Checklist/Flow

-Computing Descent Point / Descent path control (Angle/VVI)
-Engine / Airspeed Management

Emergency Pattern

-High Key
-Low Key
-Base Turn
-Final
-TDZ Management

Pattern and Landing

-Use of Checklist/Flow
-Pattern Entry
-Perch Management
-Base Turn
-Stabilized Final
-Slip
-Low-Approach and Go-Around
-Closed Pattern
-Runway Drag Exercise
-Full-Stop Landings (TW: 3 point; wheel; tail-low)
    -Normal
    -Touchdown
    -Roll-out Directional Control
    -Brake Use

After Landing

-Use of Checklist/Flow
-Parking and Securing
    -Post-flight Inspection
    -Tie Down
    -Control Locks and Covers
    -Servicing

SEPT 2: In-Flight Emergency Procedures (.75 Hours)

In-flight Emergencies

- -Electrical Malfunction
  - -Low Amperage
  - -High Amperage
- -Electrical Fire
  - -VMC Fire Extinguished
  - -IMC / Night Fire Extinguished
- -Oil System Malfunction
- -Engine Malfunction
  - -Engine Failure / Loss of Power
  - -Engine Fire
- -Pitot / Static Malfunction
- -Induction Icing
- -Controllability Check
- -Canopy Loss During Flight
- -Cockpit Ventilation / Heat Malfunction
- -Fuel Leak
- -Fuel Transfer Malfunction
- -EFIS Malfunction
- -Flight Control Malfunction
- -Trim Malfunction
- -Flap Malfunction
- -Glide Performance
  - -Altitude Lost in Gliding Turn
  - -Glide Chart
- -Out-of-Control
  - -Spins
- -Bail-out
- -Passenger Incapacitation
- -Emergency Descent

Block 3: Basic Transition/Advanced Transition/Instructor Upgrade

Ground Lesson 3: RV-Type Weight and Balance (.75 Hours)

-RV-Types are load sensitive

- -Need to observe design limits
- -Stability and handling characteristics vary with load
- **-Different airplane with passenger and baggage**
- -Bottom line: you need to know gross weight and where CG is & understand what that means for handling and performance

-Definitions

- -Empty weight: Does it include oil (likely)? Unusable fuel (unlikely)?
- -Gross weight = empty + pilot/passenger/baggage + gas
  - -High weight = decreased performance; increased stall speed; reduced G-available
  - -Maximum gross: designated by builder / specified in operating limitations
  - -Van's Numbers Table 2-2
  - -Aerobatic gross: max weight that 6 G's is available
    - -Aerobatics with passengers? Problematic…

Table 2-3: RV-Type Basic Weight and Balance Design Limits					
Type	Maximum Allowable Gross Weight	Maximum Aerobatic Gross Weight	Forward CG Limit (Inches)	Aerobatic CG Limit (Inches)	Aft CG Limit (Inches)
RV-4	1500 LBS	1375 LBS	68.7	75.9	77.4
RV-6	1600 LBS	1375 LBS	68.7	75.3	76.8
RV-6A	1650 LBS	1375 LBS	68.7	75.3	76.8
RV-7	1800 LBS	1600 LBS	78.7	84.5	86.82
RV-7A	1800 LBS	1600 LBS	78.7	84.5	86.82
RV-8	1800 LBS	1600 LBS*	78.7	85.3	86.82
RV-8A	1800 LBS	1600 LBS*	78.7	85.3	86.82
		Maximum Utility Category		Utility CG Limit (Inches)	
RV-9/-9A	1750 LBS	1600 LBS	77.95	82.72	84.84
*1550 LBS if not equipped with the -1 wing. All CG limits inches aft of Datum. Datum for RV-4/6(A) is 60" ahead of the leading edge of the wing, and 70" ahead of the LE for RV-7(A)/8(A)/9(A).					

-Useful Load: It Depends!

-Huge variation in airplane empty weights

-Designer's empty weight vs. reality: You must have specific data for your plane

-100 lbs (+) "overweight" is not uncommon

-How old/reliable is the data?

-Not the builder?

-How good is your data? Did YOU weigh it? Calibrated scales?

-Airplanes tend to gain weight over time

-Warning sign: Both main gear weights identical

-***Good idea to re-weigh a newly purchased RV***

<table>
<tr><th colspan="6">Table 2-4: RV-Type Useful Load with Full Fuel</th></tr>
<tr><th>Type</th><th>Fuel Capacity (Gallons)</th><th>Fuel Weight</th><th>Nominal Empty Weight*</th><th>Aerobatic Useful Load Full Fuel</th><th>Maximum Gross Useful Load Full Fuel</th></tr>
<tr><td>RV-4</td><td>32</td><td>192</td><td>915</td><td>268 lbs</td><td>493 lbs</td></tr>
<tr><td>RV-6</td><td rowspan="2">38</td><td rowspan="2">228</td><td>965</td><td>182 lbs</td><td>407 lbs</td></tr>
<tr><td>RV-6A</td><td>1015</td><td>132 lbs</td><td>407 lbs</td></tr>
<tr><td>RV-7</td><td rowspan="4">42</td><td rowspan="4">252</td><td>1061</td><td>287 lbs</td><td>487 lbs</td></tr>
<tr><td>RV-7A</td><td>1114</td><td>234 lbs</td><td>434 lbs</td></tr>
<tr><td>RV-8[1]</td><td>1067</td><td>281 lbs</td><td>481 lbs</td></tr>
<tr><td>RV-8A[1]</td><td>1120</td><td>228 lbs</td><td>428 lbs</td></tr>
<tr><td colspan="4"></td><td>Utility Useful Load Full Fuel</td><td></td></tr>
<tr><td>RV-9</td><td rowspan="2">36</td><td rowspan="2">216</td><td>1015</td><td>369</td><td>519</td></tr>
<tr><td>RV-9A</td><td>1028</td><td>356</td><td>506</td></tr>
<tr><td colspan="6">*Nominal empty weight based on Van's data. Actual empty weight varies considerably, and most aircraft exceed the designer's specified nominal empty weight.
[1]RV-8/A aerobatic gross weight limit reduced to 1550 lbs if -1 wing not fitted; numbers in this Table reflect -1 wing limits.</td></tr>
</table>

-**CG range: front and back limit of CG measured in inches or percent of MAC**

-Basic limits vs. aerobatic aft limit (RV-4 example, 58" chord, datum 60" forward of wing leading edge [all moments positive]):

-Forward limit is always 68.7" aft of datum (15% chord point)

-Aft limit for normal flight 77.4" aft of datum (30% chord point)

-Aerobatic aft limit 75.9" aft of datum (27.5% chord point)

-Stability Considerations

-Forward CG

- Heavy stick
  - lbs/G
  - More aft stick for landing
- Improved stall/spin resistance & recovery
  - Higher stall speed
- Higher trim drag (reduced top speed)
- Increased pitch stability
- Overall: more stable and safe; less fun to fly

-Aft CG

- Lighter stick
  - Less stick required for landing (more pronounced pitch force changes in ground effect)
  - PIO?
- Less pitch stability
- Lower trim drag
- Decreased departure susceptibility
  - Stall/Spin recovery slower; requires more positive control input
- Aerobatic limit is there for a reason: assume no margin
- Preserves reasonable stall/spin recovery characteristics / increased likelihood of unintentional stalls (handling error)
- No intentional spins with CG aft of aerobatic limit
- Overall: less stable; more fun to fly
  - Van: CG's in aft half of range optimize handling harmony
    - Sweet spot: RV-4 example 72.3 to 75.9"
- Exceeding aft limit is dangerous
  - Control reversal possible

-CG Shift During Flight

-CG moves aft as fuel is burned

- "Most aft" at landing weight / BINGO / flame-out
- Anticipate pitch trim adjustment(s)

-May be possible to be in limits for takeoff and out of limits for landing

- Heavy passenger + baggage = worst-case

-Math

-Weight X Arm = Moment

-"Arm" is distance from "datum"

- Example: RV-4 datum 60" ahead of wing leading edge

-"Ground truth" data belongs in airframe log

-Need sufficient data aboard to compute condition
-Must be dated
-Current data must be carried in cockpit
-Did you build or buy?
-New-to-you RV-type should be re-weighed
-Leveling datum? Van's Builder's Manual (e.g., canopy rail)
-Arms
-Pilot
-Pax (tandem)
-Fuel: CG moves aft as fuel is burned
-Baggage area(s)
-Daily computations:
-Most forward / most aft (worst-case comparison)
-Tabular data for your airplane?
-Garmin X96 weight and balance page?
-Program with data for your airplane
-Easy way to calculate CG every time you fly

-Compartment structural design limits
-Cockpits: RV-4 example, 240 lbs each
-Baggage compartment: RV-4 example, 100 lbs
-You're plane?
-Still need to compute actual weight/balance
-Don't confuse compartment limits with actual weight and balance condition/limits

Blindfold Cockpit Check (.25 Hours)

-Upon completion of TR/ATR-2 and prior to TR/ATR-3, the instructor will conduct a blindfold cockpit check. The upgrading pilot will be required to locate all cockpit controls, switches and critical circuit breakers by feel.

TR/ATR-3: Basic/Advanced Transition Flight 3 (1.25 Hour Flight + .75 Hour Brief + .5 Hour Debrief)

IPUG-3: Instructor Upgrade Flight 3 (1.25 Hour Flight + .75 Hour Brief + .5 Hour Debrief + Instructional Critique)

Prerequisites

1. Block 2
2. Ground 3
3. SEPT-3

Briefing

-Limitations
-Weight and Balance
-Takeoff and Landing Data Computations (TOLD): Safety Factors
-Crew Coordination: Emergencies

Ground Operations

-Pre-flight Inspection
    -Flow
-Cockpit Management
    -Emergency Egress: Ground/Bail Out
-Engine Start
    -Use of Checklist/Flow
    -Leaning Mixture for Ground Operation
-Taxi
    -Brake check
    -Tail / Nose Wheel Steering
-Run-up
    -Use of Checklist/Flow
    -Positioning Aircraft: Hazards/Cooling
    -Confirming Canopy Security
    -Trim and Flap Setting

Takeoff and Departure

-Maximum Performance Takeoff (V_X)
    -Line-up Check
    -Directional Control:

        - -Power Application/Engine Power Effects
        - -Raising the Tail/Rotation
    - -Engine Power/Pressure Checks During Roll
    - -Rotation/Lift Off
- -Climb
    - -Acceleration: Flap Retraction
    - -V_X / High Power Climb
    - -Engine Monitoring
- -Traffic Pattern Departure
- -Level-Off
    - -Use of Trim
    - -Engine Management

Steep Turns

- -Steep Turns: 45 and 60^o Bank
    - -Constant Power (Airspeed Bleed)
    - -Constant Airspeed (FULL Power)
        - -Roll-out Lead Point / Heading Control
        - -Altitude Control

Slow Flight and Stalls

- -Slow Flight
    - -No-Flap (V_{S1} + 5)
    - -Full-flap (V_{S0} + 5)
- -Power-Off Stall
    - -Unusual attitude + AOA Recovery
- -Power-On Stall
    - -Unusual attitude + AOA Recovery

Unusual Attitudes (Visual Reference)

- -Nose High; Airspeed Decreasing
- -Nose Low; Airspeed Increasing

Confidence Maneuvers (Advanced/Instructor Upgrade Only)

- -Lazy- 8
- -Incipient Spin
- -Low AOA Aileron Roll

Advanced Handling (Advanced/Instructor Upgrade Only)

-G Warm-up
-Loop
-Barrel Roll
-Immelman

Descent/RTB

-Use of Checklist/Flow
-Computing Descent Point / Descent path control (Angle/VVI)
-Engine / Airspeed Management

Emergency Pattern

-High Key
-Low Key
-Base Turn
-Final
-Energy/TDZ Management

Pattern and Landing

-Use of Checklist/Flow
-Pattern Entry
-Perch Management
-Base Turn
-Stabilized Final
-Slip
-Low-Approach and Go-Around
-Closed Pattern
-Full-Stop Landings (TW: 3 point; wheel; tail-low)
    -Normal/Short/soft field
    -Touchdown
    -Roll-out Directional Control
    -Brake Use

After Landing

-Use of Checklist
-Parking and Securing
    -Post-flight Inspection

SEPT 3: Landing Emergency Procedures (.75 Hours)

Landing Emergencies

-Landing With Known Flat tire
-Emergency Landing Pattern
    -High Key
    -Low Key
    -Base Turn
    -Touchdown
-Airspeed Indicator Failure
-Ditching

Block 4: Basic Transition/Advanced Transition/Instructor Upgrade

Ground Lesson 4: EAB Airworthiness Determination (.75 Hours)

-Big Picture: Pilot determines airworthiness / Owner responsible for maintenance

-Pilot "airworthiness"

- -Certificate on person
- -ORIGINAL, valid medical on person
    - -Can't be a copy (ramp check)
- -Currency
    - -Logs: Not required to be carried in the aircraft
    - -Check ride / Competency check / Flight review
        - -Check-ride in lieu of
        - -Tail wheel endorsement
    - -Required day / night recency of experience
        - -Tail wheel takeoffs and landings must be to a full-stop
    - -*May* be required to submit documentation ex post facto if ramp checked

-Paperwork

A Special Airworthiness Certificate (Pink)

- -Available and DISPLAYED IN COCKPIT
    - -N-number must match data plate / markings
    - -Only valid when OPERATING LIMITATIONS are aboard

R Registration Certificate

- -Temporary? Pink, 120 day limitation
- -Expiration date?

R Radio Station License

- -Only required for flight outside of CONUS
    - -Canada/Bahamas/Mexico/Etc.
    - -FCC Form 605 / Schedule C to Apply
- -If station license required, then restricted radio telephone operator's permit is required

O Operating Limitations

- -Part of airworthiness certificate for experimental aircraft
- -Letter issued by FSDO to original builder

W Weight and Balance Data

- -Must be **DATED and CURRENT**

-Can be a photo copy of airframe log

- -Compass correction card?
- -Most recent VOR check?
- -Altimeter / pitot static check (24 months)?
- -Transponder check (24 months)?
- -ELT batteries (ramp check item)
  - -"D" cells in ELT? Batteries must have expiration date stamped
  - -Sealed battery pack? 5 year expiration date
  - -Additional battery in instrument panel remote actuator switch (if equipped)
  - -Decel (G) switch check
  - -Recorded in log books / sticker?
  - -406mHz (if equipped) 90 Day Check?
- -Placards:
  - -Experimental
  - -Passenger Warning

-"Condition" check vs. "Annual"

- -Experimental (homebuilt) aircraft require a condition check
  - -Not "annual"
  - -Can be performed by any A&P or original builder if issued repairman's certificate
    - -AI is NOT required / there is no type certificate to comply with
  - -Due at the end of the 12^{th} month
  - -Builder can develop checklist
    - -Do you have one?

-FAR 43 (Maintenance) DOES NOT APPLY TO EXPERIMENTAL AIRCRAFT, *sort of*…

- -FAR 91.319(e) Operating Limitations
- -FAR 43, Appendix D: General guidance for condition inspection
- -All maintenance "IAW AC 43-13"
  - -43-13 forms baseline for accepted maintenance practice, use it!
- -ANYONE can turn a wrench on an experimental aircraft
  - -Normal logging required
- -Only an A&P, AI or original builder (with repairman's certificate) can sign condition inspection

-Certification and Modification

- -FAR 21.191 governs certification of experimental aircraft
- -FAA guidance in order 8130.2F

-“Phase I” is initial testing in restricted area

-“Phase II” is “normal ops” for experimental aircraft

-Modification

-Major Change?

-May require FSDO interpretation

-Minor change definition: “…one that has no appreciable effect on the weight, balance, structural strength, reliability, operation characteristics, or other characteristics affecting the airworthiness…”

-Major change example: propeller swap

-”5 hours in the box” with FSDO letter required

-Some FAA maintenance inspectors are NOT familiar with homebuilt / experimental certification

-Do your homework so you can issue the answer!

<u>TR/ATR-4: Basic/Advanced Transition Flight 4 (1.25 Hour Flight + .75 Hour Brief + .5 Hour Debrief)</u>

<u>IPUG-4: Instructor Upgrade Flight 4 (1.25 Hour Flight + .75 Hour Brief + .5 Hour Debrief + Instructional Critique)</u>

Prerequisites

1. All SEPT Training Complete
2. Block 3
3. Ground 4

Briefing

-Limitations
-Weight and Balance
-Takeoff and Landing Data Computations (TOLD): Safety Factors
-Crew Coordination: Emergencies

Ground Operations

-Pre-flight Inspection
    -Flow
-Cockpit Management
    -Emergency Egress: Ground/Bail Out
-Engine Start
    -Use of Checklist/Flow
    -Leaning Mixture for Ground Operation
-Taxi
    -Brake check
    -Tail / Nose Wheel Steering
-Run-up
    -Use of Checklist/Flow
    -Positioning Aircraft: Hazards/Cooling
    -Confirming Canopy Security
    -Trim and Flap Setting

Takeoff and Departure

-High Density Altitude, Heavy Weight Takeoff
    -Line-up Check
    -Directional Control:

-Power Application/Engine Power Effects
-Raising the Tail/Rotation
-Engine Power/Pressure Checks During Roll
-Rotation/Lift Off
-Climb
-Acceleration: Flap Retraction
-V_Y Best Rate Climb
-Engine Monitoring
-Traffic Pattern Departure
-Level-Off
-Use of Trim
-Engine Management

Steep Turns

-Steep Turns: 45 and 60^o Bank
-Constant Power (Airspeed Bleed)
-Constant Airspeed (FULL Power)
-Roll-out Lead Point / Heading Control
-Altitude Control

Slow Flight and Stalls

-Slow Flight
-No-Flap (V_{S1} + 5)
-Full-flap (V_{S0} + 5)
-Engine Power Effects Induced Yaw (Go-around) Exercise
-Power-Off Stall
-Unusual attitude + AOA Recovery
-Power-On Stall
-Unusual attitude + AOA Recovery

Unusual Attitudes (Visual Reference)

-Nose High; Airspeed Decreasing
-Nose Low; Airspeed Increasing

Confidence Maneuvers (Advanced/Instructor Upgrade Only)

-Lazy- 8/Wingover
-Inverted Recovery

-Cross-controlled Stalls: Skid/Slip

Advanced Handling (Advanced/Instructor Upgrade Only)

-G Warm-up
-Split-S
-Hammerhead
-Cuban 8

Descent/RTB

-Use of Checklist/Flow
-Computing Descent Point / Descent path control (Angle/VVI)
-Engine / Airspeed Management

Emergency Pattern

-High Key
-Low Key
-Base Turn
-Final
-Energy/TDZ Management

Pattern and Landing

-Use of Checklist/Flow
-Pattern Entry
-Perch Management
-Base Turn
-Stabilized Final
-Slip
-Low-Approach and Go-Around
-Closed Pattern
-Full-Stop Landings (TW: 3 point; wheel; tail-low)
    -Normal/Short/soft field
    -Touchdown
    -Roll-out Directional Control
    -Brake Use

After Landing

-Use of Checklist/Flow

-Parking and Securing

-Post-flight Inspection

Block 1: Advanced Top-Off

Risk Management Review: Human Error (0.5 Hours)

-Error Control

-Accountability: yourself, your family and your fellow aviators—you are responsible for your actions; general aviation is "self-policing" –personal integrity is REQUIRED

-Non-compliance will kill you in aviation: What good are FAR's, technical manuals, procedures, and approved techniques, etc. if you don't comply? You've just broken the chain at the most basic level

-Self-discipline is critical

-Is "good enough" acceptable? Are you executing as well as you can ("top of your game")?

-If you're aiming for "safe," you're aiming too low

-Required value: excellence in all you do

-Anchor yourself in the present: accept reality for what it is

-Hope is NOT a strategy

-Slow down and get there faster: accuracy trumps speed

-Rushing usually takes longer than slowing down in a high workload environment

-Negative feedback ISN'T: it's required to improve

-Best source of negative feedback? You

-Park your ego; take no offense

-Pay Attention to Detail

-Aviation is inherently unforgiving of error, there's nothing bigger than the little things

-Error Producing Conditions

-*Fatigue: #1 cause*; we can be lousy spotting it in ourselves (increases probability of error by a ***factor of 50***)

-Acute: Short-term

-Chronic: Long-term; effects are CUMULATIVE; recovery varies with severity

-Personal symptoms?

-Easiest to fix, counter with rest: 8 hours of sleep desired, naps (20-30 minutes) help

-High Risk/Low Frequency events (increase error probability by 17)

-Short field, obstructed approach

-High density altitude, maximum gross weight takeoff

-Counter by recognizing potential; prepare

-Time Pressure (increase error probability by a factor of 11)

-Classic "get thereitis"

-Counter by recognizing it; turn it off

-Objectively remove yourself from the timeline: reset as required

-EXTERNAL, e.g., the engine quits? You've still got X amount of altitude (energy) and Y amount of time to work the problem…take it one step at a time and work the problem

-Counter by prioritizing and using all time available: If you've got six seconds available, spend 5 seconds thinking and 1 good second executing!

-Low Signal to Noise Ratio (increase error probability by a factor of 10)

-Excessive background noise; most prevalent during high or low workload phases

-High workload = lots of noise

-Low workload = complacency

-Counter by identifying high/low workload segments; "sterile cockpit"

-One Way Decision Gates (increase error probability by a factor of 8)

-"Point of no return;" late recognition won't help

-Counter with exit strategy: if/then logic (e.g., missed approach criteria)

-Information Overload (increase error probability by a factor of 6)

-Confusion caused by too much data; adds stress

-Classic aviation example: channelized attention

-Counter by prioritizing: what's important now?

-Poor Communication (increase error probability by factor of 6)

-Listening is (usually) more important than talking

-Counter by listening actively; strive for clear/concise; confirm (read-back)

-Faulty Risk Perception (increase error probability by a factor of 4)

-Failure to ID risk; ID the WRONG risk; comfort with risk

-Understand the real math: quantitative analysis? Don't fret mid-air collision or inflight fire to the extent you disregard stall/spin during approach and landing…

-Counter by listing risk factors and prioritizing; set realistic risk level—there is no such thing as "low risk flying"

-Distraction

-Look for interruption in routine

-Counter by actively directing attention

-Routine Non-compliance

-"Normalization of Deviance"

-Coined in the wake of Challenger investigation

-This is what occurs when there is NO NEGATIVE CONSEQUENCE

-Rule violation
-Bad judgment
-Ignorance
-Eventually, the math catches up with you
-Counter by applying integrity, self-discipline and excellence in all you do
-Making Mistakes
-Mistakes take you off your game: FIDO, “forget it and drive on”
-Address when appropriate (debrief, or even never), not “now”

-Hazardous Attitudes

-Anti-authority
-“No one tells me what to do”
-Impulsiveness
-“I need to do something about this NOW”
-Invulnerability
-“Can’t happen to me”
-Too competitive/macho
-“That’s nothing, watch this”
-Resignation
-“Why bother, there’s nothing we can do”
-Pressing Too Far
-“I’ve got somewhere I’ve GOT to be”
-Vanity/Ego
-“I’d rather die than look bad”
-Corollary: misapplication of expertise…professional expertise in non-aviation does not directly translate into aviation expertise
-Procrastination
-“I’ll get to it”

<u>Ground 1: RV-Type Handling (.75 Hours)</u>

-**NO TWO AIRPLANES ARE IDENTICAL / *Handling Characteristics Vary***

-Prototype testing less rigorous than standard category factory flight test

-Construction: Rigging/Fairings

-Configuration / Weight (CG)

-Different airplane with passenger and/or baggage aboard

-Performance and handling characteristics of individual aircraft validated by flight test?

-**Static Margin (Pitch Stability)**

-More pronounced variation with tandem versions: Pitch stability trends towards neutral as RCP and baggage load increases; side-by-side types, less CG range/effect

-All RV's: CG moves aft (decreasing margin) as fuel is burned

-Tandem: Movement proportional to initial load—if RCP is occupied/baggage carried, shift will be GREATER than if solo

-Review Weight and Balance information, and determine maximum loads to:

A) Operate within aerobatic envelope

-***Observe design limits: critical to ensure adequate handling characteristics (i.e., sufficient static margin available)***

B) Determine ***G allowable***

-"G Available" is the amount of G the airplane is capable of generating at any time as a result of dynamic pressure (speed). Above V_A, G available exceeds design limits.

-"G Allowable" is the amount of G the airplane can sustain and remain within design limits. G allowable ***decreases*** as gross weight increases.

-"Asymmetric G Allowable" is the amount of G the airplane can sustain when maneuvering about two axes ***simultaneously***. It is always less than "symmetric G allowable."

C) Establish "target G"

-"Target G" is the amount of G applied to achieve a desired maneuver.

Note
IAW Training Rules, the maximum target G is 4.

-Anticipate (neutral) control response

-Stick becomes pitch rate controller at neutral stability: Be ready to ***move the stick as required to establish desired attitude, AOA/Airspeed***; anticipate over-shoot tendency

-E.g., high climb angles

-***SMOOTH APPLICATION OF FLIGHT CONTROLS IS CRITICAL***

-Airplane does not become suddenly uncontrollable, however designer's limits ARE NOT CONSERVATIVE—***LIMITED STATIC MARGIN AT AFT AEROBATIC CG LIMIT***

-Farthest aft point tested by designer using prototype

-Critical to ensure adequate (spin) recovery characteristics

-Aerobatics with passengers? *Problematic for most airplanes* due to weight restrictions (as well as CG)

-Stick Force Lightening: Gradient linear for a given TAS / CG combination, but:

-Stick length or geometry may be adjusted by builder

-Stability / margin affected by ATTITUDE

-Nose-up, low airspeed, high power (V_X climb) = reduced margin

-Acrobatics: longitudinal axis nearly vertical = reduced margin

-Landing: ground effect + low aspect ratio = pitch adjustment during the flare (ease or stick forward, more pronounced in tandem airplanes)

-Handling improves as speed decreases

-Heavy stick with forward CG / high speed

-***Biggest impact on stick force gradient: CG location***

-Larger variability in Tandem versions

-As CG moves aft, stick controls pitch rate more so than AOA: control forces become lighter

-At neutral stability nose stays where you put it vs. correcting to trim condition

-Stall/spin resistance reduced as CG moves aft

-*DO NOT EXCEED AFT LIMIT*

-Stability becomes neutral for most RV-types at aft CG limit

-This is aft of aerobatic aft limit

-**Operating near/at aft CG limits:**

-Little or no trim change required over wide speed band

-Light stick forces; *easy to over-control*

-Nose does not readily drop when aircraft is stalled

-Tendency for pitch control reversal just prior to stall

-Neutral/negative phugoid at low airspeed

-Maximum Allowable Gross Weight

-Operation Limitations/Builder specifications vs. designer's limits

-***Structural margin UNKNOWN when operating beyond design limits***

Table 2-5: RV-Type Aerobatic Limits					
Type	Max Aero Gross	+ G Limit	- G Limit	Forward CG Limit[1]	Aerobatic CG Limit[1]
RV-4	1375 LBS	+ 6.0	- 3.0	68.7	75.9
RV-6					75.3
RV-6A					
RV-7	1600 LBS			78.7	84.5
RV-7A					
RV-8	1600 LBS*				85.3
RV-8A					

*1550 LBS if not equipped with the -1 wing. Asymmetric maneuvering reduces allowable G by 20-33%: -2.4 to +4.8 or -2.6 to +4.0. Asymmetric G limits are not specified by Van's Aircraft.

[1]Inches aft of datum. Datum for RV-4/6(A) is 60" ahead of the leading edge of the wing, and 70" ahead of the LE for RV-7(A)/8(A).

-Yaw

-Positive stability throughout the envelope

-Excursions (fish tailing) likely in turbulence

-Rudder NOT effective for singular roll control (lift vector placement)

-Limited dihedral effect to generate roll

-Sufficient authority to be effective post-stall

-Slips: full deflection slips with or without flaps practical

-Limited effect on CAS (wing mounted pitot)

-Effect of gear fairings

-Destabilizing when installed (vertical area ahead of aerodynamic center)

-Reduce airframe drag by approximately 15% (Van's)

-Roll

-Tending to neutral stability throughout the envelope

-Aileron primary means of controlling roll / lift vector

-Rudder somewhat effective at high AOA

-**Overall Control Harmony: very light ailerons, light rudder, heavier elevator**

-Stability Check

-Flown before maximum performance maneuvering

-Provides expectation that aircraft is rigged properly and basic stability is present on each axis

-Risk mitigation considerations:

-Aircraft must be *loaded within designer's limits*

-Actual weight and balance should be *calculated* (how accurate is the data?)

-How to execute:

-Establish trimmed level cruise flight

-Pitch: Ease nose up 10-20^o and relax longitudinal pressure

-Observe deadbeat response (tendency to return to trim condition)

-Reestablish trimmed level cruise

-Roll: Apply 45^o bank and relax lateral pressure

-Observe roll response (neutral or slight tendency to roll wings level)

-Reestablish trimmed level cruise

-Yaw: Note slip indicator then smoothly apply rudder and relax pedal pressure

-Observe yaw response (tendency for yaw excursions to damp)

-Reestablish trimmed level cruise

-Stalls: straight wing, Frise-type ailerons, no wash-in or wash-out, no stall strips (most airplanes)

-Power-off: non-event (e.g., 60 MPH / 52 KTS CAS)

-Notable engine power effects at all throttle settings (including idle)

-Use rudder to keep the ball centered

-May have to sacrifice desired attitude or heading control

-If aileron is used to counter engine power effects at idle, sufficient cross-control will exist at stall to cause a (left) wing drop

-Nose may or may not drop if full aft stick is held

-Distinct buffet

-CG dependent (static margin available): with forward CG, airplane "nods" and remains controllable post stall; with aft CG airplane remains in stalled condition and may depart (spin) with little warning (will recover quickly, ¼ to ½ turn with neutral controls [ease] with neutral rudder)

-Wing drop common in deep stall; yaw in direction of wing drop

-Aircraft will tend to depart in yaw if deep stall is held

-First indication of breakdown in directional stability: nose slice or wing drop

-Rudder effective post-stall; precise heading control not practical

-More distinct wing drop with flaps extended; left roll tendency

-Less buffet than clean stall/Limited aerodynamic warning

-Sustained deep stalls ("falling leaf") have the potential to cause horizontal stabilizer buffet

-Most horizontal tail buffet ("wet dog shake") occurs if a deep stall is induced/maintained with inside slip control inputs

-Accelerated: Any attitude/any airspeed

-AERODYNAMIC WARNING PROPORTIONAL TO G-LOAD

-Minimal buffet at low G

-Rapid application of flight controls? Can "beat" aerodynamic warning (i.e., stall without observed warning cues)

-2.1 G stall @ ≈ 80 MPH CAS (Pattern speed); 60^o bank?

-3G @ ≈ 95

-4G @ ≈ 110

-5G @ ≈ 123

-6G @ ≈ 135 (nominal V_A)

-Power on? Same except (much) higher pitch attitude with lift vector perpendicular to the horizon; more pronounced engine power effects

-AOA or Stall Warning System?

-Design Speed Range/Acceleration Characteristics

-V_S to V_{NE} ≈ 4:1 ratio stall speed to V_{MAX} = "Wide speed band"

-What this aerodynamic efficiency also means: ***ANY TIME THE VELOCITY VECTOR IS BELOW THE HORIZON SMOOTH AIRSPEED/G CONTROL IS CRITICAL***

-RV-types accelerate rapidly

-Gravity + low drag = rapid acceleration

-***WEIGHT IS ADDED TO THRUST WHEN THE NOSE IS DOWN*** (proportional to dive angle)

-E.g., 1800 lb airplane at 90^o dive angle can produce over 2000 lbs of "thrust" towards terra firma

-ROT: Nose down = throttle back (more critical with fixed-pitch prop)

-Need to check airspeed before pull-through when inverted

-"Bail out" (recover to wing's level) if out of parameters

-Entry parameters and G-onset/buffet management critical for keeping speed under control

-E.g., back side of a loop/split S; unusual attitude or dive recovery

-Improper control (aircraft handling error) during aerobatics can result in dangerous airspeed build-up

-E.g., falling out of a barrel roll, attempting high speed Split-S, etc.

-Nose low, high speed unusual attitude recovery critical skill set (including emergency dive recovery)

-Symmetric vs. Asymmetric Maneuvering

-***Symmetric***: one axis at a time

-***Roll THEN pull***

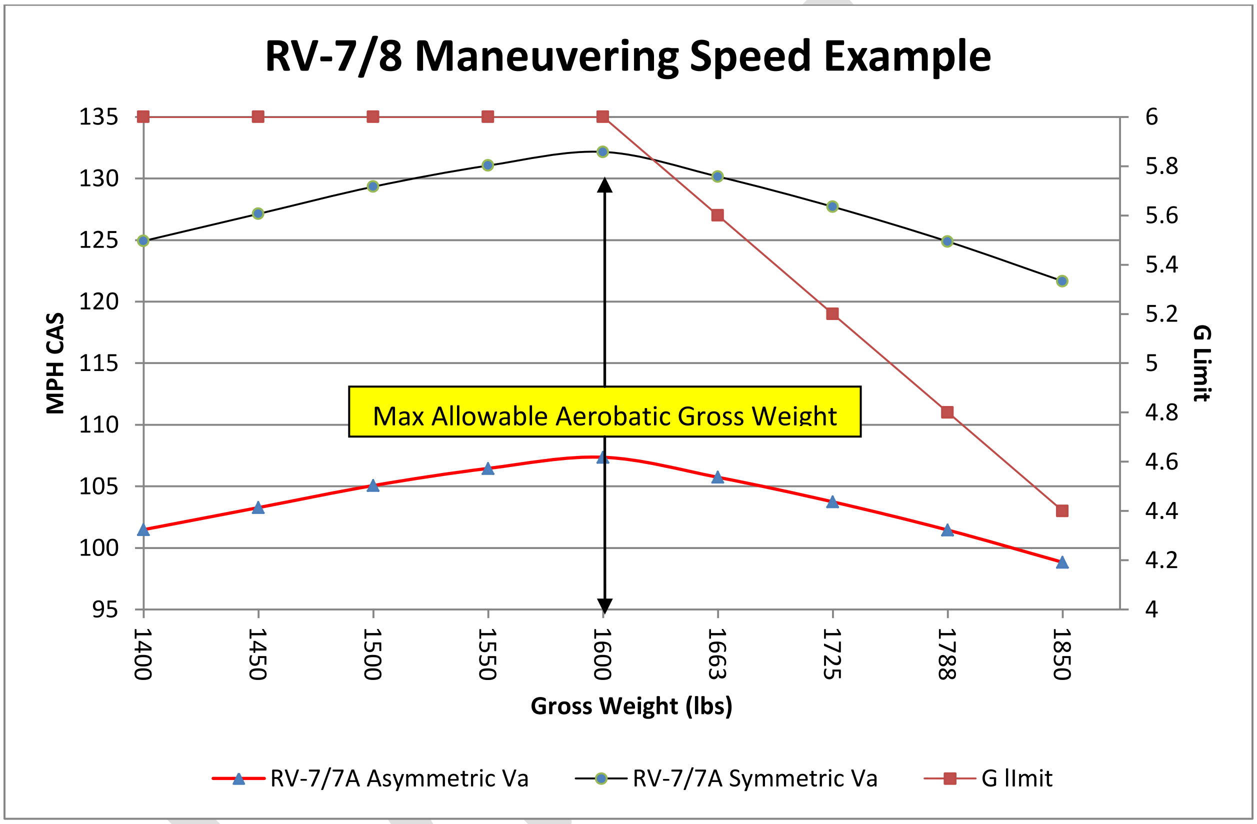
-***Asymmetric***: one or more axis simultaneously (e.g., barrel roll)

-***Rolling AND pulling***

-Puts more stress on the airframe

-Van's Aircraft doesn't specify asymmetric G limits

-ROT: reduces "g allowable" by 33%



-Maneuvering Speed/"Corner Velocity"

-***Understanding and properly applying maneuvering speed is a critical concept***

-"Maneuvering speed" = "corner velocity"

-NOT a static value: changes as a function of gross weight (decreases with weight)

-*Calculate* appropriate reference numbers for symmetric and asymmetric application of flight controls (G) for *actual flight configuration*

-Have two "hang your hat" numbers available, one for symmetric, one for asymmetric

-$V_A = V_S$ (stall speed) x √ (square root) G-limit

-Symmetric positive g-limit = 6

-Square root of 6 ≈ 2.5

-Therefore, ***symmetric V_A ≈ 2.5 x stall speed***

-Asymmetric positive g-limit = 4

-Square root of 4 = 2

-Therefore, ***asymmetric V_A ≈ 2 x stall speed***

-V_A is really the stall speed that corresponds to a particular limiting G

-ROT training envelope: ***4G's, speed at or below V_{NO}, snap maneuvering initiated below calculated asymmetric V_A***

-Designer's viewpoint: RV-types not conducive to "snap" maneuvers

-Loaded within design limits and good stability check? Maneuver symmetrically with impunity below corner; aircraft will stall before load limit is exceeded

-***Above corner? G application is CRITICAL; i.e., how you move the stick***

-Smooth, application of flight controls

-Unload, roll, pull = symmetric G limit

-Rolling pull? Asymmetric limit applies

-See Table 2-2 for example of RV-4 G-available as a function of airspeed

-Load limits will be exceeded before the airplane stalls

-At normal RV cruise speed it's possible to develop 9.5 to in excess of 11 G's with abrupt stick application

-Example: Loop entry target speed 180 MPH CAS, target G 4; but use caution—aerodynamically *10.7 G's are available* at the start of that maneuver—only 6 G's are *allowable* assuming loaded within aerobatic design limits

-Best instantaneous turn performance in any plane occurs at corner velocity: minimum radius; maximum rate

-Bottom line: Below maneuvering speed, lift is limiting factor; above maneuvering speed, ***the pilot*** is the limiting factor

WARNING

Structural (fatigue) damage can occur any time design limits are exceeded or if there is a construction error or material flaw. Fatigue damage is cumulative over time and May result in structural damage or failure at loads less than design limit.

-**Loss of Control**

-Indications:

-Buffet; and/or

-Nose stops tracking; and/or
-Wing drop/rock; and/or
-Nose Slice (yaw); and/or
-Nose Rise (stick force lightening)
-Power Effects
-*Tends* to cause left yaw/nose slice
-Mitigated with IDLE power but present at ALL throttle settings

-***Uncontrolled yaw is what will get you into trouble post-stall***
-You can "beat" aerodynamic warning: rapid control input can cause a departure without aerodynamic warning

-"UNLOAD FOR CONTROL" Concept: AOA recovery (stall)
-***Ailerons neutral***
-***Establish 0 to 1/2 G condition***
-Engine (oil) limitations / fuel starvation (carb)
-Carb float is poor man's aural G-meter!
-Does an inverted oil system work at zero G?
- Stall speed dramatically reduced (zero G = zero V_S)
-Prioritize: maintaining aircraft control is more important than engine parameters
-***Rudder (as required) to counter yaw*** (nose slice/wing drop)
-Airplane is ballistic
-Unloaded; airspeed increasing
-Velocity vector on/below horizon
-Roll to recover
-ROT for nose high recovery: Degrees nose up (start) = degrees nose low (finish)
-Fuel odor in the cockpit? Normal
-Nose low? Airspeed build-up is primary concern
-***Power: As required***
-Idle to reduce power effects
-Carbureted engine? Don't be surprised if it quits
-Prop likely to stop if it's light weight (wood)
-Be ready for air-start post recovery
-Starter vs. dive to windmill

-Recovery: ***AIRCRAFT IS NO LONGER OUT-OF-CONTROL WHEN UNLOADED TO 0 – ½ G AND AIRSPEED IS INCREASING PAST 100 MPH / 90 KTS CAS***

-***Unintentional Spins***

-Airplane resistant to spins unless pro-spin controls are input/held (i.e., uncoordinated flight is maintained post-stall)

-Spin resistance proportional to CG location…airplanes more spin prone, less warning with AFT CG (Tandem)

-Nose slice is best yaw cue; if you see it post-stall, you are set up for an incipient spin

-Neutralizing the controls will ***always*** help

-Auto recovery in less than one turn/snap roll likely if controls neutralized immediately

-Inertial coupling can occur if you apply anti-yaw rudder with simultaneous forward stick (auto roll).

-Think of "stick forward" as "ease" or "release back pressure"

-Low Altitude

-***<u>Unintentional spins that occur in the traffic pattern should be considered non-recoverable</u>***

-AOA/Airspeed awareness is critical in the pattern

-Observe min airspeed / Max AOA limits

-A 2-G accelerated stall occurs at approximately 80 MPH CAS

-Skidding turns higher risk than slipping turns: A skid will cause an immediate departure as Critical AOA is exceeded; it's very difficult to get an airplane to depart in a slip (it will rudder roll "over-the-top" before autorotation)

-Below 2000' AGL, uncontrolled bailout is not practical.

-No man's land: Anti-spin controls NLT 1500' AGL with PERFECT dive recovery technique: you MIGHT make it; but you are below minimum out-of-control bail-out altitude

-RECOVERY BOLDFACE (Boldface = memory item)

-POWER IDLE

-CONTROLS NEUTRAL

-"Idilize and Neutralize"

-Recovery within 1 to 1 ½ turns no other action

-RUDDER OPPOSITE YAW (IF REQUIRED)

-Stick motion: center laterally, then longitudinally

-May need to look at stick (consider using two hands)

-Tandem/forward CG: Inertial coupling possible

-Auto roll tendency if rudder deflected

-Nose tuck past vertical if spin is result of "normal" attitude stall

-If rotation increases, use "other" opposite rudder

-ELEVATOR PAST NEUTRAL (IF REQUIRED)

-What does it take to break the stall?

-Upright = forward

-Inverted = aft

-Target zero G

-How to move the stick: smooth/aggressive

-Altimeter/bail-out cross-check? Must be OUT of the plane NLT 2500 AGL for out-of-control

-***Unintentional Spins***

-Airplane resistant to spins unless pro-spin controls are input/held

-Spin resistance proportional to CG location…airplanes more spin prone, less warning with AFT CG (Tandem)

-Neutralizing the controls will always help

-Incipient phase: recovery in ½ to ¾ turn likely if controls neutralized immediately

-Inertial coupling may occur if you apply anti-yaw rudder with simultaneous forward stick (auto roll).

-Think of "stick forward" as "ease" or "release back pressure"

-Intentional Spin Characteristics

-Designer's viewpoint: not a recreational maneuver

-Difference between tandem and side-by-side variants

-Aircraft to aircraft differences

-Pro spin controls must be maintained throughout incipient phase (≈ 2 turns)

-Expect nose tuck past vertical

-Some airplanes may enter a spiral dive vs. spin at forward CG locations

-If speed increasing above 100 KTS/MPH, recover immediately

-Power above idle may improve elevator effectiveness and help force spin entry

-Nose low, high rotation rate: 180-270 deg/sec

-Full aft stick SLOWS rotation rate

-If stick is allowed to float, expect outside aileron to float up; drive stick off center (opposite spin direction)

-Maintain pro-spin controls until it's time to recover!

-Zero CAS, VVI pegged, 1 G, ball opposite spin (EFIS indications?)

-300-500 ft/turn, 2 sec/turn

-3000 AGL 6 turns and 12 seconds from impact

-1500 AGL 3 turns and 6 seconds from impact

-Recovery requires 1.5 turns and 1000' of altitude

-Initiate recovery NLT Floor + 1000'

-More than 7 turns can disorient

-Always recover before your inner ear tumbles; tolerance will improve with exposure (and can decrease with illness!)

-Gee Whiz

-Power on spins = higher nose attitude / slower rotation rate

-10 turn spin + recovery requires ≈ 3500' of altitude

-Dive Recovery

-RV types accelerate *fast* when the velocity vector is below the horizon

-More pronounced with fixed-pitch propellers

-As a general rule, throttle back when the nose is tracking down through or below the horizon; be ready to apply G to keep speed under control

-Most common error in dive recovery is slow application of back stick during the initial phase of the recovery

-Altitude lost in a dive is a function of radial G and TAS

-Basic Emergency Dive Recovery (airspeed ≥ V_A)

-Power IDLE

-Unload momentarily to less than 1 G, roll to establish lift vector perpendicular to horizon

-SMOOTHLY apply maximum G allowable (target 6 with nominal 2 G/sec application rate, i.e., 3 seconds to establish 6 G's)

-Reduce G's and allow airplane to slow down as velocity vector/nose transits horizon

WARNING

The low drag characteristics of RV-types result in rapid acceleration in a dive. At high speed, sufficient aerodynamic G is available to cause structural damage or failure if flight controls are applied rapidly.

-Numbers to understand and know by heart

-Maneuvering Speed (V_A, symmetric) = $V_S \times \sqrt{G \text{ limit}}$

-Asymmetric ≈ Symmetric V_A reduced by 33%

-***<u>Actual IAS for V_A must be determined by flight test</u>***

-Max L/D: Approximately V_Y (Quick Reference: top of the white arc)

-Max Endurance Glide: Approximately V_X (ON SPEED)

-Max Cruise (V_{NO}) except smooth air:

-RV-4/6: 180 MPH / 156 KTS CAS

-RV-7/8: 193 MPH / 168 KTS CAS

-RV-9: 180 MPH / 156 KTS CAS

-Rough air? Slow down to reduce vertical gust effects (smoother ride); V_A if necessary

-Never exceed (V_{NE}) :

-RV-4/6: 210 MPH / 182 KTS

-RV-7/8: 230 MPH / 200 KTS

-RV-9: 210 MPH / 182 KTS

-Really a function TAS: easily exceeded in cruise descent or maneuvering flight; safety margin reduced as altitude increases.

-Over-speed? Power back and smoothly transition velocity vector above the horizon. Reduce airspeed, resume descent at reduced speed.

-TAS display (advanced instrumentation)? Use it!

ATO-1: Advanced Top-Off Flight 1 (1.0 Hour Flight + .75 Hour Brief + .5 Hour Debrief)

Prerequisites

1. Risk Management Review complete
2. Ground 1

Briefing

-Limitations/Weight and Balance
-Emergency Egress: Bail-out
-Crew Coordination: Emergencies
-Unusual Attitude Recovery
-Advanced Handling: Confidence Maneuvers and Aerobatics
-Emergency Procedures: SFO Review

Ground Operations

-Pre-flight Inspection/Servicing
-Cockpit Management
    -Emergency Egress: Ground/Bail Out
    -Securing Lose Items
-Use of Checklist/Flow
-Engine Start
-Taxi
    -Brake/steering check
-Run-up
    -Positioning Aircraft: Hazards/Cooling

Takeoff and Departure

-Use of Checklist/Flow
-Normal/Cross-Wind Takeoff
    -Line-up Check
    -Directional Control:
        -Power Application/Engine Power Effects
        -Raising the Tail/Rotation
    -Engine Power/Pressure Checks During Roll
    -Rotation/Lift Off
-Climb
    -Acceleration: Flap Retraction

- V_Y / Cruise Climb
- Power Adjustment / Temperature Monitoring / Proper Use of Mixture Control

-Pattern Departure
-Level-Off

- Use of Trim
- Engine Management

-Stability Check: Pitch / Roll / Yaw

Steep Turns

-Steep Turns: 60° Bank

- Constant Power (Airspeed Bleed)
- Constant Airspeed (FULL Power)
    - Roll-out Lead Point / Heading Control
    - Altitude Control

Slow Flight and Stalls

-Slow Flight Review

- No-Flap (V_{S1} + 5)

-Power-Off Stall Review
-Power-Off Deep Stall
-Power-On Stall Review

Unusual Attitudes (Visual Reference)

-Nose High; Airspeed Decreasing
-Nose Low; Airspeed Increasing

Confidence Maneuvers

-Lazy- 8/Wingover
-Incipient Spin
-AOA Recovery
-Low AOA Aileron Roll

Advanced Handling

-G Warm-up
-Acceleration Maneuver
-Aileron Roll
-Barrel Roll

-Loop
-Cloverleaf

Descent/RTB

-Descent Planning
-Engine / Airspeed Management

Emergency Pattern

-High Key
-Low Key
-Base Turn
-Final
-Energy/TDZ Management

Pattern and Landing

-Use of Checklist/Flow
-Pattern Entry
-Perch Management
-Base Turn
-Stabilized Final
-Slip
-Low-Approach and Go-Around
-Closed Pattern
-Full-Stop Landings

After Landing

-Use of Checklist/Flow
-Parking and Securing

Block 2: Advanced Top-Off

Ground Lesson 2: RV-Type Handling (.75 Hours)

-NO TWO AIRPLANES ARE IDENTICAL / Performance Varies

-Engine / Prop / Weight / Empty CG

-"Light Nose" = O-320 + light-weight prop

-"Heavy Nose" = O-360 (or more) + constant speed prop

-Primary difference in take-off and landing performance

-Climb to lesser degree

-Cruise is cruise, regardless

-No difference on top end with cruise / constant speed prop

-Glide: Depends on propeller type/pitch (ROT: 10:1 or better)

-Different airplane with passenger / cargo / density altitude Δ

-RV-Types are load sensitive

-Need to observe design limits

-Stability and handling characteristics vary with load

-Different airplane with pax and baggage

-Bottom line: you need to know gross weight and where CG is & understand what that means for handling and performance

-**CG range review: front and back limit of CG measured in inches or percent of MAC**

-Basic limits vs. aerobatic aft limit (RV-4 example, 58" chord, datum 60" forward of wing leading edge [all moments positive]):

-Forward limit is always 68.7" aft of datum (15% chord point)

-Aft limit for normal flight 77.4" aft of datum (30% chord point)

-Aerobatic aft limit 75.9" aft of datum (27.5% chord point)

Math review

-Weight X Arm = Moment

-"Arm" is distance from "datum"

-Example: RV-4 datum 60" ahead of wing leading edge

-*"Ground truth" data in airframe log*

-Need sufficient data aboard to compute condition

-Must be dated

-Did you build or buy?

-New-to-you RV-type should be re-weighed
-Leveling datum? Van's Builder's Manual…
-Arm
-Pilot/front cockpit
-Passenger/rear cockpit (tandem)
-Fuel: CG moves aft as fuel is burned
-Baggage area(s)
-Daily computations:
-Most forward / most aft (worst-case comparison)
-Tabular data for your airplane?
-Garmin X96 weight and balance page? iPad App?
-Program with data for your airplane
-Easy way to calculate CG every time you fly

-Compartment structural design limits review
-Cockpits: RV-4 example, 240 lbs each
-Baggage compartment: RV-4 example, 100 lbs
-You're plane?
-Still need to compute *actual* weight/balance

-Quality of flight test data and pilot handbook/documentation varies
-Outstanding general performance CAN FOSTER COMPLACENCY

-Stability Considerations
-Forward CG
-Heavy stick
-Lbs/G
-More aft stick for landing
-Improved stall/spin resistance & recovery
-Higher stall speed
-Increased pitch stability
-Overall: more stable and safe; less fun to fly
-Aft CG
-Lighter stick
-Less stick for landing
-PIO?
-Less pitch stability
-Decreased departure susceptibility
-LOWER STATIC MARGIN

-Stall/Spin recovery slower; requires more positive control input

-**Aerobatic limit *is there for a reason: <u>assume no margin</u>***

-Preserves reasonable stall/spin recovery characteristics / increased likelihood of unintentional stalls (handling error)

-No intentional spins with CG aft of aerobatic limit

-Overall: less stable; more fun to fly

-Van: CG's in aft half of range optimize handling harmony

-Exceeding aft limit is dangerous

-Control reversal probable

-CG Shift During Flight

-CG moves aft as fuel is burned

-"Most aft" at landing weight / BINGO / flame-out

-May be possible to be in limits for takeoff and out of limits for landing

-Heavy passenger + baggage = worst-case

-"Aerobatic" Configuration

-Your airplane; your limits

-de facto: Single-seat aerobatic airplane; full design envelope available for maneuvering flight

-You *might* still be there with a light passenger

-Wiggle room? *G-allowable computation* and CG Location

-Treat aerobatic aft CG limit as sacrosanct

-6 positive G's allowable at maximum aerobatic gross weight

-G limit at design maximum gross weight? Interpolation?

-Asymmetric considerations: reduce limit by 20%

-Bottom line: some degree of maneuvering practical up to design maximum gross weight…but you need to establish that envelope

-This envelope will be less forgiving of error that basic aerobatic envelope

-Parachutes are heavy; 2 adds approximately 30 lbs to bottom line…

-"Normal" aerobatic envelope (assuming no inverted systems installed): 0 to +4 G's; sufficient for normal recreational aerobatic/all-axis maneuvering

-Over G Potential

-An "over G" occurs when you exceed design limits; only way you'll likely know is if you have a recording G-meter

-An asymmetric over G is not recorded

-Most likely to occur at high speeds with improper control application

-Over G potential increases in tandem aircraft with the rear cockpit occupied

-Lower stick force gradient

-Lower static margin; aircraft rotates faster about lateral axis (i.e., more responsive) and you need to anticipate

-Side-by-side types have lower static margin to begin with; but handling remains fairly consistent across the load band

-What if an over G occurs?

-Knock it off: cease maneuvering and land as soon as practical; after you are safely on the deck, sort out the maintenance inspection plan

-Over-speed Potential

-Bottom line up front: *ANY TIME THE NOSE IS DOWN BE READY TO DEAL WITH THE ACCELERATION*

-Technical answer: any time the velocity vector is below the horizon, the airplane is going to accelerate; if the lift vector is also below the horizon, it's REALLY going to accelerate! Think "gravity assist"

-Velocity vector: where the airplane is going (just as if all of the mass of the plane were acting through a single point in space—imagine a ball traveling through the air)

-Lift vector: the direction in which lift is being produced (think line straight up through your head [or the tail of the airplane])

-Airframe over-speed can also mean engine over-speed if the airplane has a fixed pitch propeller

-Any time you fly an "over-the-top" maneuver (e.g., loop, Split-S, etc.), you need to anticipate acceleration on the "back side" of the maneuver

-Adjust power

-*Check the airspeed before you start a pull through*

-If it's too high, roll-out and try again; DON'T continue

-Too high? Depends on proficiency; ROT 100 KTS/MPH CAS

-Smoothly establish back pressure (you can pull right up to the edge of the buffet)

-Nose stops tracking? You just encountered an accelerated stall; ease

-Rate the nose through

-Use airspeed and G as your guide; accept the recovery altitude—you can learn to "play" that as your skills improve

ATO-2: Advanced Top-Off Flight 2 (1.0 Hour Flight + .75 Hour Brief + .5 Hour Debrief)

Prerequisites

1. Ground 2

Briefing

-Emergency Egress: Bail-out
-Crew Coordination: Emergencies
-Unusual Attitude Recovery
-Advanced Handling: Confidence Maneuvers and Aerobatics

Ground Operations

-Pre-flight Inspection/Servicing
-Cockpit Management
    -Emergency Egress: Ground/Bail Out
    -Securing Lose Items
-Use of Checklist/Flow
-Engine Start
-Taxi
-Run-up

Takeoff and Departure

-Use of Checklist/Flow
-Maximum Performance Takeoff
    -Line-up Check
    -Directional Control
    -Engine Power/Pressure Checks During Roll
    -Rotation/Lift Off
-Climb
    -Acceleration: Flap Retraction
    -V_Y / Cruise Climb
    -Power Adjustment / Temperature Monitoring / Proper Use of Mixture Control
-Pattern Departure
-Level-Off
    -Use of Trim
    -Engine Management
-Stability Check: Pitch / Roll / Yaw

Steep Turns

-Steep Turns: 60° Bank

- -Constant Power (Airspeed Bleed)
- -Constant Airspeed (FULL Power)
  - -Roll-out Lead Point / Heading Control
  - -Altitude Control

Slow Flight and Stalls

-Power-Off Stall
-Power-On Stall
-Cross-controlled Stalls: Slip/Skid

Unusual Attitudes (Visual Reference)

-Very Nose High; Airspeed Decreasing

- -Ballistic or flop recovery

-Nose Low; Airspeed Increasing

- -Botched barrel roll
- -High speed Split-S entry

Confidence Maneuvers

-Lazy- 8/Wingover
-Incipient Spin
-Inverted Recovery

Advanced Handling

-G Warm-up
-Aileron Roll
-Barrel Roll
-Loop Review
-Split-S
-Immelmann
-Cuban 8

Descent/RTB

-Descent Planning
-Engine / Airspeed Management

Emergency Pattern [If desired or proficiency not demonstrated on TOP-1]

-High Key
-Low Key
-Base Turn
-Final
-Energy/TDZ Management

Pattern and Landing

-Use of Checklist/Flow
-Pattern Entry
-Perch Management
-Base Turn
-Stabilized Final
-Slip
-Low-Approach and Go-Around
-Closed Pattern
-Full-Stop Landings

After Landing

-Use of Checklist/Flow
-Parking and Securing

Block 1: Recurrent

Notes

- EAB pilots operating in a General Aviation environment enjoy a level of unrivalled flexibility and freedom. General aviation has relatively few regulatory encumbrances, and "oversight" is an individual responsibility. As a result safety depends upon the development of each individual pilot's basic skills, knowledge and risk management/decision making skills.
- FAR 61.56 requires regular evaluation of pilot and decision making skills, and aeronautical knowledge. This review is intended to offer pilots the opportunity to design a personal currency and proficiency program in consultation with an instructor. This block of instruction is designed to be custom tailored to suit individual pilot requirements.
- The instructor conducting this block of training has the discretion to determine the maneuvers and procedures necessary for the pilot to demonstrate safe exercise and privileges of the pilot certificate held. It is a proficiency-based exercise, and the objective standards of behavior contained in Table 1-2 should be used for the purposes of evaluation.
- Times contained in this syllabus track may be adjusted at the instructor's discretion.

Safety and Risk Management Review (0.5 Hours)

Note

The following guide has been prepared to assist with briefing and discussion. It may be modified at the instructor's discretion. Additionally, various courses available at www.faasafety.com meet the intent of this briefing and may be substituted at the instructor's direction. Pilot's completing on-line training in lieu of this brief/discussion will present the appropriate certificate of completion to the instructor prior to the conduct of training. Recurrent training documentation will be annotated appropriately.

-Mishap Review

-Bottom line up front:

-Most dangerous periods, initial transition and flight test (first 5 hours)

-Highest odds of dying: handling error during descent and approach

-Second highest odds of dying: takeoff/climb phase

-Lowest threat: mid-air collision or weather

-"Normal Ops" Statistics of what kills pilots (2010 GA aggregate); use #'s for risk ASSESSMENT

-Stall related 15%

-Unknown 14%

-Loss of Control 11%

-Controlled Flight into Terrain 10%

-Mechanical 8%

-Loss of Control in IMC 7%

-Fuel 5%

-Mid-air 2%

-Icing/Convective Activity 1%

-EAB aircraft suffer mishap rate out of proportion for size of fleet and hours flown

-EAB Statistics (2011 Nall Report); use #'s for risk ASSESSMENT

-Mechanical 25.3% (8% lethal)

-Fuel Management 6.1% (8.3% lethal)

-Takeoff/Climb 12.6% (40% lethal)

-Descent/Approach 5.1% (80% lethal)

-Landing 25.3% (2% lethal)

-Other Pilot Related 9.1% (38.9% lethal)

-Unknown 12.1% (45.8% lethal)

-Point to ponder: *an AOA indicator might save your life*

-Risk Management Review

-Error Control

-Accountability: yourself, your family and your fellow aviators—you are responsible for your actions; general aviation is "self-policing" –personal integrity is REQUIRED

-Non-compliance will kill you in aviation: What good are FAR's, technical manuals, procedures, and approved techniques, etc. if you don't comply? You've just broken the chain at the most basic level

-Self-discipline is critical

-Is "good enough" acceptable? Are you executing as well as you can ("top of your game")?

-If you're aiming for "safe," you're aiming too low

-Required value: excellence in all you do

-Anchor yourself in the present: accept reality for what it is

-Hope is NOT a strategy

-Slow down and get there faster: accuracy trumps speed

-Negative feedback ISN'T: it's required to improve

-Best source of negative feedback? You

-Park your ego; take no offense

-Pay Attention to Detail

-Aviation is inherently unforgiving of error, there's nothing bigger than the little things

-Error Producing Conditions

-*Fatigue: #1 cause*; we can be lousy spotting it in ourselves (increases probability of error by a factor of *50*)

-Acute: Short-term

-Chronic: Long-term; effects are CUMULATIVE; recovery varies with severity

-Personal symptoms?

-Counter with rest: 8 hours of sleep desired, nap 20-30 minutes help

-High Risk/Low Frequency events (increase error probability by 17)

-Short field, obstructed approach

-High density altitude, maximum gross weight takeoff

-Counter by recognizing potential; prepare

-Time Pressure (increase error probability by 11)

-Classic "get thereitis"

-Counter by recognizing it; turn it off

-Objectively remove yourself from the timeline: reset as required

-EXTERNAL, e.g., the engine quits? You've still got X amount of altitude (energy) and Y amount of time to work the problem…take it one step at a time and work the problem

-Counter by prioritizing and using all time available: If you've got six seconds available, spend 5 seconds thinking and 1 good second executing!

-Low Signal to Noise Ratio (increase error probability by 10)

-Excessive background noise; most prevalent during high or low workload phases

-High workload = lots of noise

-Low workload = complacency

-Counter by identifying high/low workload segments; "sterile cockpit"

-One Way Decision Gates (increase error probability by 8)

-"Point of no return;" late recognition won't help

-Counter with exit strategy: if/then logic (e.g., missed approach)

-Information Overload (increase error probability by 6)
-Confusion caused by too much data; adds stress
-Classic aviation example: channelized attention
-Counter by prioritizing: what's important now?
-Poor Communication (increase error probability by 5.5)
-Listening is (usually) more important than talking
-Counter by listening actively; strive for clear/concise; confirm (read-back)
-Faulty Risk Perception (increase error probability by 4)
-Failure to ID risk; ID the WRONG risk; comfort with risk
-Understand the real math: quantitative analysis? Don't fret mid-air collision or inflight fire to the extent you disregard stall/spin during approach and landing…
-Counter by listing risk factors and prioritizing; set realistic risk level—there is no such thing as "low risk flying"
-Distraction
-Look for interruption in routine
-Counter by actively directing attention
-Routine Non-compliance
-"Normalization of Deviance"
-Coined in the wake of Challenger investigation
-This is what occurs when there is NO NEGATIVE CONSEQUENCE
-Rule violation
-Bad judgment
-Ignorance
-Eventually, the math catches up with you
-Counter by applying integrity, self-discipline and excellence in all you do
-Making Mistakes
-Mistakes take you off your game: FIDO, "forget it and drive on"
-Address when appropriate (debrief, or even never), not "now"

-Hazardous Attitudes
-Anti-authority
-"No one tells me what to do"
-Impulsiveness
-"I need to do something about this NOW"
-Invulnerability
-"Can't happen to me"
-Too competitive/macho
-"That's nothing, watch this"
-Resignation

- "Why bother, there's nothing we can do"

-Pressing Too Far

- "I've got somewhere I've GOT to be"

-Vanity/Ego

- "I'd rather die than look bad"

-Procrastination

- "I'll get to it"

Ground Lesson: Regulatory Review (.5 Hours) / Tailored Instruction (.5 Hours)

-Pilot "airworthiness"

-Certificate on person

-ORIGINAL, valid medical on person

- -Can't be a copy (ramp check)
- -Duration?

-Currency (FAR 61.57)

- -Logbook: Not required to be carried
- -Check ride / Competency check / Flight review
  - -Check-ride in lieu of
  - -Tail wheel endorsement
- -Required day / night recent experience
  - -Tail wheel takeoffs and landings must be to a full-stop
- -Instrument currency (if appropriate)
- -*May* be required to submit documentation ex post facto if ramp checked
- -Fitness for Flight (AIM Chapter 8, Section 1)
  - -Illness and Medication
  - -Alcohol: minimum time limit vs reality (hang-over)
  - -Fatigue: acute vs. chronic
  - -Stress
  - -IM SAFE = "Illness; Medication; Stress; Alcohol; Fatigue; Emotion"

-Big Picture: Pilot In Command makes aircraft airworthiness determination (FAR 91.7) / Owner responsible for maintenance (FAR 91.403)

-Aircraft Paperwork

A Special Airworthiness Certificate (Pink)

- -Available and DISPLAYED IN COCKPIT
  - -N-number must match data plate / markings
  - -Only valid when OPERATING LIMITATIONS are aboard

R Registration Certificate

- -Temporary? Pink, 120 day limitation
- -Expiration date?

R Radio Station License

- -Only required for flight outside of CONUS
  - -Canada/Bahamas/Mexico/Etc.
  - -FCC Form 605 / Schedule C to Apply

-If station license required, then restricted radio telephone operator's permit is required

O Operating Limitations

-Part of airworthiness certificate for experimental aircraft

-Letter issued by FSDO to original builder

W Weight and Balance Data

-Must be **DATED and CURRENT**

-Can be a photo copy of airframe log

-Compass correction card?

-Most recent VOR check?

-Altimeter / pitot static check (24 months)?

-Transponder check (24 months)?

-ELT (91.207)

-"D" cells in ELT: Batteries must have expiration date stamped

-Additional battery in instrument panel remote actuator switch

-Decel (G) switch check

-Recorded in log books / sticker?

-Placards:

-Experimental

-Passenger Warning

-"Condition" check vs. "Annual"

-Experimental (homebuilt) aircraft require a condition check (FAR 91.319/Operating Limitations)

-Not "annual"

-Can be performed by any A&P or original builder (repairman's certificate required)

-AI NOT required: no type certificate to comply with

-Due at the end of the 12th month

-Builder can develop checklist

-Do you have one?

-Should conform to FAR 43, Appendix D

-Proper logbook endorsement: Verbiage in Operating Limitations

-Van's Service Bulletins: Available on-line at the Van's web site

-Airworthiness Directive Compliance (91.409)

-Grey area as regards EAB

-Rules of Thumb

-No airframe AD's, however designer/kit manufacturer may issue Service Bulletins; service bulletins are non-regulatory in nature but merit careful owner consideration

-Component AD's should be complied with

-Bottom Line: are you (or is your estate) prepared to answer if failure to comply with a designer's recommended service bulletin or component AD is a factor in a mishap?

-FAR 43 (Maintenance) DOES NOT APPLY TO EXPERIMENTAL AIRCRAFT, sort of…

-FAR 91.319(e) Operating Limitations

-FAR 43, Appendix D: General guidance for condition inspection

-All maintenance "IAW AC 43-13"

-43-13 forms baseline for accepted maintenance practice, use it!

-ANYONE can turn a wrench on an experimental aircraft

-Normal logging required

-Only an A&P, AI or original builder (with repairman's certificate) can sign condition inspection

-Operating Limitations Review (FAR 91.319)

> **Note**
>
> Use the Operating Limitations for pilot's aircraft or the aircraft to be operated during the conduct of recurrent training.

-Phase I: Test

-Phase II: "Normal Ops"

-FAR 91.205 Equipment Requirements

-Aircraft may not be operated for hire

-LODA Restrictions (when appropriate)

-Pilot must advise passengers as to EXPERIMENTAL nature of the aircraft

-FAR 91.9 Placards plus EXPERIMENTAL placard (FAR 43.23[b])

-Aerobatic Flight (FAR91.103) when appropriate

-Logbook entry/endorsement

-Major Change/Modification Requirements (FAR 21.93)

-Some FAA maintenance inspectors are NOT familiar with homebuilt / experimental certification

-FAA Guidance: FAR 21.191 / Order 8130.2F

-Do your homework so you can issue the answer!

-“Experimental” call: First call to tower/ATC; remarks section of flight plan

-Airports and Airspace

-Traffic Patterns (FAR 91.126)

-Left unless published/marked FOR LANDING

-No turns? Straight in is legal

-Departures: No regulatory guidance

-Tower? Comm NLT 4 NM up to 2500’ AGL

-Right of Way Rules (FAR 91.113) apply

-See and Avoid/common sense always over-rules

-Lower has priority; de facto: Straight in has priority over pattern

-Airborne has priority over ground (taxi)

-Cruising Altitudes (FAR 91.159, 91.179 and AIM 7-2)

-Above 3000’ AGL: “Odd men fly East”

-Minimum Altitudes (FAR 91.119, 91.177)

-Anywhere: forced landing without undo hazard to people/property on the ground

-Exception: Directed by ATC

-Formation (91.111): “Arrangement” required

-Types of Airspace (AIM Chapter 3)

-Tailored Instruction

-Instructor discretion/pilot request

-May be developed by utilizing applicable portions of this briefing guide

-Written examination is not required for this block of instruction, but the written examination portion of this guide may be used in whole or part to support the conduct of recurrent training at the instructor’s discretion.

-Additional Resources (www.faa.gov):

-“Conducting an Effective Flight Review” FAA Publication

-AC 61-98B “Currency Requirements and Guidance for the Flight Review and Instrument Proficiency Check”

-Courses available at https://www.faasafety.gov/gslac/ALC/course_catalog.aspx

-Multiple applicable courses are appropriate to this block of instruction

-Courses may be assigned to pilot in advance of training

-Course completion certificate required

RECUR-1: Flight (1.0 Hour Flight + .5 Hour Brief + .5 Hour Debrief)

Prerequisites

1. Mishap / Risk Management Review
2. Ground Lesson

> **Note**
>
> The RECUR-1 guide has been prepared to assist with flight conduct. It may be modified at the instructor's discretion. It includes a baseline flow of basic maneuvers and emergency practice designed for a pilot meeting currency requirements in Part 1. Confidence maneuvers and advanced handling are optional.

Briefing

-Training Rules
-Weight and Balance Review
-Takeoff and Landing Data Computations (TOLD) Review
-RV Type Handling Considerations
-Crew Coordination: Emergencies
-Engine Failure: Takeoff/Initial Climb; Enroute; SFO (simulated flame-out) Pattern
-Tailored Discussion, as required

Ground Operations

-Review Basic Servicing (Incorporated in walk around or deferred to post-flight discussion):
    -Fuel
    -Oil
    -Air (Tires)
    -Brake Fluid
-Review Pre-flight Inspection
    -Flow
-Review Cockpit Management
    -Cockpit Set-up
    -Emergency Egress: Ground/Bail Out (as appropriate)
-Engine Start
    -Review/emphasize Leaning Mixture for Ground Operation
-Taxi

-Brake check
-Prop Blast and Power Control
-Normal Taxi
-Run-up
-Positioning Aircraft: Hazards/Cooling/Aircraft configuration (flaps)
-Proper use of Mixture during run-up

Takeoff and Departure

-Maximum Performance Takeoff
-Line-up Check
-Directional Control:
-Power Application/Engine Power Effects
-Raising the Tail/Rotation
-Engine Power/Pressure Checks During Roll
-Rotation/Lift Off
-Climb
-Acceleration: Flap Retraction
-V_X / High Power Climb
-Review Reduced Pitch Stability
-Transition to cruise climb
-Engine Monitoring and mixture control
-Level-Off
-Use of Trim
-Engine Management: Power Setting and Mixture Control Review

Basic Aircraft Control

-Straight and Level Flight
-Basic Stability Exercise (Pitch/Roll/Yaw)
-Turns
-Roll-out Lead Point / Heading Control
-Altitude Control

Steep Turns

-Steep Turns: 45 and/or 60^o Bank
-Constant Power (Airspeed Bleed) and/or
-Constant Airspeed (FULL Power)
-Roll-out Lead Point / Heading Control

-Altitude Control

Slow Flight and Stalls

-Slow Flight
- -No-Flap (V_{S1} + 5)
- -Full-flap (V_{S0} + 5)

-Power-Off Stall
- -Nose low, coordinated turn (simulated base turn)

-Power-On Stall
- -Nose high, climbing turn (simulated crosswind turn)

-Go-around Exercise: Power-up/V_{MC} Yaw Drill
- -Simulated go-around

Unusual Attitudes (Visual or Instrument Reference, as desired)

-Nose High; Airspeed Decreasing
-Nose Low; Airspeed Increasing

Confidence Maneuvers (Optional)

-As Desired
- -Lazy- 8/Wingover
- -Chandelle
- -AOA Recovery
- -Low AOA Aileron Roll
- -Inverted Recovery
- -Incipient Spin

Advanced Handling (Optional)

-As Desired
- -G Warm-up
- -Acceleration Maneuver
- -Basic Roll
- -Barrel Roll
- -Loop
- -Cloverleaf
- -Split S
- -Immelmann
- -Cuban 8

Descent/RTB

-Use of Checklist
-Engine / Airspeed Management
    -Review Proper use of Mixture Control
    -Review V_{NE} and V_{NO} Considerations

Emergency Landing Pattern

-High Key
-Low Key
-Base Turn
-Final
-TDZ Management

Pattern and Landing

-Pattern Entry
-GUMPS Check
-Perch Management
-Base Turn
-Stabilized Final
-Slip
-Low-Approach and Go-Around
-Closed Pattern
-Full-Stop Landings
    -Normal and/or maximum performance (short field)
    -Touchdown
    -Roll-out Directional Control
    -Brake Use

After Landing

-Use of Checklist
-Review Parking and Securing

WRITTEN EXAM AND REVIEW

> **Note**
>
> This is intended to be an open-book exam, corrected to 100%. It supports Basic/Advanced Transition and Instructor Upgrade tracks. It should be administered to the upgrading pilot/instructor upon successful completion of Block 4. Answers should conform to the RV-type to be operated in the field (i.e., at the conclusion of training). This may or may not be the airplane utilized for transition training. Not all questions may be applicable to all airplanes; therefore the instructor will need to determine applicability. Additional questions or study areas may be developed/assigned at the instructor's discretion.

1. According to Operating Limitations issued by the FAA, the maximum allowable gross weight for the RV-type to be operated is __________________ lbs. The designer's recommend maximum gross weight for this type is ________________ lbs. Explain why these two numbers may be different:

   ____

   ____

2. The maximum allowable weight for aerobatics is:
   a. Determined by structural limits of the airplane and specified in the builder's manual
   b. Determined by the builder and specified in the Operating Limitations issued by the FAA
   c. Varies as a function of maximum G-allowable
   d. Is not specified

3. True or False. FAR Part 43 delineates maintenance requirements for Experimental-Amateur Built (EAB) aircraft.

4. The stick force gradient (lbs of pull required per G) for the typical RV-type airplane is a function of:
   a. Pitch attitude (in degrees)
   b. Airspeed
   c. CG Location
   d. Constant under all flight conditions

5. The CG is referenced from a datum located ___________ inches ahead of the leading edge of the wing. This location was chosen to ensure that all computed moments are positive / negative (choose one).

6. The AEROBATIC CG limits are ______% MAC (_______inches aft of datum) to _______% MAC (________inches aft of datum).

7. The aft CG limit for all operations is ______% MAC (______inches aft of datum).

8. RV-type airplanes are equipped with:
    a. Split flaps
    b. Fowler flaps
    c. Plain flaps

9. True or False. Airworthiness Directives may apply to components (including engines) utilized in EAB aircraft.

10. Total fuel capacity is _____ gallons (_____ gallons per side).

11. Usable fuel is _____ gallons.

12. Using the minimum recommended runway length chart in AC90-89A, determine the distance required to takeoff at minimum smooth lift-off speed, fly for 5 seconds at that speed without climbing and landing and stopping straight ahead at maximum allowable gross takeoff weight listed in the Operating Specifications: _________ feet.

13. Using a Koch Chart, adjust the answer obtained in Question #12 for an airport pressure altitude of 4000 feet at 85°F.

14. True or False. The engine should be leaned for cruise operation at all altitudes.

15. Using the engine operator's manual, checklist or pilot's information manual compute expected fuel flow for a 65% cruise condition at 8500 feet MSL based on leaning technique used: ________ GPH. When leaning at his condition, use ________° F ROP or run lean of peak.

16. Using the engine operator's manual, checklist or pilot's information manual, compute expected fuel flow for a 75% cruise condition at 3000 feet MSL based on leaning technique used: _______ GPH. When leaning at his condition, use ________° F ROP or run _________° F lean of peak.

17. CG moves forward / aft (choose one) as fuel is burned. This effect is lesser / greater (choose one) in tandem aircraft with a rear seat passenger.

18. Maximum demonstrated cross-wind component for RV-type airplanes is:
    a. 15 KTS
    b. 17 KTS

c. 20 KTS
d. Not specified

19. True or False: No attempt should be made to restart a secured engine after a fire.

20. The glide ratio for RV-type to be operated is ____:1. This translates to _____NM glide per 1000’ of available altitude.

21. Maximum RANGE glide speed is ______ MPH / KTS.

22. True or False. Phase I Operating Limitations may apply for test periods after major modification.

23. Who may perform maintenance on an EAB aircraft?
    a. Anyone
    b. A certified Air Frame and Powerplant Mechanic
    c. The builder
    d. All of the above

24. RV-type aircraft exhibit _____________ lateral stability.
    a. Negative
    b. Neutral
    c. Positive

25. _____________ stability (___________) has the most critical effect on aircraft performance.
    a. Lateral (roll)
    b. Directional (yaw)
    c. Longitudinal (pitch)

26. What is the approximate ratio of V_{NE} to V_S for RV-type aircraft:
    a. 3:1
    b. 4:1
    c. 5:1
    d. 6:1

27. The airfoil section utilized in the RV-4/6/7 and -8 stalls at _____ to _____ degrees angle of attack.

28. True or False. Indicated stall speed increases with and increase in gross weight.

29. A 2G accelerated stall occurs at approximately ______ KTS / MPH.

30. True or False. A slip (insufficient rudder in a turn) is more likely than a skid (excessive rudder in a turn) to cause a spin in the event critical angle of attack is unintentionally exceeded when maneuvering.

31. Minimum out-of-control bail-out altitude is ______ feet AGL.

32. Maximum allowable engine RPM is _______.

33. Minimum fuel pressure is ______.

34. V_{S1} (stall speed, flaps up) is ______ KTS / MPH CAS at maximum gross weight.

35. True or False. CAS for V_X (best angle of climb speed) decreases as gross weight decreases.

36. Normal tire pressure is ______ to ______ PSI.

37. True or False. Ash-less dispersant and mineral oil may be mixed.

38. Spins greater than _____ turns may result in pilot disorientation.

39. True or False. The indicated airspeed associated with V_{NE} decreases with altitude.

40. Carson's number is an airspeed associated with maximum fuel efficiency. CAS for Carson's number for the RV-Type aircraft is approximately:
    a. 100 MPH
    b. 120 MPH
    c. 95 KTS
    d. 150 KTS

41. L/D_{MAX} represents the point of maximum endurance, and if holding is required and fuel is critical, holding should be performed at L/D_{MAX}. The speed for L/D_{MAX} is _____ KTS / MPH.

42. Manifold pressure changes ____ inches per 1000 feet of altitude change.

43. True or False. An increase in touchdown speed has a greater effect on landing roll distance than does an increase in landing weight.

44. Assuming the engine is equipped with a carburetor, the pilot should be aware that ice can form in the venture with outside temperatures between ____^{o}F and _____^{o}F and is most likely to form in the ____ to ____ degree F range. Relative humidity may be as low as ____ to ____%.

45. True or False. Visible moisture must be present for carburetor ice to form.

46. True or False. Use of the throttle controlled accelerator pump on carbureted engines may increase the chance of induction fire during start.

47. Tail wheel equipped airplanes with Whitman style landing gear may suffer from gear shimmy during deceleration following landing. The factor MOST LIKELY to influence shimmy is:
    a. Outside air temperature
    b. Tire pressure
    c. Type of surface (hard or soft)
    d. Out of balance wheels

48. True or False. The best technique to counter wheel shimmy is light break application.

49. Assuming the RV-Type airplane is equipped with a manifold pressure gauge and tachometer, what combination of RPM and MP would produce approximately 65% power?
    a. 2400 RPM/21" MAP
    b. 2200 RPM/26" MAP
    c. 2150 RPM/20.5" MAP
    d. 2500 RPM/23" MAP

50. Recommend minimum oil quantity for a local 1 hour flight is ________ qts.

51. Maximum oil capacity is ________ qts.

52. 100LL Aviation gasoline weighs ______ lbs per gallon. The arm of the fuel tanks used to compute actual weight and balance is _______ inches.

53. Maximum allowable baggage capacity is _______ lbs (assuming gross weight and CG are within limitations).

54. Maximum recommend cylinder head temperature for a typical Lycoming O-320/-360 installation is _______ degrees F for maximum engine life.

55. Maximum oil pressure limit is ______ PSI.

56. You are on a cross-country stop-over and servicing the airplane. During your last oil change, you serviced the airplane with Aeroshell 100 AD oil. The FBO you are at only has Phillips multi-weight AD oil available. Can you top off with this oil to continue on to your destination? Yes / No (choose one).

57. Which portion of the Federal Aviation Regulations specifies the maintenance REQUIRED for EAB aircraft?
    a. FAR 43

b. FAR 23
c. FAR 25
d. FAR 91

58. Which portion of the Federal Aviation Regulations specifies accepted methods and techniques to be utilized for aircraft repair and maintenance?
    a. FAR 43
    b. FAR 23
    c. FAR 25
    d. FAR 91

59. True or False. Asymmetric G limitations are not specified by the designer.

60. Maximum cruise speed for normal operation (V_{NO}/top of the green arc) is ________ KTS / MPH.

61. Lycoming defines a minor engine over-speed as _____% or less of rated maximum RPM for a period not to exceed _____seconds.

62. The maximum speed at which FULL flaps may be extended is _____ KTS / MPH.

63. True or False. Passengers must be briefed on the experimental nature of the airplane before flight.

64. For a typical emergency parachute, fastest chute opening occurs at _____ MPH. _____ to _____ seconds is required for a full chute; and generally _____ to _____ feet will be lost during deployment at terminal velocity for the opening sequence to occur. Pack opening should occur no later than _____ feet AGL to ensure a fully-deployed chute prior to landing.

65. A fuel asymmetry of more than _____ gallons will require the use of aileron trim (if equipped).

66. Which primary flight instrument(s) utilize(s) pitot and static pressure?
    a. Altimeter
    b. Turn and Bank
    c. VVI
    d. Airspeed Indicator

67. (RV-4 only) True or False. The most common cause of canopy loss in flight is the pilot failing to properly secure the canopy before takeoff.

68. True or False. At speeds above V_A, pilot-induced over-G is not possible, because aerodynamic limits (stall) will occur before reaching structural limits.

69. True or False. If you are performing a cruise descent at a speed in excess of V_{NO} but less than V_{NE} (i.e., in the yellow arc), and encounter a vertical gust (turbulence) of sufficient magnitude, it is possible to exceed aircraft structural limits and cause permanent deformation of the structure.

70. What best defines velocity vector?
    a. The direction in which lift is acting
    b. A point roughly 90 degrees to the angle of attack
    c. The direction in which the airplane is moving, but not necessarily pointing
    d. The direction in which the airplane is pointing

71. When loaded within aerobatic limitations specified by Van's aircraft, what are the G-limits of the airplane? +_____G's to -_____G's. What are the G limitations at maximum allowable gross weight? +_____G's to -_____G's.

72. Asymmetric maneuvering is defined as simultaneous control inputs in two (or more) axis, e.g., rolling and pulling simultaneously. As a rule of thumb, asymmetric maneuvering reduces allowable G by _____%.

73. (Tandem types only) True or False. When approaching for landing in a solo configuration, it is typical to use nearly full nose-up trim capability. This trim force must be trimmed out in the event a go-around is performed or balked landing occurs.

74. True or False. No significant yawing motion will occur if the throttle is advanced rapidly during go-around at low airspeed at high angle of attack.

75. RV-Type aircraft exhibit:
    a. Neutral longitudinal static stability
    b. Positive longitudinal static stability
    c. Negative longitudinal dynamic stability
    d. Positive dynamic stability about the longitudinal axis

76. Which design characteristic DOES NOT contribute to lateral stability in RV-Type airplanes?
    a. Dihedral
    b. Proper distribution of weight
    c. Keel effect
    d. Lateral CG offset

77. True or False. Unless power, pitch control and G-loading are properly modulated; all RV-Type aircraft are capable of rapid acceleration to dangerously high airspeeds when the velocity vector is below the horizon.

78. (RV-4/-6/7) True or False. The Whitman style landing gear is very tolerant of early forward stick application during a wheel landing.

79. For operations from high elevation airports, Lycoming recommends ground leaning for smoothness prior to takeoff when field elevation exceeds ________ feet MSL.

80. Lycoming stipulates that detonation margin is reduced when leaning at power settings above _____%.

81. What is the primary danger when operating in excess of maximum allowable gross weight?
    a. Decreased critical angle of attack
    b. Decreased stall speed
    c. Reduced structural margin
    d. High landing speed

82. For normally aspirated Lycoming power plants, 75% power can be maintained up to what approximate altitude?
    a. 10,000-11,000 feet MSL
    b. 6500 feet MSL
    c. 7000-8000 feet MSL
    d. 7000-8000 feet AGL

83. When operating off a turf runway, it's recommended that grass height not exceed:
    a. 1/3 wheel diameter
    b. ½ wheel diameter
    c. 1 wheel diameter
    d. Not specified

84. True or False. RV-type cruise climb performance is relatively consistent over a broad band of airspeeds.

85. The factor that determines at what point an airplane may encounter hydroplaning when landing on a wet runway is:
    a. Depth of water
    b. Touchdown speed
    c. Tread depth
    d. Tire pressure

86. (IFR Only). In the event an RV-type airplane encounters structural icing conditions, the portions of the airframe most likely to make ice first are:
    a. The pitot tube and leading edge of the horizontal stabilizer

b. The base of the canopy
c. The leading edge of the wings
d. The landing gear

87. True or False. For Lycoming power plants, the engine is warm enough for takeoff when the throttle can be opened smoothly and the engine does not hesitate, surge or run roughly.

88. What limitations are associated with starter operation? Crank time should be limited to _____ seconds; with a _____ second cool-down between attempts. This cycle may be repeated up to _____ times.

89. Recommended approach speed for RV-type aircraft is:
    a. 1.2 V_S
    b. 1.3 V_S
    c. 1.3-1.4 V_S
    d. Not specified

90. Which RV-type airplane primary control surface is cable activated:
    a. The ailerons
    b. The elevator
    c. The ailerons and rudder
    d. The rudder

91. True or False. Compared to most typical production light aircraft, RV-type aircraft stall power-on at relatively low pitch angles.

92. (Tail wheel Only) True or False. After landing, a ground loop is more likely to occur during the roll-out/deceleration phase.

93. What is maximum allowable cylinder head temperature? _____ degrees F.

94. True or False. RV-type airplanes equipped with a wooden propeller should have the propeller bolts inspected, re-torqued and properly safety wired on a regular basis.

95. Where can the pilot find weight and balance information for the RV-type airplane to be operated?
    a. In the builder's manual
    b. In the pilot's operating manual
    c. In the pilot's information manual
    d. In the cockpit

96. True or False. You did not build your RV-type aircraft, but purchased it from the builder. Only an A&P mechanic may perform maintenance on the aircraft.

97. True or False. A well-executed water landing normal involves less deceleration violence than a poor tree landing or a touchdown on extremely rough terrain.

98. Concerning stall recovery characteristics, if an inadvertent stall occurs, RV-type aircraft (when loaded within design limits and rigged in accordance with instructions in the builder's manual) require _______________ to resume flying.
    a. A simple unload/release of back-pressure
    b. Full-forward stick
    c. Maximum power
    d. A combination of maximum power and forward stick

99. You are the third owner of an RV-type aircraft originally completed in the mid 1990's. You wish to review service bulletins for the type. Where do you find designer's service bulletins?
    a. In the FAA database
    b. By requesting them from the local FSDO
    c. On-line at Van's Aircraft web site
    d. By calling the technical support phone number at Van's Aircraft
    e. C or D above

100. Regarding your third-hand, mid 90's vintage RV-type, it came with very little documentation other than the minimum required by FARs. You should consider:
    a. Purchasing a set of preview plans for the type (including the builder's manual) from Van's Aircraft
    b. Reviewing type-specific forum discussion on-line on vansairforce.net
    c. Joining the local EAA chapter and/or contacting an EAA Flight Advisor
    d. All of the above

101. True or False. It is possible to derive specific performance information for the RV-type to be operated without flight test.

102. List the documents the MUST be carried on-board the aircraft at all times for operation within the United States:
    a. ____
    b. ____
    c. ____
    d. ____

103. True or False. The airframe maintenance log need not be carried in the aircraft.

104. True or False. When loaded within design limits and rigged in accordance with instructions in the builder's manual, RV-type aircraft exhibit good post-stall directional control capability.

105. For the purpose of an overhead type emergency landing pattern, "low key" is defined as:

   a. A point directly above the planned TDZ from which a descending spiral can be flown without use of power to landing
   b. A point 180 degrees abeam the planned TDZ from which a gliding turn can be flown without use of power to landing
   c. Final roll-out point, from which a 5-6 degree glide path can be maintained to the desired TDZ without use of power
   d. Any point from which sufficient altitude and airspeed exist in combination to allow a gliding descent to a desired TDZ without use of power

106. For a spin to occur, what aerodynamic force *must* be present post-stall:

   a. Roll
   b. Pitch
   c. Yaw
   d. Any uncoordinated condition can produce a spin post-stall

107. Post-stall yaw/wing drop is properly countered by use of:

   a. Aileron
   b. Rudder
   c. Elevator
   d. Full throttle

108. True or False. If the airplane is unloaded and airspeed is increasing past 100 KTS/MPH, it is no longer out-of-control.

109. True or False. A spin that occurs at or below pattern altitude (1000 feet AGL) is likely to be unrecoverable.

110. With overshooting winds, you apply inside (left) rudder in a left base turn in an attempt to prevent an over-shoot of final. To maintain bank angle, you apply outside (right) aileron input. These control inputs are referred to as a ________. The ball will be deflected ________. If critical angle-of-attack is exceeded with these control inputs, the airplane will ________.

a. Slip/left/stall straight ahead (minimal roll)
b. Skid/left/snap right (roll over the top)
c. Slip/right/snap left (roll underneath)
d. Skid/right/snap left (roll underneath)

111. Under what aerodynamic condition is a stall impossible?
a. High airspeed
b. Aft CG location
c. Zero G
d. Forward CG location
e. None of the above

112. Longitudinal (pitch) stability is reduced

a. At high angle of attack
b. At steep climb angles and high power settings
c. With a forward CG location
d. At high airspeed

113. If equipped with a properly calibrated AOA system and conventional airspeed indicator, which reference should be primary in the landing pattern and during maneuvering flight?

114. In the emergency landing pattern, "High Key" is located over the _________________ at an altitude of _______________ to ________________ feet AGL. Airspeed at High Key should be _________________.

115. Below what power setting can the typical Lycoming engine be leaned without concern for detonation?

a. 75%
b. 60-65%
c. 55%
d. Never

116. Avoid mixture settings in the typical Lycoming engine that produce EGT between peak and __________^{o}F rich of peak at 65% power (for the richest cylinder).

117. Below what power setting (typical Lycoming engine) may any leaning technique be used?

a. 80%
b. 75%

c. 65%
d. 55%

118. True or False. The type of propeller fitted (e.g., constant speed, fixed-pitch etc.) will have a significant impact on engine-out glide performance.

119. To maximize glide performance in an engine out situation with a controllable pitch propeller and sufficient oil pressure is available, adjust pitch to

a. Course / high RPM
b. Fine / high RPM
c. Course / low RPM
d. Fine / low RPM

120. True or False. For RV-types, V_A (maneuvering speed) increases as gross weight increases up to aerobatic gross weight limits (RV-4/6/7/8) or utility gross weight limit (RV-9) and decreases at weights above aerobatic gross (RV-4/6/7/8)/utility gross (RV-9) up to maximum allowable gross weight.

121. Maneuvering speed (also referred to as "corner velocity") must be determined by flight test. To compute maneuvering speed

a. Multiply stall speed by the square root of G allowable (G-limit)
b. Double G limit and add to best climb speed
c. Multiply the square root of V_{NO} (maximum structural cruising speed) by G allowable (G-limit)
d. Multiply stall speed times two and add G-limit

122. True or False. "Asymmetric" (rolling) G-limits are not specified by Van's Aircraft.

123. G Limits with flaps deployed are

a. Equal to normal aircraft G limits
b. Not specified by Van's Aircraft
c. Different for half (20^{o}) flap and full (40^{o}) flap settings
d. Less than normal FLAPS UP G limits

Part 3: Techniques, Procedures and Handling Characteristics

TECHNIQUES, PROCEDURES, FLOWS AND HOOKS

Technique vs. Procedure

Procedures are specified by the manufacturer of a part, component or airplane. Techniques are the methods that pilots utilize to comply with procedures, standards, regulations and/or operate the airplane. Techniques may be taught, developed, debated and adjusted, but procedures must be developed and, generally, adhered to under non-emergency/abnormal circumstances. As a manufacturer, the builder of an experimental/amateur built (EAB) aircraft has the latitude to develop, test and specify procedures in the form of a checklist or manual. A subsequent owner may modify or develop and test alternative procedures or amend any existing checklists or manuals. In the case of the typical RV, most of the homework has already been done by the kit builder and the manufacturers of components used in the airplane (e.g., the engine manufacturer's manual), but some research and testing will be required. Not all RV's have detailed operating instructions, so instructors may have to assist the upgrading pilots with developing techniques or researching and developing procedures appropriate to the airplane to be flown.

The first step in developing a coherent checklist or manual is to read the component manufacturer's manuals. Sounds simple, but in most cases builders and, especially, purchasers of already flying RV's have a tendency to depend on WOM ("word of mouth,") or techniques offered by a flight instructor or mechanic. The very first place to start is the Van's builder's manual. If the upgrading pilot didn't build the RV to be operated, they can obtain a manual and set of preview plans from Van's Aircraft. The other important manual to digest is the one prepared by the engine manufacturer. While Lycoming has a tremendous amount of variety even within engine types (a "type" in this case meaning "O-320" or "O-360"), there is a basic manual available for all certified variants of these engines. If the engine conforms to one of the configurations listed in the manual, then any procedures listed in the manual should be considered as imperative, i.e., "must comply" items, provided there is a proper engineering basis for doing so. The upgrading pilot should also be aware of any service bulletins/instructions or airworthiness directives associated with the engine type, since this is the mechanism the manufacturer uses to update manual procedures. If the engine is experimental, but is a derivative of a certified configuration, it may be practical to start with the appropriate Lycoming manual and adjust as required, if a specific manufacturer's manual is not available. If the engine builder has prepared a manual or set of operating specifications, that can form the basis of the procedural operation of the engine. A current list of manuals is contained in Lycoming Service Letter L114AT (Reciprocating Engine and Accessory Maintenance Publications) available on the Lycoming web site. This service letter is updated from time to time, so be sure to reference the most current edition.

One important caveat: when reviewing any manuals, updates, service bulletins, service letters, etc., critical review is required. It may be necessary to differentiate between valid engineering and test information and information based on legal or marketing amendment. For the most part, information drafted by engineers and test pilots tends to be data based: tables, limitations, specifications, etc. Information presented as a procedure (or technique) may or may not have a proper basis in engineering or flight test and should be carefully reviewed prior to adoption.

Whether the Lycoming engine is high-compression, low-compression, carbureted or injected, the appropriate manual will address each type. Section 3 of Lycoming operator's manuals contains operating instructions. If the word "recommended" is used, it should be considered as one possible basis for developing a procedure. If, however, there is a valid scientific reason for adopting an alternative procedure, then that may be utilized in lieu of any manufacturer's recommendations. If the words "shall, will, do, do not, always, etc." are used, any procedure or recommended technique shouldn't deviate from these instructions. If the word "may" is used, the best way to interpret that is the same as "recommended." If a recommend technique differs from a procedure in the engine manufacturer's manual, it's necessary to answer the "why" question and determine the validity of that technique. As the manufacturer (builder) or owner of an EAB, the upgrading pilot has the latitude to revise or develop procedures as he sees fit.

Let's look at some specific examples of procedures and techniques as they would affect the operation of a typical O-320/360 Lycoming engine. The Lycoming-specified procedure is not to lean the engine at power settings greater than 75% below 3000 feet density altitude. How and when the engine is leaned at power settings below 75% is a matter of technique. One technique is to simply not touch the mixture control at or below an arbitrary density altitude (e.g., 3000-5000 feet). This is, generally, a poor technique, but a valid one nonetheless. The Lycoming Operator's Manual offers three techniques for leaning at power settings below 75%: using an EGT, using a flow-meter (fuel flow gauge), and leaning with the manual mixture control (i.e., by ear). In this case, when developing a checklist/manual, a cruise procedure might be "Power Set – AS DESIRED, Mixture –LEAN (for power settings below 75%)." Based on the engine configuration and the extent of engine monitoring available, this procedure can then be fleshed out with a recommended technique for accomplishing leaning.

This manual offers basic leaning techniques that may form the basis for adaptation to specific RV-type aircraft fitted with a typical Lycoming power plant. This information is based on combustion science and may deviate from information provided in Lycoming engine manuals in some cases. Extensive discussion regarding proper leaning techniques is beyond the scope of this publication and will be unique to each engine installation and configuration. ***This is one area that requires careful technical study and also one area where the engine manufacturer's manual may not be all that helpful, or even contain poor or erroneous information.*** The other place that a Lycoming manual may be of little use is if the engine is fitted with an advanced ignition system, balanced injectors, a modified induction system or other improvements. Another "game changer" is the adoption of advanced engine monitoring systems. The accuracy of these displays can provide a new precision to engine operation that wasn't available in the past. Depending on the configuration of the engine, it may take some research to cull through the information available to establish procedures or develop techniques for a specific installation.

Another area where substantial manufacturer's information will be available is for installed avionics components. Ensure the upgrading pilot has the manuals and instructions for the versions of avionics and software installed in the airplane. In many cases, due to the rapid advance in technology (software in particular), manuals are available on-line.

What constitutes an invalid technique? The answer is pretty straight-forward: anything that will result in damage or an unsafe situation developing. By way of a non-RV example, but easily understood: putting the gear down on short final may result in a gear-down landing, but makes it difficult to fly a stabilized approach. It may also result in an error of omission, i.e., forgetting to put it down. Therefore, most folks will extend the gear prior to the final approach fix, a specific altitude AGL or beginning the base turn—double checking at least once to confirm "three down." The short final example is a poor technique. An invalid technique would be to extend the gear after touchdown. On the other hand, in an engine-out situation, delaying gear extension may be appropriate, or it may even be desirable to make a gear-up landing under some conditions. These exceptional techniques are examples of airmanship (i.e., judgment) over-riding rote application of procedure.

RV applicable example. All RV's are equipped with flaps, but the use of flaps is not required for flight. There are likely some pilots that never use flaps, and there are probably some pilots that always use flaps; but likely there are a good number of pilots that usually use some flaps. So what does that mean? It means there are many different techniques, even if the discussion is reduced to two-position, manual flaps built according to plans under no wind/minimal cross-wind conditions. For takeoff, some pilots will use ½ flaps (20 degrees); others will only use flaps for takeoff with an aft CG, and others that won't ever use flaps for takeoff. Nevertheless, if flaps are used, they must be retracted prior to exceeding maximum flap extension speed (procedure). When decelerating for landing, flaps may be extended any time speed drops below maximum flap extension speed (procedure), when desired (technique). Actually getting manual flaps down at that speed is problematic. So to keep things orderly, one technique would be to apply half flaps decelerating through V_{FE} and then applying full flaps at 80 MPH /70 KTS CAS, adjusting trim and power, and stabilizing the descent for the final approach or base turn. There could be lots of variation in technique, but only one applicable procedure related to the operation of manual flaps (i.e., retracting prior to accelerating to appropriate V_{FE} or extending after decelerating through appropriate V_{FE}). V_{FE} for RV-types varies by flap position. For RV-4/6/7/8 types, V_{FE} for 20^{o} (half) flaps is 110 MPH/95 KTS CAS and V_{FE} for more than 20^{o} flaps is 100 MPH/87 KTS CAS. For the RV-9, V_{FE} for 16^{o} flaps or less is 100 MPH/87 KTS CAS and V_{FE} or 16^{o} of flaps or more is 90 MPH/78 KTS CAS.

Note that the flap example did not include wind considerations. What about gusty or cross-wind conditions? In that case, then a different technique may be more appropriate. So it turns out other than never using flaps, the “proper” use of flaps under existing conditions may require several different techniques. Just to make things more confusing, a technique (or procedure) may be bound by specific parameters. For example, regarding the use of flaps for takeoff, it may be desirable to use ½ flaps for takeoff if the cross wind component is less than XX KTS. If the cross-wind component exceeds XX KTS, then a no-flap takeoff should be made. Now, if the builder/owner chose, it could be specified that this technique is, in fact, a procedure for the airplane. A recommended instructional technique is to assist the upgrading pilot with developing a “standard” flap configuration for takeoff and landing and using that configuration for normal operations.

Flows

A “flow” is simply a means of accomplishing a checklist. It can be based on a mnemonic, a classic example of which is a “GUMP” check (“gas, undercarriage, mixture, and propeller”) prior to landing. Another example might be “tanks balanced, pumps on, area clear, loose items secure” prior to beginning any maneuvering flight. Flows can also be based on cockpit lay-out, a printed checklist or easy to apply memory aid. Use of a flow makes the checklist a “check” list vs. a “do” list. In other words, the pilot develops or memorizes a flow, accomplishes that, then cross-checks the appropriate checklist. A “do” list is simply following the written checklist, one step at a time. Either technique is valid. A combination of both techniques can be highly effective: using a flow to accomplish the majority of tasks and a written checklist for ensuring critical items have been accomplished. The instructor may need to work with the upgrading pilot to ascertain which technique or combination works best. Generally, a combination of the two works best with flows being used for accomplishing most tasks and checklists adhered to for ensuring critical tasks have been accomplished. Flows can be especially helpful during high demand phases of flight or as a cross-check prior conducting a maneuver or flight event (e.g., a pre-takeoff flow prior to pushing up the power or a "GUMP" check prior to beginning final descent for landing). Due to the varying nature and quality of EAB checklists, some revision may be necessary as training progresses and experience is gained.

Hooks

A "hook" is using something as a cue to remember to do something else. Hooks can be just about anything. For example, a GUMP check may always be a hook for turning on the landing light (or checking carburetor throat temperature, etc.) prior to beginning the base turn or final segment of the straight-in approach. Another example of a hook is "brutal leaning on the ground." If mixture is adjusted (lean) for ground operations, it should be so lean that if power is advanced for even a magneto check, insufficient mixture exists—i.e., hearing the engine hesitate when power is advanced is the "hook" to adjust mixture. One worthwhile hook in an RV is a "passing 100 (MPH or Van's specified flap limit speed for the RV type operated), flaps up" on every takeoff. This may prevent unintentional flap-extended climb-out when flaps are used for takeoff.

Summary

A "procedure" is something MUST be done, a limit or instruction that SHALL be adhered to; a "technique" is a method used to accomplish a task or comply with a procedure. The manufacturer of the aircraft (builder) develops any applicable procedures for that aircraft. Developing procedures takes some thought and research, and procedures should be validated by testing. They can be contained in checklists and/or manuals. If the upgrading pilot is not the builder, and such checklists and manuals do not exist, they can be developed providing that they do not conflict with the operating limitations for the airplane. This guide provides generic techniques and suggested procedures that may be adopted for training purposes or to assist with development of a pilot's handbook for a typical Lycoming-powered RV-type if specific builder's guidance is not available.

Techniques range from good to invalid. A good technique is anything that allows efficient and effective accomplishment of a task. An invalid technique is one that fails to accomplish the task, causes damage or an unsafe condition to develop. Techniques can be debated, discussed, analyzed, and modified ad nauseam. Since there are as many different perspectives as pilots, ultimately a truly "good" technique is what works to get the job done as safely and efficiently as possible for a particular pilot. It is incumbent upon the instructor to be able to offer one or more techniques to assist the upgrading pilot with task completion; and, when operating EAB aircraft, it may be necessary to do so without other written guidance being available.

A "flow" is a means of accomplishing a checklist and a "hook" is something that helps the pilot remember to do something else.

> **Note**
>
> - ***When teaching, instructors should clearly delineate whether or not they are providing the upgrading pilot with a technique or a procedure.***
> - Due to the lack of technical information for specific EAB aircraft, it may be necessary to help the student develop an appropriate procedure or technique applicable to the aircraft to be operated.

EMERGENCY EGRESS TRAINING

The instructor should offer emergency egress training appropriate the type and configuration of the RV to be operated for upgrade training. As a minimum, this training should cover emergency ground egress considerations. If the aircraft is to be operated for aerobatic flight and/or is equipped with a jettisonable canopy and parachutes are installed (regardless of type), then this instruction should also include in-flight egress and parachute landing considerations.

<u>Emergency Ground Egress</u>

The following basic checklist may serve as a guide for emergency ground egress if such a checklist is not included in the builder's documentation:

1. Fuel – OFF
2. Mixture – OFF
3. Ignition – OFF
4. Master Switch – OFF

If circumstances permit, effort should be made to secure the engine, fuel and electrical systems prior to leaving the aircraft during an emergency.

5. Harness – RELEASE

Ensure the upgrading pilot fully understands how to secure and properly adjust the harness and is capable of rapidly releasing it as well. If a parachute is warn, it is generally quicker to retain the chute during emergency egress, however, ensure that the upgrading pilot can release the parachute harness in the cockpit and egress without it.

6. Canopy – OPEN

Generally, the canopy should be retained until the last step in the egress sequence as it may offer additional protection from external fire or other hazards. Ensure that the upgrading pilot fully understands the canopy latching mechanism and can operate it by feel. Emphasize the need to ensure both occupants are ready to egress before opening the canopy. Emergency ground egress should be practiced until the upgrading pilot is comfortable with and capable of conducting emergency egress.

Parachute Pre-flight Inspection

If specific parachute manufacturer's guidance is available, it should be followed for preflight inspection of the parachutes. If not, the following generic information may serve as a guide: Check fabric for stains, wear, dampness and/or mildew. Check any quick release snaps for function and corrosion. Look for frayed or damaged webbing and inspect for broken or missing stiches. Ensure the release pins are properly installed and ensure the d-ring can be pulled from the pocket easily. Check the data card for re-pack currency (180 days).

Determining Minimum Bail-out Altitude

As an instructor, it may be necessary to assist the upgrading pilot with computing minimum altitude for controlled or uncontrolled bail-out and offer techniques for determining when bail-out vs. forced landing may increase the chance of survival under emergency conditions. If specific guidance does not exist, the following discussion offers some considerations and techniques that may be applied to assist with developing a suitable bail-out decision matrix.

Use of an appropriate maneuvering floor. One of the primary benefits of using a maneuvering floor, is that it accommodates the use of an "out-of-control" bail-out should the need arise to abandon the airplane (assuming, of course, parachutes are warn and the canopy can be opened or jettisoned in flight). Although it sounds obvious, the primary cause of unsuccessful bailout attempts is delaying the decision to egress.

Since RV-types require a manual bail-out, the first number to consider when computing bail-out altitude is the minimum opening altitude for the typical back or seat-pack chute that will insure a fully inflated chute prior to hitting the ground. If there is specific test data or a recommended altitude from the chute manufacturer, it should be used in computations. If there isn't specific information, then assume pack opening should occur no later than 1000 feet AGL to give at least one swing under an inflated chute prior to commencing a parachute landing fall. This number assumes that 2-3 seconds is required to obtain a full chute and the altitude lost during deployment at terminal velocity will be 200-500 feet. This means it is necessary to be clear of the airplane and pulling the rip cord no later than 1000 feet AGL. This number, plus any desired margin, can form the basis for a ***minimum controlled bail-out altitude***. In other words, if below this altitude it makes no sense to bail-out since there isn't adequate time or altitude available. The margin to add to the minimum number is a personal choice, and the chute manufacturer may specify a speed for mast rapid deployment (e.g., 100 MPH), so personal controlled minimum bail-out altitude becomes 1000 feet AGL plus whatever margin is desired (in additional feet AGL) at 100 MPH. This is MINIMUM controlled bail-out altitude; so higher is better if the situation allows. This also means that if under control and BELOW minimum bail-out altitude, then parachute egress is no longer an option and a forced landing is the only viable option.

Out-of-Control Bailout. It will take some time to get out and clear the plane, during this time, the plane will (likely) be descending; so the actual egress needs to start earlier to ensure that there is time to pull the rip cord no later than the minimum altitude required to obtain a fully inflated chute prior to commencing a parachute landing fall. For the purpose of simplicity, "out-of-control" is defined as any situation or set of circumstances beyond which the pilot is capable of maintaining aircraft control. ***The key element is to emphasize the need to determine at what point primary emphasis must switch from trying to save the airplane to saving the crew.***

Since it is necessary to be clear of the plane and pulling the rip cord no later than 1000 feet AGL to make sure at least one swing in the chute is obtained prior to landing, the next thing to determine is how long does it take to jettison the canopy, release the harness and get out? After practicing emergency ground egress, a good estimate of the time required to bail-out should be available. This time is individual—computation of minimum out-of-control bailout altitude should be based on observed average time with any desired safety margin added.

Example. If normal, practiced egress time is 5 seconds, and a 5 second safety margin is added; analyze the numbers based on a 5-10 second egress sequence. The key to determining egress time is to practice, determine INDIVIDUAL egress time and add ANY desired margin based on personal capability and canopy configuration.

After determining a time required to egress, the next number to consider is the aircraft descent rate when "out-of-control." It is impossible to accommodate all conditions, but a reasonable baseline may be auto-rotation (spin) descent rates. If specific flight test data is available for the airplane operated, it should be used. If not, consider using 120-150 feet per second for the typical two-seat RV in a developed auto-rotation mode (spin). Higher numbers are more conservative than lower numbers in this case, so err on the side of caution.

Based on 5 seconds required to egress plus a 5 second safety margin, and assuming a developed spin and descending at these rates, 1200 to 1500 feet of vertical fall will be required to exit the plane. In a perfect world, if the airplane is in a developed spin and egress is begun at 2200-2500 feet AGL and executed within 5-10 seconds, the crew should get at least one good swing in the chute prior to landing. The altitude at the high end of this range (e.g., 2500 feet) should then be added to local terrain elevation (and rounded UP to an easily memorized and identified number) to determine "minimum out-of-control" bail-out altitude in feet MSL (so that it may be read directly from the altimeter).

The proper place to develop a bail-out matrix is on the ground, during planning and practice. A realistic altitude should be computed based on physics, the dynamic performance of equipment, egress skill and any desired safety margin. It is imperative for upgrading pilots to be familiar with installed equipment and egress should be practiced until it is "automatic." Be sure to follow any parachute manufacturer's instructions when available. Instructors should assist upgrading pilots with developing an "if/then" matrix: "if" out-of-control at or above computed minimum bail-out altitude, "then" bail-out—it is time quit trying to save the plane.

Note

If accurate flight test data for the airplane shows that recovery from a developed, up-right spin is practical, it can be used to increase the utility of an "if/then" decision matrix. For example, if flight test indicates that upright spin recovery requires 1 ½ turns and 1500 feet of altitude (including dive recovery) and the pilot is SURE about the spin mode and familiar with a tested/proven recovery technique that will replicate this performance with current load (weight and balance) conditions, it may be argued that bailing out at 2000 feet AGL isn't necessary since there is sufficient altitude to recover. This may be correct, however, if not and the bail-out sequence is delayed until passing 1500 feet AGL in an attempt to recover, there may no longer be adequate time to get out and still get even a partially inflated chute prior to hitting the ground. If good data exist, however, it's practical to tweak the "if/then" logic to make it more useful. For example, **IF passing pre-determined out-of-control bailout altitude (feet AGL) AND the airplane hasn't unloaded and airspeed hasn't begun to increase past 100 mph/90 KTS CAS, THEN bail-out; or IF passing XXXX feet AGL AND the airplane is unloaded AND airspeed is increasing past 100 mph/90 KTS CAS, THEN attempt recovery.**

Instructors should emphasize that any maneuvering conducted below minimum out-of-control bail-out altitude carries inherent risk. A well-chosen maneuvering floor should be at or above computed minimum out-of-control bail-out altitude. The difference between the maneuvering floor and minimum out-of-control bail-out altitude is time to decide. Instructors should assist upgrading pilots with determining how much time is desired.

Controlled bail-out. Instructors should also introduce upgrading pilots to the concept of controlled bail-out. This would be appropriate when real-time risk assessment deems a bail-out and parachute landing to be a lower risk option than an attempting an off-field landing. Some examples of when bail-out may be preferable to a forced landing attempt would be in the event of an in-flight fire, if a forced landing site cannot be seen (e.g., at night or under instrument meteorological conditions) or if flying over rugged terrain.

Parachute landing considerations. Most emergency pilot parachutes are equipped with control toggles installed on the risers. With the chute deployed if the pilot raises his hands up the risers, he should be able to grab the steering toggles. If equipped with toggles, pull on the appropriate toggle to turn the parachute in the desired direction (the ultimate objective is to avoid hazards on the ground and land facing into the wind). To turn right, pull the right toggle or riser, and conversely, to turn left, pull on the left toggle or riser. Forward speed may be used to maneuver away from hazards on the ground; however it should be minimized prior to landing by turning the parachute into the wind. Rate of descent will increase during turns. Turns and/or corrections should not be attempted below 200 feet AGL. Passing 200 feet AGL, the pilot should focus eyes on the horizon; ensure that feet and knees are held together with knees slightly bent and toes pointed forward. Arms should be up, holding the risers (unless landing in trees). After landing, roll in the direction of motion at touchdown and immediately disengage from the chute by any means practical.

If a tree or power line landing appears imminent, leg position remains the same as a normal landing fall, but the pilot's head should be turned sideways for a power line landing to present minimum frontal area. If landing in the trees, the pilot's head should be turned sideways or, alternatively, hands should be placed over the face with thumbs extending along the jaw and chin clinched firmly against the neck. This position serves to protect the face and neck area when descending through the branches. For water landings, a downwind landing is recommended so the parachute lands in front of the pilot. Always assume a normal landing position when landing in the water, since the depth of water may not be known. If a floatation device is worn, it should be inflated prior to a water landing.

AIRWORTHINESS DETERMINATION AND PRE-FLIGHT INSPECTION

Airworthiness Determination. Ensure the upgrading pilot understands how to make an airworthiness determination based on documentation and pre-flight inspection. This material is covered in the academic briefing for Block 4. Highlight any local resources that may be available to assist a pilot with making an airworthiness determination under real-world, unsupervised conditions, e.g., an A&P, flight advisor, CFI, mentor, RV wingman, "buddy" pilot, etc.

Pre-Flight Inspection

The importance of a thorough pre-flight or thru-flight inspection prior to each flight cannot be over emphasized. If a checklist or builder's/pilot's manual exists for the aircraft, review it with the upgrading pilot. Emphasize the need to develop a personal flow for the conduct of the inspection, so that the upgrading pilot conducts the inspection the same way each time the aircraft is operated. By establishing continuity, it will equip the upgrading pilot with a solid habit pattern that will better withstand potential distractions or interruptions under unsupervised field conditions. Van's aircraft recommends that special attention be given to checking tire condition and pressure when close fitting wheel fairings hide the majority of the tire/wheel/brake assembly from view. If the upgrading pilot is the owner/operator of the aircraft, point out the need to remove the wheel pants on a regular basis to inspect the wheel and brake assemblies.

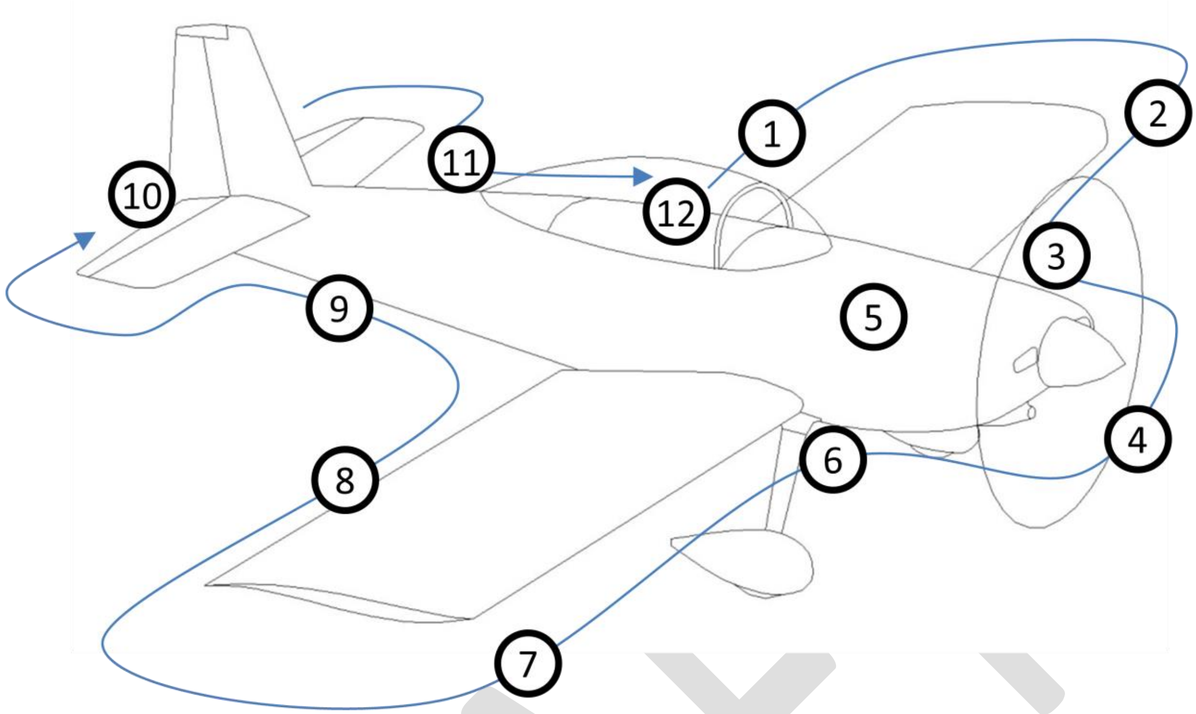
> **Note**
>
> Some RV types equipped with Whitman-style landing gear (-3/-4/-6/-7/-9) may utilize non-standard (low) tire pressure to assist with gear scrubbing to avoid shimmy during deceleration. Shimmy is generally present on a paved surface at low speed (10-20 MPH/KTS). Turf surfaces generally have sufficient rolling resistance to provide a damping action that minimizes or eliminates shimmy. Lower air pressure increases rolling resistance, thereby increasing damping action to mitigate shimmy tendencies.

Interior Pre-flight. The preflight inspection should begin in the cockpit. Due to different configurations, it is impossible to suggest a general, generic inspection. The battery voltage should be checked along with any electric fuel pumps and fuel quantity indicators. Depending on fuel system configuration, it may be necessary to have the boost pump ON to obtain a fuel sample at the gascolator(s), if equipped. The upgrading pilot should be familiar with the fuel pressures required for normal system operation. Emphasize the need to investigate any fuel odor that is not the result of sampling as that could be indicative of a leak. Belts and harnesses should be checked for condition, security and operability. Flight controls should be checked for interference with cockpit equipment (including exposed rudder cables running along the cockpit sides). Brake master cylinders should be checked for signs of leakage in the area around the rudder pedals. Canopy operation and condition should be checked and the canopy should be cleaned as necessary. If equipped with cockpit flight control locks, they should be removed.

Exterior Pre-flight. A generic walk-around pattern and preflight checklist is included below. If a builder's checklist exists, it should be used for the conduct of the pre-flight inspection. Each RV varies and although this basic flow is based on Van's baseline configuration, all items may not be applicable for all aircraft. There will variation and the instructor may have to assist the upgrading pilot with ensuring adequate familiarization of the airplane to be operated for upgrade to ensure all items are covered during the inspection. In addition to items recommended in the checklist, conventional pre-flight inspection techniques apply to RV-types. As all metal airplanes, RV-types lend themselves to visual inspection. Any evidence of leaking should be inspected. Fuel will evaporate quickly, but if the airplane has been serviced with aviation gasoline, a blue stain is indicative of a fuel leak. Fuel leaks in RV-types *tend* to occur at loose fittings, leaking fuel tank rivets and fuel quick drains (but may occur at any point in the fuel system). Engine oil leaks will typically be encountered at the aft lip of the lower cowling. Hydraulic (brake) fluid leaks *tend* to occur at master cylinders in the cockpit or brake caliper assemblies on the wheel, but may occur at any point in the system. If the RV-type operated is equipped with rigid metal brake lines, they should be inspected regularly for signs of cracking, especially where they are attached directly to brake caliper assemblies. The airplane and all flight controls should be inspected for general condition to include loose ("smoking") or missing rivets, dents, scrapes or other damage. Since RV-types are low wing airplanes that sit relatively close to the ground, there is a tendency to inadequately inspect lower wing and tail surfaces and the belly area. Extended flaps and the lower tail surfaces on tail wheel equipped airplanes are prone to damage, especially if the RV-type is not fitted with wheel pants and/or operated off an unimproved field and these areas should be inspected regularly.

Note

Depending on fuel line configuration, some fuel venting may occur with full tanks when the airplane is on the ground. This occurs due to heat expansion of the fuel and may be normal for the RV type operated. Depending on conditions, fuel may drip or spit from vents until sufficient head space is generated inside the tank.



1 – Left Wing Trailing Edge

Flap – Secure, hinge bolts/jam nut secure, rod end bearings free

Aileron – Normal movement, no play, hinge bolts/jam nut secure, rod end bearings free

2 – Left Wing

Tip – Secure, lights (if equipped) operable

Landing light – Check cover/operable (if equipped)

Pitot tube – Cover removed, no blockage, secure, properly aligned (if installed on left wing)

Aileron bellcrank inspection plate(s) – Secure

Fuel tank – Secure, no missing screws; no leaks; visually check fuel level and ensure fuel cap is secure (it may be necessary to hold the forward half of the cap down when pushing the locking lever aft to make a good seal); fuel sample from quick drain, as required

3 – Left Main Gear

Fuel Vent – clear

Fairings (if installed) – Secure

Tire – Condition, pressure

Brakes – Line chaffing, no binding, minimum 1/8” of pad remaining on each side of disk, disk wear, lines secure, no leaks

Chocks – Remove

4 – Nose

Cowling – Secure; condition check
Exhaust – Check security of pipes
Propeller – Condition check
Spinner – Secure
Intakes – Clear; air filter clean, not blocked (if visible/equipped)
Gascolator – Drain, as required (if equipped)
Oil Breather Tube – Clear
Engine Driven Fuel Pump Overflow Drain – No evidence of fuel present
Nose Gear – Condition check (if equipped)
Nose Tire – Condition, pressure (if equipped)

5 – Oil

Quantity – Check
Dip Stick Tube – Secure
Oil Door – Secure

> **Note**
>
> Due to cowling restrictions, some RV types may have non-standard dipstick configurations. Ensure the upgrading pilot is familiar with the dipstick markings, operation and oil servicing requirements, as installed.

6 – Right Main Gear

Fuel Vent – clear
Fairings (if installed) – Secure
Tire – Condition, pressure
Brakes – Line chafing, no binding, minimum 1/8" of pad remaining on each side of disk, disk wear, lines secure, no leaks
Chocks – Remove

7 – Right Wing

Fuel tank – Secure, no missing screws; no leaks; visually check fuel level and ensure fuel cap is secure (it may be necessary to hold the forward half of the cap down when pushing the locking lever aft to make a good seal); fuel sample from quick drain, as required
Aileron bellcrank inspection plate(s) – Secure

Pitot tube – Cover removed, no blockage, secure, properly aligned (if installed on right wing)
Landing light – Check cover/operable (if equipped)
Tip – Secure, lights (if equipped) operable
Landing light – Check cover/operable (if equipped)

8 – Right Wing Trailing Edge

Aileron – Normal movement, no play, hinge bolts/jam nut secure, rod end bearings free
Flap – Secure, hinge bolts/jam nut secure, rod end bearings free

9 – Right Rear Fuselage

Static Port – Clear

10 – Empennage

Fairings – Secure
Elevator – Normal freedom of movement, no play; hinge bolts secure; trim tab and connectors secure; no differential elevator movement (grab both elevators and attempt to move them in opposition)
Rudder – Normal freedom of movement, no play; hinge bolts secure; cables secure
Tail Wheel – Steering chains/hardware; normal freedom of movement (limited by tail wheel linkage); check rudder horn for wear
Inspection Plate (s) – Secure

11 – Left Rear Fuselage

Static Port – Clear

12 – Canopy

Clean
Mounting – Secure: hinge(s), locking lever, support(s) (if installed)

"Big Picture" Last Look. After completing the walk around, move to a position directly ahead of the nose and take a relaxed, good look at the airplane. Look for any missed/unremoved covers/streamers, cowling plugs, chocks, tie-downs, external control locks, etc.

NORMAL PROCEDURES

One of the challenges faced by operators of EAB aircraft is development of suitable normal techniques and procedures. Unless prepared by the builder, no pilot's operating handbook is available (nor is one required under current regulations), and there is a wide variation of equipment, power plants and propellers that equip even aircraft of the same type. In most cases, basic checklist data may be available. However, in some cases, no or little specific information is available. The quality of flight test data available will vary widely. As with emergency procedures, the primary consideration is that upgrading pilots and instructors in RV type aircraft should never assume anything, unless they are familiar with the specific aircraft to be operated.

Unless specific checklist, handbook, and/or flight test data is available, a generic approach may be required to assist upgrading pilots with developing normal techniques and procedures. This section addresses a list of topics that offers a starting point for developing specific techniques and/or procedures that may be adapted to the RV type operated for training. Normal operations will be addressed in phase-of-flight order: ground operations, takeoff, in-flight and landing. Generic checklists are provided that may be modified at the discretion of the instructor and/or upgrading pilot and provide a starting point if aircraft specific information is not available. Generic engine operation information is for a typical Lycoming installation. *Not all cases are applicable to all RV-types, and* ***all cases will require critical review and consideration by the instructor and/or upgrading pilot to determine whether or not they may be applied to the specific RV-type operated for training****, and, if so, what modifications must be made for applicability.* ***In any case, if specific builder's or manufacturer's guidance is available, it should be followed in lieu of any information presented in this guide.***

GROUND OPERATIONS

PASSENGER BRIEFING

1. Experimental Warning
2. Egress – NORMAL and EMERGENCY
3. Strap In / Loose Items / FOD (Foreign Object Damage) Potential
4. Intercom Use
5. Control Interference (including secondary controls)
6. Change of aircraft control
7. Airsickness considerations

FAR's require that passengers be briefed as to the experimental nature of the aircraft. The briefing should also include sufficient instruction for normal and emergency egress (and parachute use, if applicable), intercom (e.g., noise cancelling headset) use, control interference (including secondary controls, flaps, brakes, etc.), change of aircraft control (when applicable) and securing items. Consider politely asking passengers to empty their pockets and stowing any items that could fall out during flight, especially if all-attitude maneuvering is anticipated.

> **Warning**
>
> Items dropped in a control stick well or on the cockpit floor could cause interference with normal flight control operation.

SOLO FLIGHT

1. Empty Seat/Rear Cockpit and Baggage Area - SECURE

Although more critical for tandem types with the rear cockpit is unoccupied, emphasize the need to properly secure (or remove) cushions, harnesses and equipment and loose items to avoid interference with the primary and secondary flight controls (as fitted). Discuss/consider techniques for stowing and securing baggage.

BEFORE START

1. Harness – SECURE
2. Canopy – SECURE

The canopy should be secured for start. It should be fully closed and latched, or it should be locked in the intermediate position prior to engaging the starter. A non-locked or improperly secured canopy could be damaged during engine start or ground operation by prop blast or wind. It may be necessary to limit RPM with the canopy open or secured in an intermediate position.

Caution

Ensure that the upgrading pilot fully understands proper canopy operation, including the use of intermediate canopy positions (when appropriate). Improper canopy operation could result in damage to the aircraft and/or loss of canopy due to prop blast or failure to secure post-takeoff. Depending on canopy configuration, starting the engine with the canopy in the fully open position could damage the canopy, attachment hardware or fuselage.

3. Chocks—REMOVED
4. Brakes – SET

Brakes should be checked for normal operation prior to and immediately after start.

5. Fuel Selector Valve – TAKEOFF TANK

Generally, the same fuel tank should be used for start, taxi and takeoff to ensure an adequate supply of fuel. At low power settings, sufficient residual fuel may remain in the fuel system to allow the engine to operate for several minutes prior to failure due to starvation. If a selector is unintentionally turned OFF or an empty tank is unintentionally selected immediately prior to takeoff, sufficient residual fuel may remain to allow the initial takeoff to occur with power loss occurring shortly after lift-off. If necessary, familiarization with proper fuel tank selector actuation should be practiced on the ground.

6. Fuel Caps—VISUALLY CHECK SECURE
7. Flight controls – FREE AND CORRECT
8. Anti-collision Lights – ON
9. Prop Blast/Propeller – CLEAR PRIOR TO START

Generally, anti-collision lights should be ON any time the engine is running during ground operations. This serves as a visual signal to ground personnel that the propeller is turning and is a hazard. If system installation permits, it is a good technique to select anti-collision lights on just prior to engine start.

Prop Blast. Consider potential prop blast effects prior to start. It may be necessary to physically re-position the airplane prior to start to mitigate effects on other airplanes, personnel, structures or equipment. Depending on surface type and condition, it may be necessary to add (substantial) power to begin taxiing or to make the initial turn out of a parking spot. Generally, pulling forward using minimum required power to begin moving and reducing power PRIOR to turning is a good technique when departing a crowded ramp. In some cases, it may be more prudent to pull or tow the airplane out of the parking spot and realign the fuselage for start to mitigate prop blast hazard. When taxiing, ensure sufficient forward momentum exists prior to turning—this will allow turns to be conducted using minimum RPM. This precludes the need to "blow" the airplane through the turn using increased RPM as the tail swings. All RV-types exhibit excellent rearward visibility. The pilot should always be aware of where prop blast is blowing and should clear the new "prop blast zone" BEFORE turning. ***Pilots should remain aware of their prop blast at all times during ground operations.***

START

Engine starting procedures and techniques will vary according to the type of power plant fitted and its configuration. Even with a "typical" Lycoming installation, there will be variation. One primary difference is whether or not the aircraft is fitted with a carburetor or fuel injection. Additionally, advanced ignitions systems (e.g., electronic) may require special consideration. If specific builder's information is not available in the form of a checklist and/or handbook, component manufacturer's guidance should be utilized to develop suitable procedures and techniques. Lycoming publishes engine manuals for each variant of engine produced and these manuals can be a good starting point. Instructors may have to assist upgrading pilots with obtaining and understanding manufacturer's recommendations.

Cold Weather Considerations. Engine manufacturer's guidance should be followed regarding application of pre-heat, engine start and warm-up prior to run-up/takeoff. Some aircraft are equipped with engine pre-heat and/or pre-oiling systems. If specific guidance does not exist for a particular Lycoming installation, if ambient temperature is below 10°F, the engine *must* be pre-heated. Pre-heat *should* be used for block temperatures below 40°F. Oil viscosity should be appropriate for ambient temperature (See ALL WEATHER OPERATION section).

Caution

Specific component manufacturer's procedures, techniques and/or recommendations should be followed. Information in this section is generic in nature and is only presented for consideration in the event specific guidance is not available and it is necessary to assist the upgrading pilot with developing suitable procedures and techniques for starting.

1. Ignition Power Source – AS REQUIRED

Follow builder's and/or component manufacturer's guidance for operation of the ignition source(s) during start. If the airplane is equipped with conventional magnetos, only one magneto may be equipped with an impulse coupling. If this is the case, the airplane must be started using that magneto alone. Typically, if only one impulse coupling equipped magneto is installed, it is installed in the left position. If the airplane is equipped with a properly jumped, conventional LEFT/RIGHT/BOTH keyed switch, switching occurs automatically. If the airplane is equipped with magneto switches and a starter button (or switch), then it may be necessary to properly configure switches prior to and after start. If both magnetos are equipped with impulse couplings, then either or both may be used for start. If the airplane is equipped with electronic ignition or a hybrid system, follow builder's and/or component manufacturer's guidance for starting and run-up operations.

2. Mixture – AS REQUIRED
3. Carb Heat/Alternate Air Source – OFF (if installed)
4. Fuel Boost Pump – AS REQUIRED
5. Fuel Pressure – CHECK

Manufacturer's guidance should be consulted to determine appropriate fuel pressure limits and indications. As a rule of thumb, carbureted engines operate at relatively low fuel pressure and injected engines operate at higher pressure. The upgrading pilot should be familiar with fuel pressure indications appropriate for the engine installation and auxiliary boost pump system fitted to the RV-type utilized for training. Discuss the sound that the auxiliary pump produces and the difference in sound (when appropriate) between a primed and cavitated pump (a typical self-priming electric pump can be quite loud when cavitated). Point out when fuel odor in the cockpit should be investigated and when it may be expected (e.g., leaking b-nut vs. flooded engine).

Note

In addition to a thorough understanding of manufacturer's operating limits, smells, sounds and vibration characteristics are important ways humans relate to the aircraft being operated. Attempt to brief the upgrading pilot to the extant practical on what to expect with ALL senses so that unfamiliar sensations do not catch the upgrading pilot off guard and cause channelized attention.

6. Prime – AS REQUIRED (if installed/procedure varies by installation)

Starting Carbureted Engines. Ensure the upgrading pilot understands how to properly prime the engine (when required) using the primer (if equipped) and/or accelerator pump. Not all RV-types are equipped with primers. Priming techniques will vary between carbureted and fuel injected engines. Typically, the tendency is to OVER-PRIME. This can result in difficult or non-starting and may even cause an induction fire. It is generally desirable to *under*- rather than *over*-prime an engine prior to start. With a warm engine, priming may not be required. If the RV-type operated for training is equipped with a plunger type primer, pause momentarily when pulling the plunger aft to allow the pump to fill. The upgrading pilot should listen and feel the plunger motion to ascertain if fuel is being pumped to the engine. There may be an audible change in the sound of the auxiliary (electric) fuel pump if it is on while priming using a plunger-type primer. Some carburetors are fitted with a throttle actuated accelerator pumps. These accelerator pumps only deliver fuel to the carburetor throat, and can be an effective means of starting the engine without the use of a primer. The simplest method is to set the mixture to full rich and start cranking the engine while quickly pumping the throttle. This generally takes no more than 1-2 pumps, and as soon as the engine fires, reduce the throttle to IDLE (RPM approximately 800-1000 RPM). This method works for both hot and cold starts.

Warning

- When installed, primer plungers should be locked after priming. An unsecured primer plunger may cause loss of power.
- Leaking primer pumps or excessive use of the accelerator pump can result in induction fire.
- If equipped, throttle-actuated accelerator pump should only be used if the propeller is turning (i.e., starter engaged)

Starting Fuel Injected Engines. Fuel injected engines may require specific priming procedures that may vary for cold vs hot start. A typical Lycoming engine fitted with a precision RSA-style injection servo is generally started in the following manner:

Cold Start. Select WOT (wide open throttle), mixture full RICH and run the boost pump for 2 seconds after observing a rise in indicated fuel pressure (if fuel pressure rise is NOT observed, do not run the boost pump for longer than 3 seconds total). DO NOT over-prime (i.e., run the boost pump longer than 2 or 3 seconds, as appropriate). Return the mixture to IDLE cut-off and reduce the throttle to a position just above the IDLE stop. Crank the engine, and when it catches, advance the mixture to full RICH. After the engine stabilizes, it may be leaned for ground operation.

Hot Start. Utilize the same procedure as a cold start without priming.

7. Throttle – LOWEST PRACTICAL RPM (or IAW Manufacturer's Guidance)

Generally, the engine should be started lowest practical RPM to minimize wear during start. Power should be advanced to normal warm-up RPM after start and normal oil pressure is noted.

8. Propeller—CLEAR
9. Starter – ENGAGE (Release when engine starts)

Observe the starter manufacturer's operations limits for maximum engagement time, number of engagements and cool-down time(s), to avoid starter overheating or damage.

10. Oil Pressure – CHECK

Caution

Oil pressure should rise within 30 seconds (or less, if specified by the builder or engine manufacturer) of start. If not, shut down and investigate.

11. Throttle – WARM-UP RPM (after positive indication of oil pressure)

Flooding. If there is flooding of the engine without a fire, the pilot should follow engine manufacturer's guidance for an attempted re-start. Alternatively, if sufficient time is available, it may be practical to discontinue the starting sequence and allow excess fuel to evaporate before continuing with a normal start. If time and circumstances permit, allowing excess fuel to evaporate may be the safest course of action in the event the engine is unintentionally flooded during a start attempt.

AFTER START

1. Mixture – LEAN AGGRESSIVELY FOR GROUND OPERATION

The engine should be leaned for proper ground operation after start using RPM as a reference. This will prevent lead fouling and carbon build-up at low power settings. Once the engine has stabilized after start, slowly reduce the mixture until the RPM rises and just begins to fall. The mixture control may be well aft (almost IDLE CUT-OFF), depending on configuration and rigging. At this mixture setting, the engine will hesitate if power is advanced above normal ground operational RPM (800-1200). This is normal and increasing the mixture may be required if additional power is required for ground maneuvering.

> **Caution**
>
> Failure to lean *aggressively* during ground operation could leave the mixture at a setting that will provide enough fuel for run-up and/or takeoff at dangerously lean levels, i.e., the engine will run, but insufficient fuel is available to prevent detonation and engine damage from occurring at power settings above that required for ground operation. Leaning *aggressively* for proper operation at low power settings will cause the engine to hesitate if power is advanced with the mixture control unintentionally leaned.

2. Boost Pump – OFF (or IAW builder's or manufacturer's Guidance)

Unless specified by the builder or engine manufacturer, the auxiliary boost pump is generally turned off during ground operations (including run-up) to ensure normal operation of the engine driven fuel pump.

3. Electrical Charging Source – AS REQUIRED
4. External Lights – AS REQUIRED
5. Electrical Equipment/Avionics—AS REQUIRED
6. Altimeter(s)/(EFIS Baro) – SET

The altimeter(s) should indicate ± 75 feet of known field elevation with the correct barometer setting. If current altimeter setting is not available, the altimeter should be set to field elevation.

7. Engine – WARM UP AS REQUIRED

ENGINE GROUND OPERATION (Typical Lycoming Installation)

The way the engine is operated on the ground greatly influences formation of lead salt deposits on spark plugs and exhaust valve stems. Proper operation of the engine on the ground (warm-up, landing, taxi and engine shut-down) can greatly reduce the deposition rate and deposit formation which cause spark plug fouling and/or exhaust valve sticking.

The engine should be operated at engine speeds between 1000 and 1200 RPM after starting and during the initial warm-up period. Avoid prolonged closed throttle idle engine speed operation (when practical). At engine speeds from 1000-1200 RPM, the spark plug core temperatures are hot enough to activate the lead scavenging agents contained in the fuel which retards the formation of the lead salt deposits on the spark plugs and exhaust valve stems. Avoid rapid engine speed changes after start-up and only use the power setting required to taxi. Be aware of prop blast effects at all times during ground operation.

Caution
Unless required, avoid power settings in excess of 1000-1200 RPM during ground operations to mitigate noise, prop blast, propeller damage and brake wear during taxi.

TAXIING

1. Brakes and steering – CHECK
2. Power and brakes – AS REQUIRED

When beginning to taxi, the brakes should be tested immediately for proper operation. This is done by first applying power (or simply releasing brakes) to start the airplane moving slowly forward, then retarding the throttle (if used) and simultaneously applying pressure smoothly to both brakes the confirm proper brake operation. If the RV-type operated for training is equipped with a steerable tail wheel, tail wheel steering should also be checked for normal operation. If there is any doubt about proper brake operation or steering, the engine should be shut down before directional control is lost.

Normal taxi power is IDLE to 1000 RPM. Taxi operations should normally be conducted with the flaps retracted to avoid the possibility of damage.   Aerodynamic controls should be applied to the maximum extent to assist with steering and controlling the airplane on the ground. For airplanes equipped with a steerable tail wheel, the pilot should keep the control stick in the full aft position under most conditions to ensure proper steering. The large rudder is generally highly effective for steering RV-types during ground operations. For quartering headwinds, aileron on the upwind side should be raised commensurate with wind speed to aid in control. For quartering tailwinds, roll to downwind should be used. The airplane will tend to weathervane into the prevailing wind. If aerodynamic control (and tail wheel steering, when equipped) is insufficient to maintain heading, differential braking may be required. Avoid "dragging" the downwind brake under these conditions.

Caution

- ***When moving on the ground, the pilot should devote primary attention to taxiing. Accomplishing cockpit tasks while taxiing could lead to an inadvertent loss of directional control or collision.*** If it is necessary to perform cockpit tasks, the pilot should consider stopping the aircraft. If "heads down" time is required, the aircraft should not be in motion while these tasks are accomplished.
- Due to prop wash and airplane landing gear geometry, full aft stick should generally be used for taxi operations for tail wheel equipped airplanes unless the tailwind component exceeds 15 KTS.
- Rapid application of brakes during taxi operations can result in nose-over (tail wheel types) or nose gear damage.

Tail Wheel Steering. To turn tail wheel equipped RV-types on the ground, the rudder should be applied in the desired direction of turn, using power and braking to control taxi speed. The rudder should be held in the direction of the turn until just short of the point where the turn is to be stopped, then the rudder pressure released or slight opposite pressure applied as needed. Rudder and tail wheel steering should be used as the primary means of directional control during ground operations. Differential braking may be used to steer the airplane but only sparingly and with caution to avoid a nose-over or loss of directional control. Different types of tail wheels may be fitted, some of which may be non-swiveling. If a non-swiveling wheel is fitted, consider increasing turn radius (when practical) to avoid unnecessary tail wheel wear or skidding/hopping. Depending on the type of tail wheel fork fitted, the pilot should be observant for possible hazards that could result in catching the fork and damaging the tail wheel assembly (e.g., a concrete "step" on a hard surface taxiway, etc.) Tail wheel steering response will depend on how the tail wheel is rigged and familiarity should be gained through taxi practice with the RV-type operated for training.

Nose Wheel Steering. Van's nose wheel assemblies are free-castoring (i.e., positive nose wheel steering is not provided). Aerodynamic (rudder) control will be proportional to power setting and taxi speed. Some control may be available, and any turn should be lead with rudder in the appropriate direction. If insufficient rudder authority exists to provide desired turn performance, then differential braking should be applied in the direction of the desired turn.

Taxi Speed Control. Use care when applying brakes, differential or symmetrical. ***For normal taxi operations, power should be the primary means used to control speed*** and feet should be kept off of the brake pedals to avoid overheating brakes and unnecessary wear. After the airplane begins to move, idle power is generally sufficient for taxi, especially on paved surfaces. ***Do not ride the brakes when taxiing. If necessary, apply brakes to slow to a suitable speed and then release the brakes.*** A downhill gradient on a paved taxi surface presents a challenge to speed control. Keep taxi speed low and avoid rapid brake application as this could place unnecessary stress on nose wheel assemblies or cause a nose over in tail wheel equipped RV-types. If equipped, GPS displayed ground speed can assist with taxi speed control.

Landing Gear Rigging. Absent cross-wind, properly rigged and functioning RV-types should track straight on the ground without pilot input. If the airplane does not or there is a pronounced uncommanded turning tendency this could be an indication of a dragging/malfunctioning brake, wheel or tire problem (including wheel pant interference) or a miss rigged main gear or tail wheel steering system (if equipped).

Note

Due to close fitting wheel pants on many RV-types, preflight inspection of wheel and brake assemblies can be problematic. Pilots of RV's fitted with wheel pants need to be attuned to any change in ground handling characteristics that could be indicative of a brake or wheel malfunction. Wheel pants need to be removed on a regular basis to inspect brake and wheel components.

Some RV-types fitted with Whitman style main gear and tail wheels may experience gear shimmy. Although not common during operations at normal taxi speed, shimmy can be the result of multiple factors. If shimmy is encountered, the aircraft should be slowed (or even stopped) to a point at which shimmy stops and then accelerated to a taxi speed that does not cause shimmy. Operation off grass generally provides sufficient scrubbing action to preclude gear shimmy.

Design Eye Height. RV-types are engineered with a design eye height that allows the pilot to see just over the nose. Due to the wide variation in configuration and pilot anatomy, it is not always practical to achieve design eye height, however an attempt to do so should be made if circumstances allow. Utilization of design eye height allows for a common frame of reference and assists with teaching and learning visual cues. For tail wheel equipped airplanes, pilots that are able to achieve design eye height generally have sufficient over-the-nose visibility to taxi without utilizing s-turns. If over the nose visibility is compromised in any way, s-turns during taxi to maintain visibility may be required. If forward visibility is compromised, any stopping during taxi should be performed "off axis" when practical to allow clearing in the direction of taxi when taxi is resumed.

Cockpit Ventilation and De-fogging. It may be desirable or necessary to ventilate the cockpit during taxi operations to maintain a suitable cockpit temperature. Due to variations in canopy rigging and ventilation systems, specific guidance cannot be provided. In general, if the canopy is in an intermediate position, it should be secured. Sliding canopies can, generally, be operated in any position during ground operations, however consideration to prop blast effect, other aircraft and wind should always be given, regardless of the type of canopy fitted. Flip-over or clam shell canopies provide a greater challenge and unless equipped with a mechanism to lock the canopy in an intermediate position, it may be necessary to operate with the canopy in the fully locked position when taxiing to preclude canopy damage. During high humidity conditions, some canopy fogging may be experienced in certain airplanes. The upgrading pilot should become familiar with de-fogging options (even if that means wiping the inside of the canopy) to maintain visibility during ground operations. Ventilation systems may not provide adequate airflow during ground operations to fully defog the windscreen.

<u>BEFORE TAKEOFF</u>

It is preferable to orient the airplane into the wind for run-up, when practical. For tail wheel equipped airplanes, flaps up and aft stick should be maintained when running the engine at power settings greater than 1200 RPM when the airplane is not moving to aid in keeping the tail down. Regardless of gear configuration, ***care should be taken to position the aircraft so as to preclude the possibility of prop blast generated by run-up becoming a hazard to people, equipment or other aircraft on the ground; even if this means <u>not</u> pointing into the wind.***

1. Controls – CONFIRM FREE AND CORRECT

Bubble canopies allow full view of all flight controls from the cockpit. Full view is not always practical in side-by-side RV-types, but every effort should be made to confirm proper flight control operation prior to flight. If visibility or physical limitations make viewing the flight controls impractical from the cockpit, the upgrading pilot should consider conducting a flight control check during the pre-flight inspection to allow observation of correct and unrestricted movement. For tail wheel airplanes, it may not be possible to check full rudder deflection on the ground due to friction caused by the tail wheel steering systems. Depending on configuration, elevator trim tab position may be visible from the cockpit if the elevator is held in the full up position. A passenger, equipment or other items in the cockpit may cause interference with the flight controls.

2. Trim – SET
3. Fuel – CHECK
    a. Valve
    b. Quantity
    c. Pressure

For normal operation it is desirable to start, taxi and takeoff on the same fuel tank. This will insure proper fuel flow after takeoff if sufficient fuel supply exists. ***Switching fuel tanks immediately prior to takeoff is not recommended.*** The run-up should be performed only utilizing the engine driven fuel pump (typical Lycoming installation) to confirm proper operation.

Warning

Fuel quantity gauge calibration and accuracy varies by installation. Fuel level should be confirmed visually prior to flight to ascertain fuel on board. In some installations, even when properly calibrated, gauges may only read accurately with the tanks full and/or empty.

4. Canopy—SECURE
5. Flaps – UP
6. Stick – FULL AFT (tail wheel equipped)/AS REQUIRED (nose wheel equipped)
7. Mixture – AS REQUIRED
8. Throttle – RPM IAW Manufacturer's Guidance (Typically 1700-1800 RPM)

Note

Precise RPM setting for run-up is unimportant. Mixture should be advanced only enough to support run-up RPM.

    a. Ignition System – CHECK

i. Maximum drop: AS SPECIFIED

ii. Maximum differential: AS SPECIFIED

iii. Magneto Systems: CHECK FOR EGT RISE ON SINGLE MAGNETO

> **Caution**
>
> - Falling or unstable EGT(s) when operating on a single ignition system may be indicative of a problem with a spark plug or other ignition system component.
> - ***Ensure both ignition sources are on for takeoff.***
> - Run-up RPM settings are generally sufficient power to *takeoff* in most RV-types. Ensure the airplane and flight controls are properly positioned, flaps are up, brakes are set and prop blast is not a hazard when performing a run-up.

b. Carb Heat/Alternate Air Source – CHECK

Follow engine manufacturer's guidance for performance of run-up. The information in this section is not intended to replace specific builder's or component manufacturer's guidance.

> **Caution**
>
> ***Ensure stick is full aft and flaps are up for tail wheel equipped airplanes when performing engine run-up.*** Even neutral stick may result in "nose nod" as power is advanced to run-up speed. Additionally, if on a wet grass or slick (e.g., wet/icy) surface, failure to apply sufficient back stick may result in uncommanded yaw as power is applied (the left wheel may slide or hop over the ground with the brake locked). If any nose nod or uncommanded yaw is experienced, reduce power.

Typical Lycoming Installation, Engine Operation on the Ground. Full rich should be used for engine starting operations in accordance with the engine manufacturer's recommended starting procedure. Lycoming aircraft engines are not equipped with a choke, thus the requirement to use full rich for start. The engine should be started at as low an RPM as practical (idle is desired). ***After engine start and stabilization*** (approximately 30 seconds—oil pressure indication and smooth operation), ***the mixture should be leaned aggressively for ground operation.*** The engine should be adjusted for smooth operation at 1000-1200 RPM for warm-up. The 1000-1200 RPM range is recommended to keep the spark plugs sufficiently hot to avoid buildup of lead salt (assuming 100 octane leaded avgas is being burned). Higher RPM operation may require mixture enrichment (i.e., engine will begin to run roughly is power is advanced above 1000-1200 RPM). Mixture must be richened for run-up and takeoff. Full rich mixture should be used for takeoff at density altitudes below 3000 feet.

High Density Altitude Takeoff. The engine should be leaned for maximum power prior to takeoff if density altitude exceeds 3000 feet in accordance with the engine manufacturer's or builder's recommendations. If equipped with EGT, and normal sea level target EGT is known (i.e., the EGT noted at sea level at WOT and full RICH mixture), a full-power run-up may be conducted and mixture adjusted to normal target EGT (nominally 1250-1320^{o} F for a typical engine with an 8.5:1 compression ratio). If specific guidance or data doesn't exist (or the airplane is not equipped with EGT), a full-power run-up should be conducted and mixture leaned just enough to smooth operation at maximum RPM and then richened slightly (without degrading RPM).

Note

Target EGT (when equipped) is a function of engine compression ratio. 8.5:1 was selected as an *average* representative example. Lower compression engines will have a target EGT approximately 100^{o}F higher and target EGT will be lower for high compression engines (9.5-10:1). If target EGT is not specified by the builder or engine manufacturer it must be determined by testing.

Typical Lycoming Installation, Conventional Magneto Ignition Source. Magneto drop-off check procedures are detailed in Lycoming Service Instruction 1132B as revised. The information in this section is from the Service Instruction. To perform the ignition system check, align the aircraft into the wind (if practical), confirm flaps UP, ensure prop blast won't be a factor for other aircraft, vehicles, personnel or structures, maintain aft stick in tail wheel equipped airplanes and smoothly advance the power to 1700-1800 RPM/Manufacturer's recommended setting. For a conventional, keyed ignition switch, move the ignition switch from BOTH to LEFT, allow the engine to stabilized on the single ignition system for 5-10 seconds and note RPM, EGT and engine smoothness and then return the ignition switch to BOTH. EGT will rise when operating on a single magneto (due to slower burn time and less peak pressure, resulting in less expansion of combustion gases). Then, repeat the check on the RIGHT system. At the conclusion of the check, be sure the BOTH position is selected. Do not operate on a single magneto for too long a period; a few seconds (5-10) is usually sufficient to check drop-off and proper EGT rise while minimizing the potential for plug fouling. A falling/erratic EGT, rough running engine, excessive RPM drop or differential constitutes a bad magneto check and warrants troubleshooting the ignition system before flying.

Excessive RPM Drop, Smooth Engine during Magneto Check. Smooth operation of the engine but with a drop-off that exceeds the normal specification of 175 RPM is usually a sign of propeller load condition at a rich mixture. If that is the case, slowly lean the mixture until the RPM peaks, then retard the throttle to 1800 RPM and repeat the magneto check at the newly leaned mixture setting. If the drop-off doesn't exceed 175 RPM (and difference between the two magnetos doesn't exceed 50 RPM) and the engine is running smoothly, then the ignition system is operating properly. Return the mixture to full rich after completion of the mag check and proceed normally.

Rough Engine during Magneto Check (Oil Fouled Spark Plug). If engine roughness is noted when selecting a single magneto, it is likely that a spark plug has fouled and may not be firing properly. In this case, advance power to 1800-2000 RPM while aggressively leaning until engine roughness is noticed. Advance the mixture to smooth engine operation and allow the engine to run at speed for approximately 30 seconds. Return the power setting to 1700-1800 RPM and repeat the magneto check. This technique will help clear an oil fouled plug. If the plug is lead-fouled or damaged, the engine will continue to run rough and takeoff should not be attempted.

Caution

If this technique is used to clear a fouled plug successfully, ensure mixture is properly adjusted for takeoff after clearing the plug(s) and completing the run-up.

Monitoring EGT during Magneto Check. EGT will typically rise 50-100^{o}F during the magneto check, but the exact amount of rise is not critical. Higher rise will be experienced if the mixture is leaned during the magneto check.

Note

An in-flight ignition system check on a properly leaned engine developing cruise power provides a much better means to check individual system components than does the ground check. Periodic in-flight checks should be conducted.

9. Throttle – REDUCE

10. Mixture – AS REQUIRED FOR TAKEOFF
11. Propeller—AS REQUIRED
12. Flaps – SET FOR TAKEOFF
13. Boost Pump – ON
    a. Check Fuel Pressure
14. Transponder – ON/ALT
15. Lights – AS REQUIRED

For a typical Lycoming installation, the engine is warmed up sufficiently for run-up and take off if power can be advanced without the engine hesitating or missing, however consideration should be given to allow the engine to warm up to at least an oil temperature of 80^{o}F prior to takeoff. Generally, do not delay takeoff after CHT has exceeded 300^{o}F (if equipped) to allow the oil to warm. Ambient temperature affects engine temperatures and higher temperatures are experienced during the summer. During cold weather operations, allow sufficient time for engine warm-up.

<u>TAKEOFF</u>

Caution

- If operating at a military or joint use airfield, it is not possible to taxi an RV-type over raised arresting gear (e.g., BAK-12, E-28, etc.) if the runway is so fitted.
- At large airports, runway centerline lighting can also pose a potential hazard and should be avoided during takeoff.

1. Mixture – AS REQUIRED
    a. Typical Lycoming installation: Full Rich Below 3000 Feet Density Altitude or Best Power (maximum RPM) Above 3000 Feet Density Altitude
2. Wind Direction - NOTE
3. Heading Indication(s) – CHECK
4. Power – ADVANCE SMOOTHLY
5. Engine Instruments – MONITOR
    a. RPM – TAKEOFF POWER
    b. Oil/Fuel Pressure – WITHIN LIMITS
6. Flaps – RETRACT ≤ V_{FE}

The aircraft should be aligned with the runway during takeoff. Proper alignment is more important than operating on the exact centerline. At design eye height, it is generally possible to see over the nose at a normal seating height (cushions and seatback adjusted to place the top of the pilot's head/headset approximately 2-3" below the canopy) when the tail wheel equipped RV-types are in a three-point attitude. The upgrading pilot should note wind conditions and position controls accordingly. The rudder should be used to maintain heading, and ailerons should be used to control drift. Power should be advanced smoothly, but not abruptly. An abrupt application of power will cause considerable yaw to the left (this condition is exacerbated by a left cross-wind condition). RV-types have a low power-loading (weight divided by horsepower) and accelerate rapidly. The pilot should anticipate the need for right rudder as power is applied (as well as when the tail comes up for tail wheel equipped airplanes). Depending on wind conditions, significant right rudder will be required to counteract engine and propeller effects during the takeoff roll. Engine instruments should be cross-checked during the initial part of the takeoff run to ensure stable readings within limits. Check for manifold pressure (when equipped) roughly equal to atmospheric pressure (altimeter setting) and RPM to indicate that the engine is producing rated power. Note that the airspeed indicator(s) are working correctly the airplane accelerates. If the engine is not producing rated power, consider rejecting the takeoff to investigate.

For tail wheel equipped airplanes, the amount of forward stick pressure required to lift the tail is proportionate to load. At high gross weight with an aft CG, more forward stick pressure will be required than if operating at solo weight. After the tail rises, the aircraft will accelerate in a two-point attitude. How far to raise the tail is a matter of technique. Tail wheel equipped RV's will fly off nicely in a tail low altitude (approximately 5-8^{o} pitch angle). A lower pitch angle may be desirable if cross-wind conditions require increased aerodynamic control (See TAIL WHEEL CONSIDERATIONS in CROSSWIND TAKEOFF). For nose wheel equipped airplanes, elevator should be applied in the takeoff roll to minimize weight on the nose wheel assembly. The pilot should establish an initial climb attitude of 8-10 degrees nose up when sufficient flying speed is reached. Rotation may be delayed if operating in gusty or cross-wind conditions.

RV-types can require fairly heavy rudder inputs to compensate for engine and propeller effects during takeoff (this is more pronounced for tail wheel equipped airplanes). Rudder is the primary means of directional control, and aileron should only be applied as necessary to assist with drift/cross-wind control. Nose wheel equipped airplanes may require differential braking to assist with directional control during the initial part of the takeoff roll under some conditions (until the rudder becomes effective), however, as a rule of thumb, use of brakes during the takeoff roll in any RV-type should be avoided unless absolutely necessary to maintain directional control.

If flaps were used for takeoff, they should be retracted after becoming airborne before passing V_{FE}. The aircraft may settle slightly during flap retraction if flaps are retracted at low speed, and it may be necessary to adjust trim to compensate for flap retraction. A maximum performance climb can result in a relatively steep climb angle at full power and limit over-the-nose visibility. Full power should be used for initial climb. If a controllable propeller is fitted, RPM may be reduced after initial climb segment, as required, for noise abatement. RV-types require significant right rudder input for low airspeed, high power operations (including climb) to counter power effects. After the initial climb segment, airspeed may be adjusted as required to assist with engine cooling without significant degradation in climb performance. See CLIMB.

Note

- "Static" RPM is the maximum RPM produced by the engine at zero airspeed. The amount of RPM produced will vary by installation. Constant speed propellers are normally adjusted to produce rated RPM for takeoff. Fixed-pitch types are a compromise, and will have target static RPM limit that should be checked at the beginning of the takeoff roll (e.g., 2200 RPM, etc.).
- For takeoff power check Manifold Pressure (when equipped) rule-of-thumb, subtract 1" from local altimeter setting for each 1000' of elevation above sea level.
- The use of partial flaps should be considered for takeoff. Use of partial flaps may improve the ability to lift the tail (for tail wheel equipped airplanes) under aft CG conditions and/or improve takeoff performance by reducing ground roll required. Flap settings below half flaps (20^o for RV-4/-6/-7/-8 or 15^o RV-9) increase lift. Flaps settings greater than half flaps increase drag. If specific flight test data isn't available, takeoff flap setting should be 20^o (or 15^o for RV-9).
- Tail wheel equipped RV-types may fly off the ground in a three-point or tail-low attitude, depending on control technique used. Ensure proper takeoff and climb pitch attitude and airspeed are maintained, even if this means utilizing forward pressure on the stick.
- If neutral trim is selected for takeoff in tail wheel equipped airplanes, the pilot should anticipate the need for forward stick.

Cross-wind Takeoff. If a direct cross-wind condition exists, and runway selection allows, takeoff with a right cross-wind is recommended. Operation with a tailwind component should be avoided, if practical.

It is important to establish and maintain the proper amount of crosswind correction prior to lift-off. Apply aileron pressure toward the wind to keep the upwind wing from rising and apply rudder pressure as needed to prevent weathervaning and maintaining alignment with the runway. Consider increasing rotation speed to assist with aerodynamic control. Pilots should use caution not to over-control as RV-types generally exhibit light stick forces and quick control response.

Tail Wheel Considerations. As the tail wheel is raised off the runway, holding aileron control into the wind may result in the downwind wing rising and the downwind main wheel lifting off the runway first, with the remainder of the takeoff roll being made on one main wheel. This is acceptable and preferable to side-skipping. If a significant cross-wind component exists, the main wheels should be held on the ground slightly longer than in a normal takeoff so that a smooth but definite lift-off can be made. This will allow the airplane to leave the ground under more positive control so that it will definitely remain airborne while the proper amount of drift correction is being established. It will also help avoid excessive side loads on the landing gear and prevent possible stress that would result from the airplane settling back to the runway while drifting. It is permissible to maintain a three-point or one main and tail wheel "two point" attitude during the crosswind take-off roll as long as the alignment of the longitudinal (fuselage) axis is properly controlled with rudder.

Short-field Takeoff. Half-flaps (20^{o} RV-4/-6/-7/-8 or 15^{o} RV-9) should be used for short field operations. Takeoff power should be applied smoothly and continuously and the need for right rudder should be anticipated while the airplane accelerates as rapidly as possible. For tail wheel airplanes, the tail should be allowed to rise off of the ground slightly (5-8^{o} pitch angle). This attitude represents a good compromise between establishing takeoff AOA and acceleration. This attitude should be maintained until the aircraft lifts off. For nose wheel airplanes, accelerate in a normal, three point attitude. At V_X, best angle climb speed (as determined by flight test), smoothly establish 15^{o} pitch initially, then adjust as required to maintain V_x all obstacles are cleared. Then the airplane should be accelerated to desired climb speed. Use of half flaps reduces pitch angle by 1-2^{o} for a given airspeed. Flaps should be retracted prior to accelerating through V_{FE}, but not, generally, before clearing any obstacle or the initial climb segment is complete.

Warning

Pitch stability is reduced at low airspeed as pitch is increased and some stick force lightening occurs. Proper climb speed/AOA should be maintained and reduced static margin anticipated when climbing at steep angles. Particular attention must be paid to pitch/speed control during climb to avoid unintentional deceleration/stall.

Soft-field Takeoff. The techniques in this section apply to soft, unimproved landing areas. A well-maintained, dry grass runway is not truly a "soft field." When operating off a properly manicured grass field, normal takeoff techniques may be used.

Half-flaps (20° RV-4/-6/-7/-8 or 15° RV-9) should be selected prior to starting the takeoff roll to provide additional lift and transfer the airplane's weight from the wheels to the wings as early as possible. The airplane should be taxied onto the takeoff surface without stopping on a soft surface. Stopping on a soft surface, such as mud or snow might bog the airplane down. The requirement to not stop enroute to the runway should be considered when planning when/how/if to accomplish pre-takeoff run-up checks. The airplane should be kept in continuous motion with sufficient power while lining up for the takeoff roll. After alignment, power should be applied smoothly and continuously and the need for right rudder anticipated. A tail-low attitude should be maintained to avoid the tendency to nose over as a result of soft spots, tall grass, etc. The airplane will fly itself off the ground if this attitude is maintained. The airplane should be allowed to accelerate to safe climb speed in ground effect. Caution should be exercised when easing forward into ground effect to avoid sinking back into the runway since the short; low-aspect ratio planform of RV-types does not generate much of a ground effect "cushion."

Caution

- Consider effects of runway contamination when estimating performance (See ALL WEATHER OPERATION).
- Grass height should not exceed 1/3 wheel diameter for operations off a turf runway.

CLIMB

1. Power – AS DESIRED (after initial climb segment)
2. Boost Pump – OFF

3. Landing Light – OFF (if used for takeoff)
4. Cylinder Head Temperature – MONITOR (if equipped)
    a. Adjust airspeed and power as necessary to keep temperature within limits
5. Mixture – SET BEST POWER CLIMBING THROUGH/ABOVE 3000 FEET DENSITY ALTITUDE
    b. Adjust for maximum RPM or maintain constant EGT (noted passing 1000 feet density altitude)

RV-types exhibit good climb performance across a relatively broad speed band that extends from ON SPEED (approximately V_X) through L/D_{MAX} (approximately V_Y) to "optimum" climb speed (V_Z/approximate to Carson's speed [maximum speed per unit of fuel burned]). This is depicted in Figure 3-1. IAS for V_X increases with altitude and IAS for V_Y decreases with altitude. Constant TAS can be flown to altitude to approximate V_Y if desired (as a rule of thumb, decrease IAS 1% per 1000 feet of altitude to accomplish this). Overall fuel efficiency can be improved, if desired, by climbing at lower groundspeed with a tailwind and higher groundspeed when a headwind is present.

During climb, monitor oil temperature and CHT (when equipped) to ensure proper engine cooling. Climb speed should be adjusted (increased) to ensure maximum CHT remains at or below 400°F when practical. RV-types exhibit good climb performance over a wide band of airspeeds. Thus, engine cooling can easily be accommodated without significant degradation in climb performance.

If aircraft specific flight test data is not available, a maximum angle climb may be approximated by establishing pitch (approximately 15-18° pitch) to maintain ON SPEED at WOT at low density altitudes (below approximately 3000'), adjusting pitch as required to maintain speed at or above ON SPEED. A maximum rate climb can be approximated by conducting a WOT climb at 10-12° pitch (roughly L/D_{MAX}). ON SPEED and L/D_{MAX} climbs can be conducted with or without use of flaps. Use of half flaps (20° RV-4/-6/-7/-8 or 15° RV-9) increases lift and results in lowering required pitch angle by approximately 1-2° for a given airspeed. Typical cruise climb occurs at 110-140 MPH/95-125 KTS CAS (6-10° pitch at WOT). At high pitch angles, over-the-nose visibility and static margin is reduced and, at high power settings and low airspeed, significant right rudder is required to counter engine power effects.

Caution
Some RV-types may exhibit negative stick-free longitudinal stability at low speed and high power (e.g., climb). If the airplane is loaded with an aft CG and operated at high power, the pilot must pay close attention to the airspeed during the climb. The aircraft may decelerate to the stall if the pilot does not properly control pitch/speed.

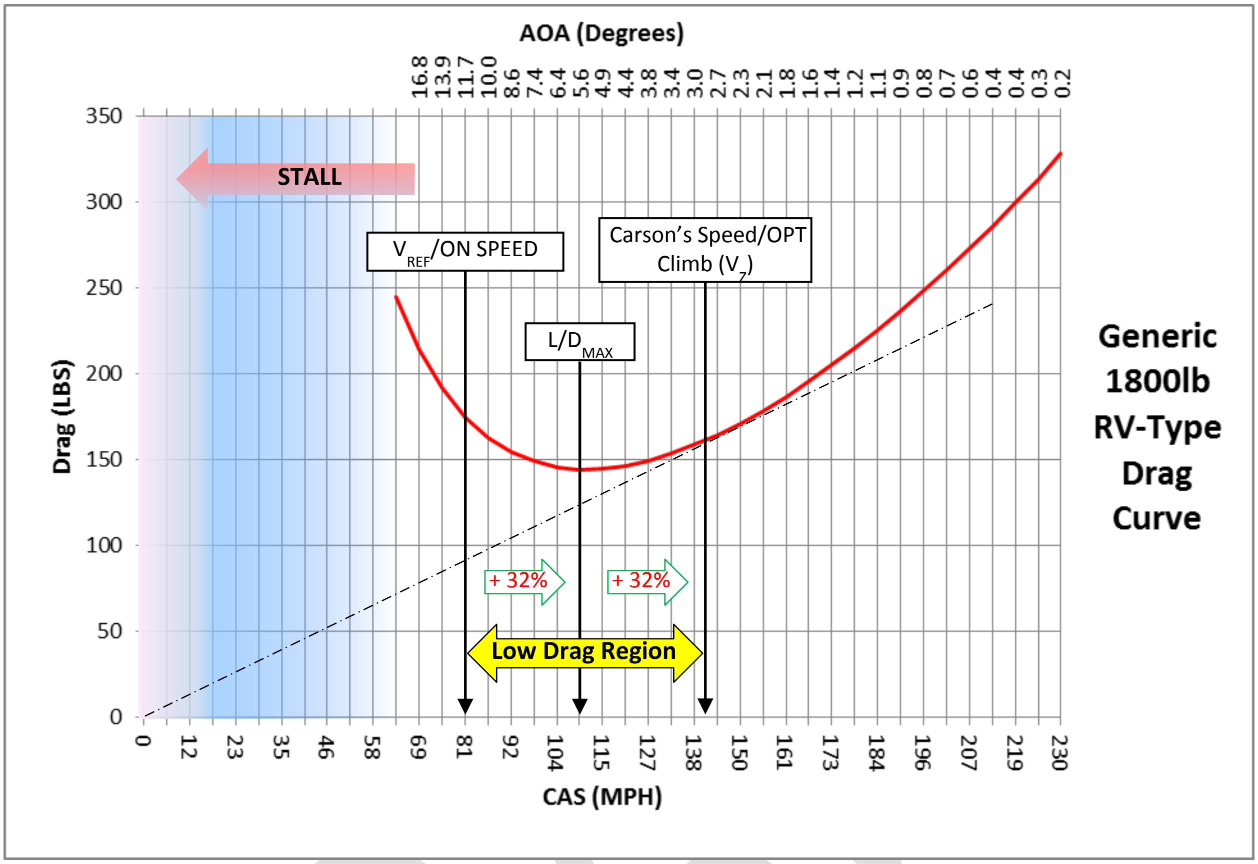


Figure 3-1: Generic 1800 Lb RV-type Drag Curve. Low Drag Region corresponds to nominal climb airspeed band.

> **Note**
>
> Pitch trim inputs are inversely proportional to airspeed. At low airspeed, larger (course) inputs are required. The trim becomes more sensitive/effective as speed increases.

Typical Lycoming Installation, Engine Operation during Climb**.** Wide-open Throttle (WOT) should be used for climb. It is acceptable for manifold pressure to exceed RPM. "Over-square" operation is permissible for airplanes equipped with controllable pitch propellers (RPM may be reduced after initial segment climb, if required/desired for noise abatement) if CHT (when equipped) and oil temperatures are within limits and mixture is properly adjusted. Full rich mixture should be used for operations below 3000 feet density altitude. Passing 3000 feet density altitude, mixture may be leaned (rich of peak) for best performance and cleaner combustion. If equipped, EGT should be noted passing 1000 feet density altitude, and mixture slowly leaned (as required) to maintain this temperature throughout the climb (typically 1250-

1320^{o}F). If equipped, CHT should be monitored during climb. If CHT exceeds 380-400^{o}F, airspeed should be increased to assist with cooling.

> **Warning**
>
> Pitch stability is reduced at low airspeed as pitch is increased and some stick force lightening occurs in all RV-types. The aircraft may diverge from trimmed speed at high power and low airspeed at aft CG. The aircraft may decelerate to an unintentional stall with stick pressure relaxed. The pilot must actively monitor pitch/speed/AOA during climb in IMC conditions or at climbs at low altitude in any weather conditions.

Optimum Climb. Because of the excellent overall performance of RV-types, the basic climb techniques described above are usually sufficient to deliver satisfactory climb performance. If, however, most efficient (optimum) climb is desired then the following technique may be used: Climb at V_Z, a speed equal to 1.32 times V_Y appropriate for gross weight and altitude (as determined by flight test). Climb at this speed until VVI decreases to 500 FPM. Maintain 500 FPM until indicated airspeed reaches V_Y and then transition to V_Y until reaching desired climb altitude. Adjust mixture for target EGT as described above and monitor CHT to maintain 380^{o}F or less on the hottest cylinder.

CRUISE

1. Power – AS DESIRED
2. Trim - ADJUST
3. Fuel Flow/Quantity – MONITOR (as equipped)
4. Fuel Selector Valve – AS REQUIRED
    a. Boost Pump ON to switch tanks

To level-off, adjust pitch and trim while allowing the airplane to accelerate to desired cruise speed. Upon reaching desired speed, adjust power (RPM/Manifold Pressure, as equipped) and adjust mixture. After power has stabilized at desired cruise setting, adjust the mixture for either lean of peak (LOP) operation or rich of peak (ROP) operation, as desired. Avoid mixture settings between peak EGT and 50^{o}F ROP.

5. Mixture – AS REQUIRED
    a. See Table 3-1

Generally, time is the primary means of determining fuel consumption. Fuel gauge is accuracy varies by installation. A properly calibrated/tested fuel totalizer may serve as a primary indication if it correlates with estimated fuel consumption based on time. Depending on installation, intermediate fuel conditions can produce variable readings and turbulence and/or maneuvering can produce indicated fuel quantity errors. Prior to switching fuel tanks, the pilot should turn the auxiliary boost pump on, check for appropriate fuel pressure to confirm pump operation, and leave it on for a several minutes following valve movement to ensure an uninterrupted supply of fuel. Consider switching fuel tanks at 30-60 minute intervals to maintain lateral weight balance. Aileron trim (when equipped) will assist in maintaining a wing's level trim condition. A six gallon differential (or greater) will likely produce noticeable rolling tendencies into the heavy wing.

Prior to switching tanks, the pilot should consider actions to be taken in the event fuel flow is interrupted during the transfer sequence. If circumstances permit, switching tanks should be accomplished only when in a position to execute a power-off landing. Switching tanks should not be performed immediately prior to or during critical phases of flight (takeoff and landing).

Pitch trim installation can be highly sensitive at cruise airspeeds and the pilot should use small adjustments to establish neutral longitudinal pressure on the control stick. Due to the inherent design maneuverability and flight characteristics of RV-types, trim should be considered an aid to reducing pilot workload. Overall ability to trim will be based on ambient conditions. Except in very smooth air, sustained "hands off" trim may not be achievable during cruise operations.

Monitor engine parameters during cruise operations.

Typical Lycoming Installation, Engine Operation during Cruise.

EGT *(if equipped)***.** Absolute EGT is a meaningless number. There is no such thing as "excessive EGT." What matters is relative change in EGT to peak EGT. After familiarity is gained with EGT performance for a specific airplane/engine; then those numbers can be used for operations (i.e., it is practical to establish target EGT[s] to assist with coarse leaning). EGT will vary from cylinder to cylinder, with less variation occurring in fuel injected engines (due to variation in the fuel/air mixture reaching each cylinder via the induction system).

CHT *(if equipped).* The closest surrogate engine parameter to internal engine pressure is CHT. Do not lean using CHT; however, as CHT does not respond fast enough to mixture change for the purpose of leaning. Also, while CHT closely mirrors the internal pressure curve for the engine, it is affected by conditions that do not impact internal pressure (OAT, CAS, density altitude and cowl/cooling efficiency). CHT has a direct effect on the temperature of the exhaust valve stems. If equipped, CHT should be monitored throughout flight. If any CHT increases above 380^{o}F for whatever reason, the pilot should take action to correct it before limits are exceeded. At 420^{o}F, the aluminum cylinder assembly has lost half of its tensile strength.

Note

By keeping the CHT for each cylinder (if equipped) below 380°F, the life of exhaust valves may be extended.

Cold Weather Operations. Cold ambient temperature/OAT (e.g., cold weather operations) results in a leaner mixture for a given mixture lever setting. Since CHT and EGT (if equipped) are absolute temperatures based on ambient conditions, additional consideration should be given to limits and reference numbers when operating in cold conditions.

Power Setting. Setting precise engine power requires the use of a manifold pressure gauge and tachometer. Specific power settings can then be determined using the appropriate Lycoming power curve (available in the engine manual) or the "rule of 48." The rule of 48 allows the pilot to *approximate* % power for a typical Lycoming installation in an RV-type. To use the rule, add manifold pressure (in inches) to RPM/100. When the sum equals 48, the engine is producing approximately 75% power. Reduce the sum by 3 for each 10% decrease in power, i.e., 45 = 65% power and 42 = 55% power, other power settings may be interpolated using this rule of thumb. All RV-types are capable of delivering good cruise performance at power settings at or below 65%. Some advanced engine instrumentation may display power setting directly if correctly installed and calibrated. Lycoming recommends cruise power settings at or below 65% for maximum engine life. "Over-square" operation does no harm if CHT (when equipped) and oil temperatures are within limits and mixture is properly adjusted: manifold pressure may exceed RPM. Precise power cannot be determined for aircraft not equipped with a manifold pressure gauge.

Caution

If specific engine manufacturer's or builder's guidance is available for leaning operations, it should be followed. Information in this manual is intended for information only or to assist with developing techniques that must be properly tested and validated.

***Fuel Flow** (if equipped).* X lbs of fuel per X lbs of air is required to produce X% power, this basic relationship is driven by the stoichiometry of combustion and is referred to as specific fuel consumption, or SFC. Required fuel flow (when known) may be set to properly lean. Required fuel flow (based on SFC) can be obtained from the engine manufacturer's power curves. The fuel delivery system (carburetor or injected) must be capable of delivering sufficient fuel flow for takeoff/wide-open-throttle operation. Typically, a significant increase in required fuel flow occurs at approximately 75% power.

Leaning/Mixture Control. Always lean for cruise operations, regardless of altitude. After level-off, adjust power to desired cruise power setting and lean in accordance with manufacturer's or builder's recommendations. Proper leaning results in cleaner combustion chambers and less lead build up on spark plugs and exhaust valves as well as saving fuel. During cold weather, leaning also aids in raising engine and oil temperatures to desirable minimums to assist with evaporating water and acids out of the oil, preventing rust and corrosion. Avoid operation between peak EGT and 50^{o}F rich of peak to avoid pressure stress (peak pressure occurs at 40-50^{o}F ROP). It is not recommended to lean to peak EGT above 65% power (a richer mixture is required for cooling and detonation is possible with an excessively lean mixture). It is possible to "lean with impunity" at or below 60-65% power, thus various leaning techniques may be experimented with. A rough running engine due to excessively lean mixture at or below 60-65% power does no harm. When leaning, roughness is caused by one or more cylinders having a lean fuel/air mixture which will not support combustion. When the engine runs rough, the leanest cylinder has gone well past peak EGT and there is insufficient fuel by weight (in that cylinder) to support combustion (With a carbureted induction system, this will result in operation as lean-of-peak as the fuel delivery/induction system is capable of delivering.). If equipped with EGT, temperature readings will require approximately 20 seconds to stabilize after mixture adjustment. If equipped, monitor CHT, which will lag EGT during mixture adjustment. ***Do not attempt to utilize CHT to lean.*** Three leaning techniques are presented in this section for consideration; however, no one leaning technique is appropriate for all circumstances:

Best Power Leaning. EGT equipped airplanes adjust mixture until the *leanest* cylinder operates 75-100^{o}F rich of peak EGT. ***This should only be done at power settings below 65%.*** This method will produce the highest airspeed, fuel consumption and CHT's. If not equipped with EGT, best power can be approximated by leaning to the point where the engine begins to lose power, then enriching slightly to restore maximum power.

Peak EGT. EGT equipped airplanes adjust mixture until the *leanest* cylinder operates at peak EGT. The engine will produce slightly less power and fuel consumption will be reduced slightly over the ROP setting for best power. Exhaust valve temperatures will be their highest for any cylinder running 35-50^{o}F ROP using this leaning technique. Peak EGT provides neither the best power nor best economy. Generally, it is the least preferred mixture setting for all operations.

Lean-of-Peak. EGT equipped airplanes adjust mixture until the *richest* cylinder operates in the range depicted in Table 3-1. This method results in much cooler exhaust valve temperatures and lowers CHT's. The engine will produce 7+% less power and fuel consumption will be 20-

50% lower than the equivalent ROP power setting. If not equipped with EGT, LOP can be approximated by leaning to the point where the engine begins to run rough and then enriching just enough to smooth operation.

Table 3-1: Mixture Adjustment Temperature Range[1]	
Power Setting	Temperature Target for ***Richest Cylinder***
Less than 65%	Mixture as Desired
65%	RICHER than 100^{o}F ROP ***or*** LEANER than PEAK
70%	RICHER than 125^{o}F ROP ***or*** LEANER than 25^{o}F LOP
75%	RICHER than 180^{o}F ROP ***or*** LEANER than 40^{o}F LOP
80%	RICHER than 200^{o}F ROP ***or*** LEANER than 60^{o}F LOP
[1] Information provided courtesy of **Advanced Pilot Seminars**	

Note

Some carbureted engines *may* be operated lean-of-peak. Using carb heat (if equipped), helps. Lean-of-peak may or may not be practical for fuel injected installations with non-balanced fuel injectors. Actual LOP EGT depends on many variables (altitude, temperature, etc.) and may range from 0^{o}F LOP to 100^{o}F LOP. Experimenting with LOP operation at or below 65% power should not cause any harm. At power settings 65% or greater, the benefits of LOP operation can be obtained by utilizing the temperature ranges specified in Table 3-1.

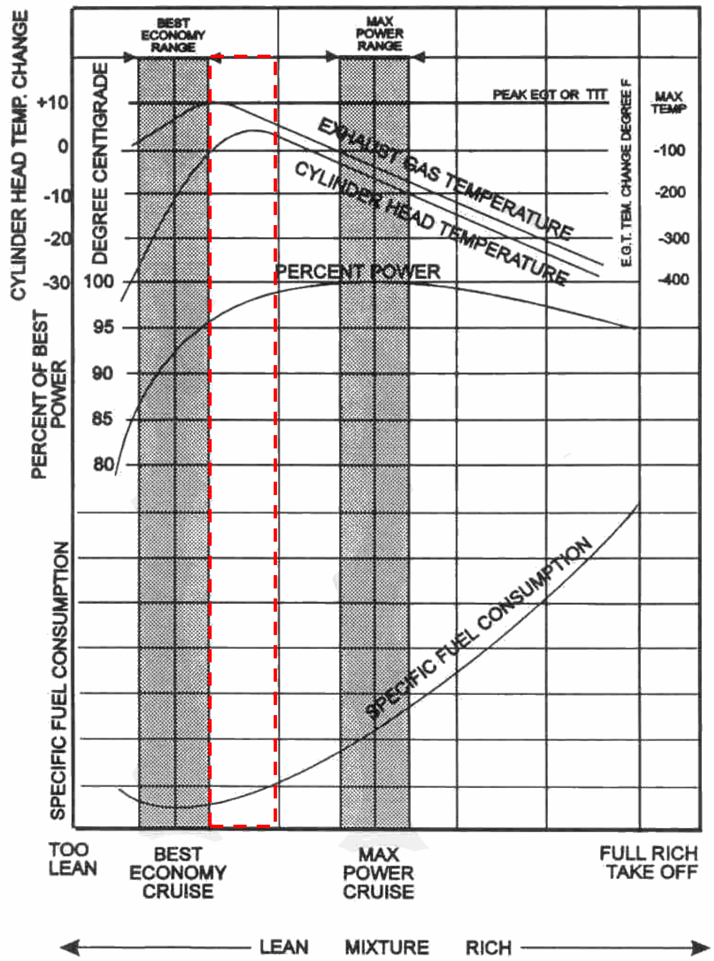


Figure 3-2. Typical Lycoming Installation: Effect of leaning on CHT, EGT, power and specific fuel consumption at constant engine RPM and manifold pressure. The red dashed area is peak EGT to 50^o rich-of-peak (ROP). Operation in this area should be avoided.

Maximum range occurs at a speed slightly greater than L/D_{MAX}. Best range glide speed as measured during flight test will a*pproximate* L/D_{MAX}. Alternatively, if data for best glide isn't available, L/D_{MAX} can be approximated by flying 105-110 MPH/91-96 KTS. If the aircraft is equipped with a properly calibrated AOA system, L/D_{MAX} may be referenced by angle of attack in lieu of indicated airspeed. Maximum endurance (most time aloft for fuel burned) occurs at L/D_{MAX}. Maximum fuel efficiency occurs at a speed approximately 32% greater than L/D_{MAX} (most speed per unit fuel burned) and represents a reasonable compromise for "maximum endurance" cruise (e.g., holding). Since the wide speed band of RV-types makes L/D_{MAX} cruise generally undesirable (due to the low L/D_{MAX} CAS), if increased range/endurance is desired; slow down and choose a higher cruise altitude (as the CAS will be will be lower for a given TAS).

Optimum Cruise. To approximate optimum cruise (i.e., most efficient cruise altitude), climb to an altitude that allows for 65% power at WOT with mixture adjusted for 25^{o} LOP. Normally, the minimum altitude that these parameters can be met is approximately 8000 feet.

DESCENT

1. Power – AS REQUIRED
2. Mixture – AS REQUIRED
    a. Note EGT at top of descent, richen during descent to maintain constant EGT or;
    b. Richen for smooth operation (as required)
3. Fuel – DESIRED TANK
4. Carb Heat – AS REQUIRED (when applicable/equipped)
5. Boost Pump – ON
    a. Fuel Pressure Check
6. Landing Light – AS REQUIRED

The low drag characteristics of RV-types necessitate descent planning to a greater extent than some general aviation aircraft. A standard descent path of 2-3 degrees is generally appropriate for cruise descent planning. Fixed pitch installations generally require a shallower descent angle (2 degrees) than airplanes fitted with controllable pitch propellers (3 degrees). For a 3 degree descent, multiply desired altitude to lose (in thousands) by 3 to determine the distance required for descent. For a 2 degree cruise descent, use altitude to lose (in thousands) times 4 to determine top-of-descent. Power setting will vary, depending on descent velocity desired and ground speed. Generally, a 15-17" MAP (when equipped) starting point will work for most airplanes. Using slightly higher power settings (19-20" MAP) and a 2 degree descent will produce speeds near maximum structural cruising speed (top of the green arc). ***Speed may be increased above maximum structural cruising speed only in calm air. It is not uncommon to experience increasing turbulence during descent, so be prepared to slow down, as required.*** Additionally, "red line" airspeed is actually true airspeed (TAS), not a fixed or indicated airspeed. Flutter margin is decreased or eliminated at high cruising altitudes. Maximum speed (TAS) should never be exceeded during descent operations. If there is any doubt as to flutter margin, maintain CAS at/below maximum structural cruising speed (top of the green arc).

When appropriate for instrument planning reference, turn radius is approximately equal to 1% displayed ground speed (when equipped) expressed as NM, assuming a standard rate turn is flown (3^{o} per second). Plan 2 NM to slow in level flight from cruise speed to holding speed and an additional NM to slow from holding speed to approach speed.

Typical Lycoming Installation, Engine Operation during Descent. As the airplane descends into heavier air, manifold pressure will increase 1" for each 1000 feet and the mixture (set for cruise altitude) will be maintained by the carburetor or RSA fuel servo. This relationship is fairly linear and it is only necessary to adjust mixture slightly for smooth operation during descent. There is no need to apply full rich mixture for descent as the fuel/air ratio is maintained from the cruise setting. As a precaution, full rich may be selected prior to landing to provide sufficient mixture for go-around. In the event of a go-around, full rich mixture is required for WOT operation. If the go-around is conducted at density altitudes greater than 3000 feet, then target EGT (if equipped) should be maintained using mixture control once established in the go-around.

VISUAL LANDING PATTERN

A basic 1000 foot AGL visual landing pattern from downwind abeam the touchdown zone is depicted in Figure 3-3. It may be adapted as circumstances require. It is designed so that sufficient energy is available to reach the runway in the event of power loss with a total ground track of approximately 1 ½ to 2 NM from abeam the TDZ to landing. The abeam point depicted in Figure 3-3 is co-located with low key (see EMERGENCY LANDING) and identical techniques may be used to fly the standard visual and emergency patterns. This visual pattern is designed to allow the pilot to concentrate on flying the airplane, maintain desired ground track, clear for traffic and achieve stabilized approach criteria when rolling out on final using minimal power without having to make configuration changes. The excellent cockpit visibility characteristics of RV-types make clearing practical during a medium banked descending 180^{o} base turn to final. Generally, the higher drag of RV-types fitted with constant speed propellers at low manifold pressure and high RPM require a slightly tighter pattern than for airplanes equipped with fixed pitch propellers. If a speed range is recommended, fixed-pitch airplanes should trend toward the lower end of the speed band and constant speed airplanes should trend toward the upper end. An alternate RECTANGULAR VISUAL PATTERN is depicted in Figure 3-8.

Pattern entry may be flown based on ATC direction or using a visual entry technique. When entering the traffic pattern, plan 1-2 NM in level flight to slow from cruise speed to pattern speed, when appropriate. Fixed-pitch equipped RV-types will decelerate at a slower rate and require a slightly larger pattern than airplanes equipped with controllable pitch propellers. A power setting of 1500 RPM (MP as required) ***or less*** may be used to slow from cruise speed to 110-120 MPH/95-105 KTS (RV-9: 100-110 MPH/87-95 KTS) CAS in level flight. The bottom of this speed band is coincident with V_{FE} for half flaps (See Table 3-2 EXAMPLE RV-TYPE PATTERN SPEEDS). Regardless of pattern entry technique (straight-in approach excepted), pilots should endeavor to fly a consistent pattern from a point abeam touchdown to the landing flare.

Pattern entry should be adjusted to arrive over the desired point abeam touchdown at desired speed and configuration.

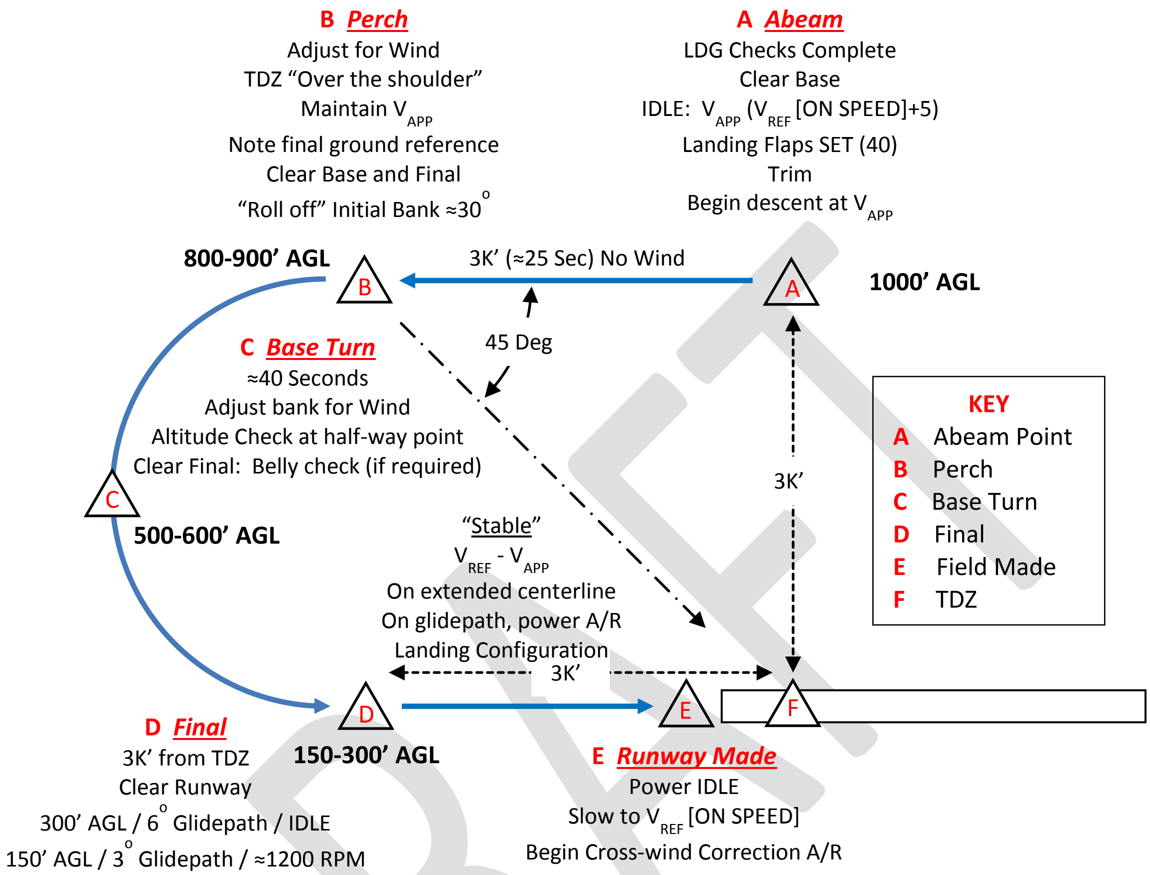


Figure 3-3: Visual Landing Pattern

Mid-field Downwind Entry. Although there is no regulatory requirement to enter the traffic pattern at non-towered airports in a specific manner, the conventional mid-field downwind entry is a standard accepted technique for doing so. A mid-field downwind entry technique for RV-types is depicted in Figure 3-4. When pointed at the runway on a 45° angle and approximately 1-2 NM from the center of the runway at pattern altitude, adjust power (IDLE to 1500 RPM, MP as required) to slow to 110-120 MPH/95-105 KTS (RV-9: 100-110 MPH/87-95 KTS) CAS. After slowing, use power as required to maintain pattern altitude (approximately 1800 RPM, manifold pressure as required). When to begin decelerating to V_{APP} and deploying half flaps is a matter of technique. One technique is to reduce power to IDLE-1200 RPM turning downwind and deploying half-flaps as the airplane slows through appropriate V_{FE}. The objective is to be at V_{APP} abeam the touchdown point. Crab for crosswind as required on downwind, maintaining desired runway spacing. For airplanes equipped with fixed pitch propellers, placing the fiberglass wingtip over the runway will provide a good visual cue for proper downwind spacing from the runway. For airplanes equipped with constant speed propellers, placing the runway in the outer 1/3d aileron span will provide proper offset. A power setting of approximately 1500 RPM (MP as required) and pitch of 6-7° will maintain V_{APP} in level flight configured with half-flaps.

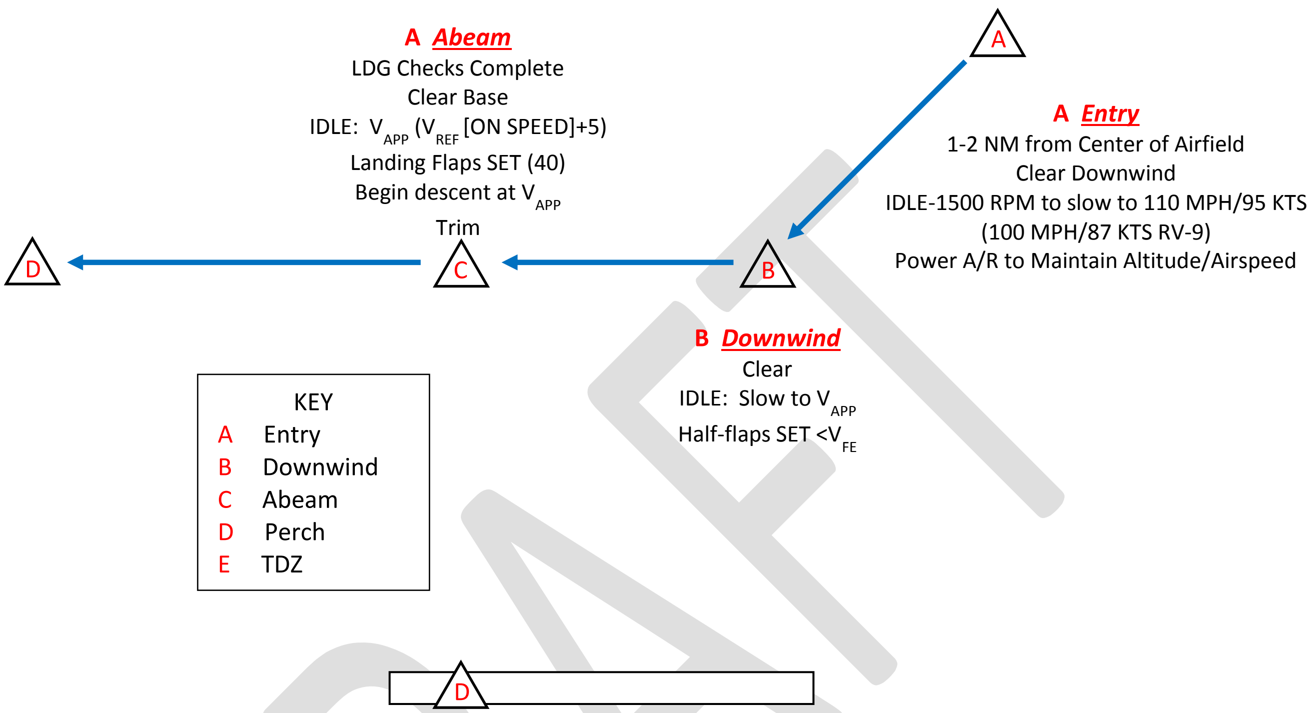


Figure 3-4: Midfield Downwind Pattern Entry

Overhead Pattern Entry. An overhead approach (upwind pattern entry) may be used to allow the pilot to determine runway conditions on the initial leg as well as safely sequencing into the traffic flow. It also allows the airplane to carry significant airspeed to the break, which can be effectively dissipated in the pitch-out to downwind. The combination of speed and altitude on the initial leg will ensure the airplane has sufficient energy to complete a successful engine-out pattern, if power loss occurs over or past the planned touchdown zone (TDZ). The overhead pattern entry is depicted in Figure 3-5. Power setting for the break may be as low as idle RPM. Half flaps (Flaps 20 RV-4/6/7/8 or Flaps 15 RV-9) should be deployed as the airplane decelerates through V_{FE} for half-flaps (RV-4/6/7/8: 110 MPH/95 KTS or 100 MPH/87 KTS for RV-9). Due to low speeds and excellent turn performance, a high G break is not required. A 20-30° banked pitch out is all that is generally required to establish normal downwind offset. The angle of bank may very during the break turn as a result of crosswind (e.g., it may be necessary to "square off" the break for over-shooting winds). The airplane should decelerate throughout the break turn and on downwind to V_{APP} no later than the abeam point. Crab as required on downwind to maintain desired spacing from the runway. For airplanes equipped with fixed pitch propellers, placing the fiberglass wingtip over the runway will provide a good visual cue for proper downwind spacing from the runway. For airplanes equipped with constant speed propellers, placing the runway in the outer 1/3d aileron span will provide proper offset. A power setting of approximately 1500 RPM (MP as required) and pitch of 6-7° will maintain V_{APP} in level flight configured with half-flaps.

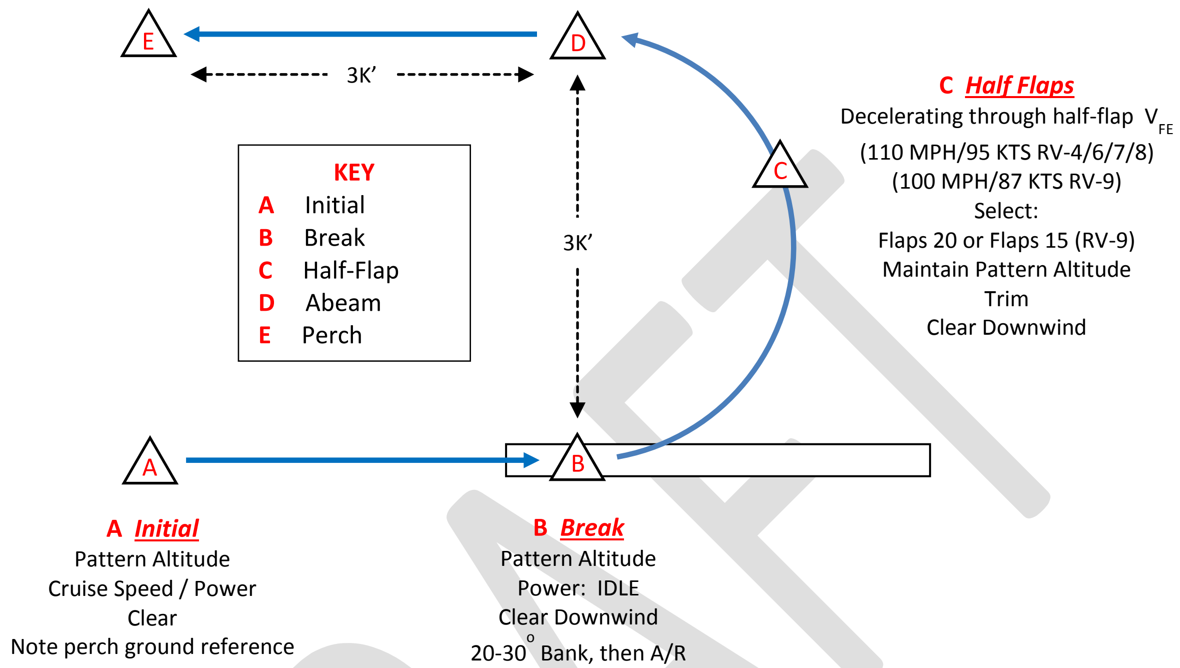


Figure 3-5: Overhead Pattern Entry via Initial (Upwind) Leg

Computing Vapp. If the airplane is not equipped with a calibrated AOA system, one technique is to fly the base turn and final approach (until landing is assured) at V_{APP} (approach speed). V_{APP} is equal to V_{REF} + 5 MPH/KTS. Van's Aircraft recommends a V_{REF} of 1.3-1.4 V_{S1}. V_{REF} is also referred to as "ON SPEED." Based on Van's published prototype data, recommended V_{APP} for RV-4/6 types is 80 MPH/70 KTS CAS; V_{APP} for RV-7/8 types is 85 MPH/75 KTS CAS; and V_{APP} for RV-9's is 75 MPH/65 KTS CAS. V speeds for specific RV-types operated for training should be validated by flight test. Table 3-2 contains pattern airspeeds derived from Van's published operating limits and prototype data expressed as calibrated airspeed. Note that V_{APP} is roughly proximate with minimum sink glide speed for fixed pitch airplanes (or airplanes with controllable propellers adjusted for low RPM). The excellent glide and low drag characteristics of RV-types make proper pattern planning and conduct important to achieve consistently stable final approaches.

Note

- When executing an overhead pattern at a non-towered civilian airfield, it should be assumed that other aircraft operating in the pattern are not familiar with the technique. When making a position report, consider calling “upwind” in lieu of “initial” when entering the pattern and, in general, give way to traffic currently operating in the pattern.
- It may be desirable to increase initial altitude by 500 feet to assist with deconfliction during pattern entry. Descend to pattern altitude on short initial using IDLE power (i.e., just prior to the break). Do not exceed V_{NO}.
- If necessary, “carry straight through” on initial and re-enter the traffic pattern via a box pattern back to initial or other traffic leg, as directed or desired.
- Regardless of visual pattern technique, give way to less maneuverable airplanes and be considerate of aircraft with limited cockpit visibility. Be alert for aircraft operating without radio. Break out of the visual pattern and re-enter, as required to ensure deconfliction.

Table 3-2: Example RV-type Pattern Speeds (CAS)

RV Type	$V_{FE\ (Flap\ 20)}$ (Half Flap)	$V_{FE\ (Flap\ 40)}$ (Full Flap)	V_{REF} [1] MPH	V_{APP} MPH	V_{REF} [1] KTS	V_{APP} KTS	$V_{S1\ (Flap\ 40)}$ [2] MPH	$V_{S1\ (Flap\ 40)}$ [2] KTS
-4	110 MPH 95 KTS	100 MPH 87 KTS	70-76	75-81	61-66	66-71	54	47
-6			69-74	74-79	60-64	65-69	53	46
-6A			72-77	77-82	62-67	67-72	55	48
-7/A			75-81	80-86	65-70	70-75	58	50
-8/A			75-81	80-86	65-70	70-75	58	50
	$V_{FE\ (Flap\ 15)}$	$V_{FE\ (Flap\ 32)}$					$V_{S\ Flap\ 32}$ [2] MPH	$V_{S\ Flap\ 32}$ [2] KTS
-9	100 MPH 87 KTS	90 MPH 78 KTS	65-70	70-75	56-60	61-65	50	43

[1] $V_{REF} = V_s$ x 1.3-1.4 (Van’s recommended, differs from standard 1.3 V_S). Also referred to as “ON SPEED”
[2] V_S = Van’s published data (calibrated airspeed) for prototypes operated at maximum design gross weight for landing. Actual stall IAS will vary from airplane to airplane and as a function of gross weight, pitot/static system configuration and airspeed indicator accuracy, and should be determined by flight test.

> **Note**
>
> - If flight test data is not available, for no-wind planning purposes, a 10:1 glide ratio can be utilized for calculations for a typical fixed-pitch equipped RV-type. Airplanes equipped with a constant speed propeller will have a steeper glide ratio with the propeller adjusted for high RPM, and initial estimates should be based on 8:1 until flight test data is available or experience is gained.
> - RV-types have a flat "drag curve" and relatively consistent glide performance over a wide speed band. This "maximum lift band" occurs between approximately 90-130 MPH/80-115 KTS. L/D_{MAX} is in the middle of this band and pattern operations are conducted on the left (slow) side of the band with ON SPEED proximate to the bottom of the band. Proper trim and precise airspeed control on base and final will greatly assist in properly controlling energy during pattern operations and landing.

AOA Use. If the airplane is equipped with a calibrated AOA system, it is recommended that AOA be used as the primary reference during pattern and landing with V_{APP} or V_{REF} (IAS, as appropriate) serving as a back-up/cross-check. For normal pattern operations, ON SPEED AOA should be flown until landing is assured.

Abeam the Touchdown Point. Landing checks should be complete prior to reaching the point abeam touchdown (low key). Passing abeam the touchdown point, reduce power to IDLE. Select landing flaps (Full flaps recommended), reduce pitch 3-6^{o} (begin descent) and trim to maintain V_{APP}. Maintain downwind ground track as the airplane approaches the perch. The time available between the abeam and perch points should be used to visualize the final roll-out point (3000 feet from TDZ) on the extended runway centerline and picking out an appropriate ground reference.

Rolling off the Perch. Under no or light wind conditions, the airplane should descend approximately 200 feet from the abeam point (approximately 20-25" and 3000' of ground travel required) enroute to the perch. Visually scan the extended runway centerline for straight-in traffic and then scan for traffic flying a wide base. As the desired touchdown point is over the pilot's shoulder (approximately 45^{o} aft of the wing line), roll off the perch and begin the base turn. Depending on the wind component down the runway, it may be necessary to roll off the perch early. More wind = earlier roll off. If overshooting winds are present (i.e., the cross-wind will tend to carry the airplane through final), the perch should be adjusted further away from the runway. If undershooting winds are present, the perch should be adjusted closer to the runway. See Figure 3-6.

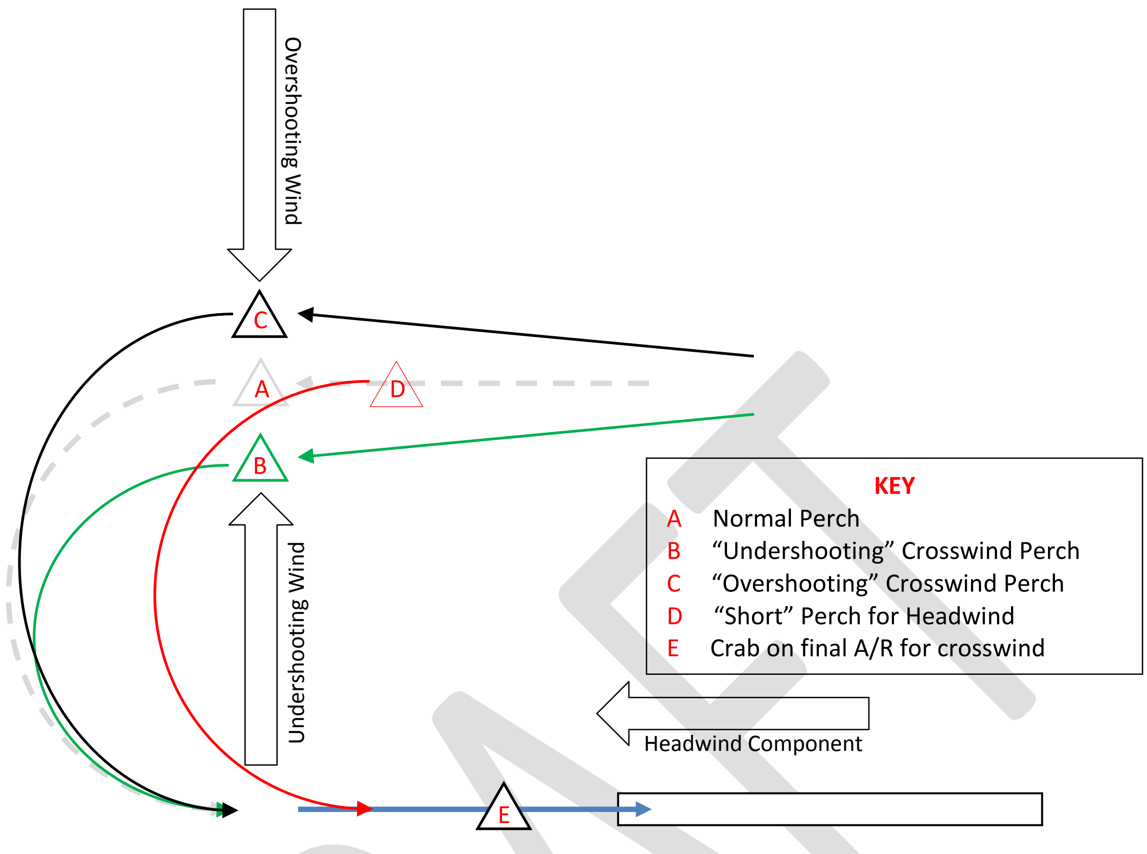


Figure 3-6: Adjusting "Perch" for Winds

Flying the Base Turn. The base turn for the standard visual pattern depicted in Figure 3-3 is a coordinated, descending 180° turn flown at V_{APP} or ON SPEED AOA. The objective of a properly flown base turn is to arrive at the desired final roll-out point at the appropriate airspeed/AOA and altitude. If cross-wind is present (over-shooting or under-shooting) it may be necessary to adjust bank during the base turn to intercept the extended runway centerline for roll-out. Visualizing the final roll-out point prior to rolling off the perch (beginning the base turn) greatly assists with properly controlling bank angle during the base turn and flying the proper ground track. Continue to scan for traffic during the base turn. RV-types possess excellent cockpit visibility, regardless of type, so that visual scan without adjusting pattern track is generally practical. If necessary, roll-out momentarily to conduct a "belly check" for traffic entering via straight-in or extended final/base. A normal base turn requires 20-30° of bank if the perch point was properly adjusted for wind conditions.

Warning

If winds, an improperly selected perch, distraction, etc. result in over-shooting final, the pilot must be cautious increasing bank to maintain ground track. If necessary, bank may be increased, but the AOA must be reduced (ease back pressure/lower nose) to compensate, especially at the low end of the approach speed band. Low altitude skidding turns (inside rudder/outside aileron) should be avoided as exceeding critical angle of attack in that flight condition will cause an immediate departure from controlled flight (snap roll underneath) that may be non-recoverable below pattern altitude. With proper AOA/airspeed control, an inside slip (aileron in the direction of the turn and rudder opposite) may be safely used during the base turn to increase descent rate, if desired. It is safer to accept the over-shoot and if not in a position to establish a stabilized final approach, go around.

Stabilized Final. To ensure sufficient energy is available for landing if the engine fails when flying a visual pattern and traffic allows, the base turn should be flown to roll-out at 300' AGL, 3000' from the planned touchdown point (6^o final glideslope) at V_{APP} under light or no-wind conditions. A standard 3^o final approach may be flown, but will require the addition of power to achieve a stabilized final approach condition. A final approach flown at a descent angle slightly greater than idle glide angle (appropriate for propeller pitch) provides extra energy, generally allowing a stabilized power-off final to be flown, when desired. For short-field (maximum performance) operations at speeds below V_{APP}, a power-on approach will be required. Increased power is required to maintain speed as speed decreases below L/D_{MAX}/ON SPEED. If an IDLE base turn is flown to a standard 3^o final, the pilot should anticipate the need to add power (approximately 1200 RPM) when rolling out on final to achieve stable parameters. Establishing crab, as required, to compensate for cross-wind will allow the pilot to judge the magnitude of the cross wind by precisely maintaining extended runway centerline. Example STABILZED APPROACH CRITERA is shown in Figure 3-9. Slow from V_{APP} to V_{REF} (IDLE power if flying a power-on approach) when the field is made.

Touchdown Zone Considerations. The normal touchdown point for a visual approach is in the first 500' of usable surface (or usable 1/3, whichever is less), obstacles permitting. When assessing the runway prior to landing, the pilot should visually estimate a "touchdown no later than" point on the runway. This point should provide a minimum of 1000' of roll-out distance for a normal landing (full flap [40^o], touchdown at $V_{S\,+}$ 5 to 10 and normal braking). This distance may be reduced to approximately 800' of dry, uncontaminated surface if a short-field landing is accomplished (full flap [40^o], touchdown at V_S to V_S +5 and smooth firm braking applied as soon as practical). Distances should be increased if the runway surface is contaminated (See Table 3-5 CONTAMINATED RUNWAY EFFECT ON TAKEOFF AND LANDING PERFORMANCE for applicable correction factors). If touchdown has not occurred prior to this point during the round-out/flare at appropriate speed, then a go-around should be executed.

Go Around/Low Approach to Closed Pattern. The closed traffic pattern is depicted in Figure 3-7. For a typical Lycoming powered RV-type, a closed pattern and full-stop landing requires approximately ½ (.5) to ¾ (.75) gallons of fuel. To go-around from a low-approach, slowly and smoothly advance power. One technique is to smoothly advance power to approximately 80% using a "2 count", trim as required and select half-flaps (Flaps 20 or 15 for RV-9) while stopping descent. Then, after half flaps are set, smoothly advance power using a "2 count" to WOT and continue to trim as the airplane accelerates. Begin a shallow climb while maintaining ground track over the runway. ***Do not jam the throttle forward when executing go-around at low altitude and low airspeed. Engine power effects are substantial at low airspeed/high AOA if power is applied rapidly.*** Depending on CG, trim forces can be significant as the airplane accelerates, especially for tandem types. The pilot must be prepared for this and ensure desired pitch is maintained during go around. Prior to accelerating through 110 MPH/95 KTS (100 MPH/87 KTS for RV-9), retract flaps. Continue to adjust trim, as required and allow the airplane to accelerate to 120-140 MPH/105-125 KTS (or faster). Execute a smooth, straight 2 G pull to establish approximately 15-25^{o} of pitch. Unload (ease the elevator forward) and stabilize climb angle momentarily. Rate of climb depends on propeller and engine fitted and gross weight, but will typically be approximately 1500-2000 FPM or greater during the initial pull-up. After stabilizing climb angle momentarily, roll toward downwind. Since this technique is based on "trading airspeed for altitude," it is necessary to unload the airplane during climb to downwind by reducing pitch throughout the "closed pull" to prevent decreasing the airspeed excessively. Depending on bank angle used, it may be necessary to "square off the turn" (i.e., fly a short cross-wind) to achieve desired downwind offset. Adjust pitch at power to roll-out at pattern altitude on a normal downwind track. Do not allow the airplane to accelerate during level-off to downwind. Roll-out should occur at or below V_{FE} for half-flaps (Flaps 20 or Flaps 15 RV-9). This will require a power reduction during the level off to IDLE-1200 RPM to maintain at or below 110 MPH/95 KTS in RV-4/6/7/8 types and at or below 100 MPH/87 KTS in RV-9s. Establish downwind to place the fiberglass wingtip (fixed pitch aircraft) or in the outer 1/3 aileron span (constant speed aircraft) over the runway. Complete landing checks and slow to V_{APP} enroute to the abeam point. Trim as required.

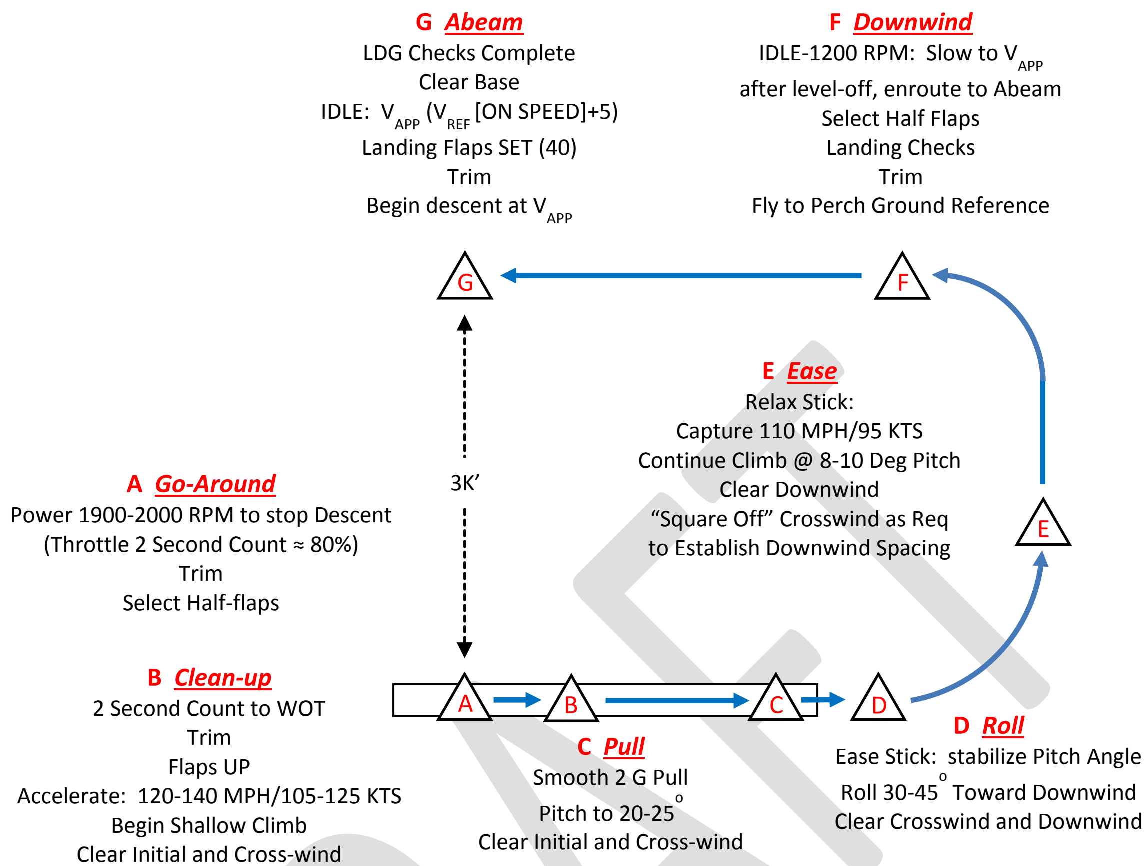


Figure 3-7: "Closed" Traffic

Breaking Out of the Traffic Pattern. RV-types possess excellent maneuverability, climb capability and cockpit visibility. For these reasons, a pattern break-out is practical if a traffic conflict exists in the visual pattern. To break-out of the traffic pattern, increase power and clean up (if flaps have been deployed) as airspeed begins to increase above V_{APP}. As airspeed increases, begin a climb at normal climb attitude (8-10^{o}) to an altitude 500-1000 feet above pattern altitude. Maintain minimum pattern maneuvering speed or greater during break-out. Use caution not to exceed appropriate V_{FE} with flaps deployed. Proceed in accordance with ATC instructions (if applicable) or re-enter via initial, mid-field downwind or other pattern leg, as appropriate.

Rectangular Landing Pattern. A basic rectangular visual traffic pattern is depicted in 3-8. The nominal 2 to 2 ½ NM ground track of this pattern is slightly different than the visual pattern described previously. The downwind offset is slightly greater, and final landing configuration (full flaps) is not established until base leg. The visual cue for establishing downwind spacing from the runway for fixed pitch airplanes is to place the runway just outside of the wingtip when established at 1000 foot AGL. For airplanes with constant speed propellers, the runway should be under the fiberglass wingtip at the same altitude. If a power loss occurs during pattern operations, it may be necessary to adjust ground track to ensure sufficient energy is available to reach the landing surface.

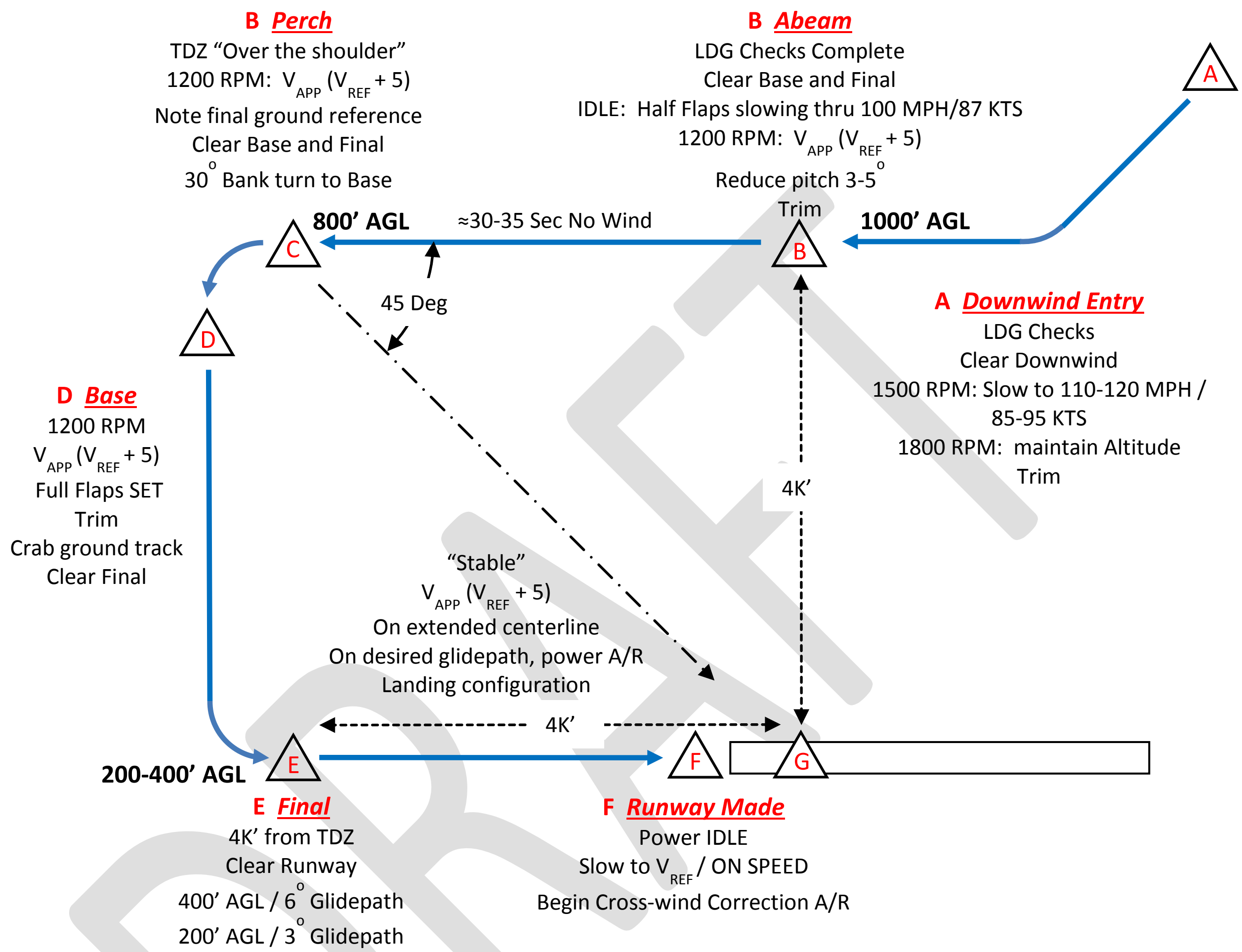


Figure 3-8: Rectangular Traffic Pattern

Note

If time, traffic and fuel permit, a planned low-approach followed by a closed, full-stop landing can allow the pilot to "practice" the pattern under ambient conditions and assess wind effects prior to attempting a full-stop landing. This can reduce risk when operating into a strange field or anytime conditions are questionable.

LANDING

1. Fuel – CHECK
2. Flaps – AS DESIRED
3. Mixture – AS REQUIRED
4. Propeller—AS REQUIRED
5. Brakes – CHECK

A power off or partial power final approach is recommended for normal landings. Fixed pitch propellers produce limited drag at low power settings, and the airplanes so equipped exhibit outstanding glide characteristics. This glide performance must be anticipated during pattern and landing operations to avoid a high final, excessive float and/or long touchdown. A constant speed propeller offers more drag when set to high RPM and manifold pressure is reduced. Constant speed equipped RV-types will have a lower glide ratio than a fixed pitch airplane. For normal landings, a minimum speed of V_{REF} (1.3-1.4 V_{S1}/ON SPEED AOA) should be maintained until landing is assured. If winds are gusting, add half the gust factor not to exceed 5 MPH / KTS (e.g., winds 15 gust 25, add 10/2 or 5) or fly V_{APP} (V_{REF} + 5 MPH/KTS). Approach at V_{REF}/ON SPEED to V_{APP} provides positive control, acceptable glide path and good forward visibility. V_{REF} provides sufficient speed margin for executing a gentle flare to reduce speed for touchdown. A stabilized final approach should be established. When flying a visual approach from a normal pattern, plan to roll-out on final at 300' AGL 3000' from the planned touchdown point. Under no-wind conditions, this will provide a 6^{o} final descent angle. This will allow a typical RV-type to glide to the planned TDZ in the event of power loss. If the approach is flown at V_{APP}, speed should be reduced (AOA adjusted) on short final when landing is assured to the bottom of the V_{REF} range. This is proximate to V_s + 10-15 MPH/KTS during the transition to flare. Regardless of landing gear configuration, all landings require that the airplane be flown on to the ground. Do not execute a high flare. Allow the airplane to decelerate to touchdown with the main gear just above the runway surface. For tail-wheel equipped airplanes, a full stall three point landing is only possible if touchdown is made tail wheel first due to the length and geometry of the main gear legs. Wheel landings with aft-swept spring gear (RV-3/4/6/7/9) require a gentle touchdown to avoid rebounding into the air. Tail-low wheel landings may be flown in any tail wheel RV-type. Nose wheel equipped airplanes should be landed on the main gear and the nose should be held up as long as practical after touchdown. The low drag of the fixed pitch propellers may result in a tendency to float during the flare proportional to airspeed carried through final approach. RV-type elevators remain highly effective throughout the landing phase. If a power off approach has been flown, the pilot should confirm the throttle is still in IDLE prior to flare and landing. Throttle creep may result in carrying unintended power into the flare which will lengthen the landing roll.

Note

- ***A stabilized approach is the key to achieving consistently good landings.*** Stable approach criteria should be established and agreed upon by instructors and upgrading pilots. If criteria aren't met, then a go-around may be appropriate. The baseline criteria are on course, on glide path (power as required to maintain), on speed (V_{APP}/V_{REF} or ON SPEED AOA, as appropriate), and landing configuration (flaps) established. See Figure 3-9: EXAMPLE STABILIZED APPROACH CRITERIA.
- ***Van's Aircraft recommends a final approach speed of 1.3 to 1.4 V_S (V_{REF}).*** V_{REF} is also referred to as ON SPEED.
- If equipped (and properly tested/calibrated), AOA should be the primary reference for base turn/final and IAS (e.g., V_{REF}) should serve as a back-up.

Common errors. One of the most common errors during landing is executing the flare too high. RV-types have sufficient elevator authority to fully-stall, regardless of airspeed. If a full stall occurs, the nose will drop quickly and a left roll will, likely, occur with flaps down. During uncoordinated flight, if a stall occurs, the airplane will roll in which the direction of yaw. The short, low aspect ratio wings are not very responsive to ground effect. The airplane is best *flown* on to the ground at a speed just above stall. Stabilize the airplane immediately above the ground, maintain attitude and shift visual focus to the far end of the runway or beyond as the airplane decelerates and it will settle on to the ground. For tail wheel equipped airplanes, it is acceptable to touchdown tail wheel first. At normal landing speeds, tail wheel equipped airplanes are still flying when touching down in a three-point attitude; transition to full aft stick as deceleration permits. If immediate aft stick is applied at normal touchdown speeds, the airplane will balloon back into the air. Full aft stick will provide positive control via the steerable tail wheel and help avoid any nose-over tendencies. Brakes should be applied cautiously to avoid over-controlling or nose-over. The technique for landing a nose wheel equipped airplane isn't much different—every effort should be made to touchdown main gear first and keep the nose up as long as practical after touchdown. Another common error is to carry excess airspeed during landing approach. A 10% increase in touchdown speed will cause a 21% increase in landing roll distance. A "touchdown no later than point" should have been determined prior landing, and if excess speed or corrections in the flare will carry the airplane past this point, a go-around may be safer than attempting to continue the landing. A 5 knot tailwind component will cause a 10% increase in touchdown speed.

Warning

Manual flaps may fail suddenly to the up position any time after deployment if the flap handle is not properly seated in the detent. In the event of failure, a loud bang will be noted along with increased sink rate. Stall speed will be increased instantaneously. If flaps suddenly fail to the up position, it is important to reduce pitch attitude to avoid unintentionally stalling, and to increase power smoothly to accelerate to flaps up approach speed. If flaps fail during the round-out and flare, this may mean allowing the aircraft to touchdown at a high sink rate and subsequent recovery from the bounce vs. attempting a high-power, high angle of attack recovery in the event of an aborted landing. In the event a stall is allowed to occur, the nose will drop rapidly, and may cause an unrecoverable excessive nose-low attitude.

To use the brakes, the pilot should slide the toes or feet up from the rudder pedals to the brake pedals. If rudder pressure is being held at the time braking action is needed, that pressure should not be released as the feet or toes are being slid up to the brake pedals because control may be lost before brakes can be applied. During the ground roll, the airplane's direction of movement may be changed by carefully applying pressure on one brake or uneven pressures on each brake in the desired direction. If practical and available runway permits, the speed of the airplane should be allowed to dissipate in a normal manner by friction and drag of the wheels on the ground and use of brakes should be minimized. If flying a tail wheel equipped airplane, use caution applying heavy braking. If the stick is full aft and braking starts to lift the tail, ease off of the brakes until further deceleration has occurred.

Caution

The pilot should be alert for changing cross-wind conditions throughout the landing roll, especially when operating off a landing surface with lateral obstacles that could cause conditions to vary along the length of the landing surface.

Wheel Landing (Tail Wheel Equipped Airplanes). Sufficient prop/ground clearance exists for the conduct of wheel landings. Wheel landings can be accomplished from a normal, stabilized approach by shifting the touchdown aim point approximately 1000' further down the runway. After shifting the aim point, a good technique is to establish a normal flight attitude with the gear nominally 1 foot or so above the landing surface. Reduce power and continue to fly the airplane with primary attention on the departure end of the runway. With power reduced, the main wheels will settle on to the runway and forward stick may be applied after the main wheels begin rolling to maintain a tail high attitude during deceleration. Do not relax stick pressure prior to touchdown. The sensitive rebound characteristics of the Whitman style landing gear (RV-3/4/6/7/9) demand precise touchdown control and early application of forward stick will likely cause the airplane to bounce back into the air. Transition to full aft stick as soon as the tail settles to establish positive tail wheel steering. Ailerons should be utilized throughout the landing to assist with correcting for crosswind induced drift.

Tail-Low Wheel Landing (Tail Wheel Equipped Airplanes). The tail-low wheel landing is a hybrid combination of both classic conventional gear landing techniques. To perform a tail-low wheel landing, a normal three-point approach should be flown. After one or both of the mains have touched, relax back pressure. Fly the tail on to the ground as the airplane decelerates. The airplane is not stalled, so do not apply abrupt aft stick during deceleration. Once the tail wheel is on the ground, full aft stick may be applied.

If attempting a tail-low wheel landing and a three-point touchdown unintentionally occurs, continue with a normal three-point landing. Tail-low wheel landings are effective in cross-wind conditions.

Caution (Tail Wheel Equipped RV-types)

- Touchdown must occur with the longitudinal axis parallel to the direction the airplane is moving along the runway. Failure to accomplish this may impose severe side-loads on the landing gear and may cause a ground loop to occur.
- Ground looping can occur at low speeds during landing roll-out. It is important to maintain proper directional control until reaching taxi speed. A loss of directional control is more likely during the deceleration phase (second half or later portion) of the landing roll out.
- ***The airplane should never be forced onto the ground by excessive forward pressure. A transition to a three-point landing or go-around is appropriate in the event of a botched wheel landing attempt.***

Example Stabilized Approach Criteria

-**Heading.** Tracking the extended runway centerline. This does not mean that final cross-wind correction for touchdown has been applied (**Alignment**), but appropriate crab is applied to track the extended centerline.

-**Glide path.** As desired. A "standard" glide path is nominally 3^o, however a glide path equal to the tested idle power glide performance will allow the conduct of a power-off approach (e.g., 6^o final). Glide performance will vary from airplane to airplane for various RV-types. The type of propeller fitted will affect glide performance.

-**Sink rate.** Stabilized commensurate with glide path. A 3^o glide path requires a vertical descent rate (VVI in FPM) = 5 x ground speed. A 6^o glide path requires a vertical descent rate (VVI in FPM) = 10 x ground speed. An estimated "target" VVI should be computed for approach.

-**Power.** As required to maintain desired glide path at V_{APP} or V_{REF}.

-**Airspeed.** V_{APP} or V_{REF} (ON SPEED).

-**Configuration.** The airplane is in landing configuration (flaps set), trimmed.

Figure 3-9: Example Stabilized Approach Criteria

Short-Field Approach and Landing

The short-field approach is a maximum performance maneuver. A transition from normal approach speed should be made so that the final portion of the approach is flown power-on, utilizing a 3-6^o descent angle. On short final (approximately 1000 feet to touchdown), speed is reduced to V_{S1} + 10 MPH/KTS. Allowance should be made for gusty wind conditions. Add half the reported gust be added to approach speed, not to exceed 5 KTS/MPH total. If equipped with AOA, transition from ON SPEED to slightly slow on short final. Touchdown will occur almost immediately after power is reduced. Flaps should be retracted as soon as practical after touchdown and maximum braking should be cautiously applied. For tail wheel types, a three-point landing should be flown.

Caution

- ***When operating at speeds below L/D_{MAX} (approximately 105-110 MPH/91-96 KTS), slower speed (increased AOA) requires increased power to maintain a constant altitude or glide path angle.***
- Operating at low approach speed reduces the stall margin and requires proper throttle control to avoid a hard landing. If a loss of power occurs on short final, it may not be possible to reach the

Cross-wind Approach and Landing

Maximum Demonstrated Cross-wind. There is no maximum demonstrated cross wind limit for RV-types. A skilled pilot may be able to accept 20 KTS of cross wind component or more. A more conservative rule-of-thumb is to use 20-25% of V_{S0} (e.g., V_{S0} = 55 MPH / KTS, 11-13 MPH / KTS maximum direct crosswind). FAR 23 certification standards require a *minimum* demonstrated cross-wind component of 20% V_{S0}. Quartering tailwinds should be avoided to the extent practical. Consideration when selecting a landing runway should be given to steady state winds vs. gusting winds. A steady wind is easier to handle than a variable wind. Lateral obstacles that could cause cross wind to vary should be noted prior to landing. Pilots should manage risk by increasing cross-wind "limits" as experience is gained. For cross-winds in excess of 10-15 KTS, consider the use of partial flaps for landing. Runway contamination (snow, ice, standing water or wet grass) reduces surface friction and will reduce cross-wind capability. Anticipate the degradation of aerodynamic control as speed decreases after landing.

Base Turn Adjustment. Any turn to final should be adjusted for over- or under-shooting winds to ensure roll-out on extended centerline. In the event of an over-shoot to final, maintain a minimum of V_{REF}/ON SPEED and coordinated flight. It is safer to accept an over-shoot than to incorrectly apply flight controls to attempt correction that could result in unintentional stall. Initial line-up should be in a crab to assess the magnitude of the cross-wind. The pilot should anticipate that conditions will change as the runway is approached. Generally, cross-winds will diminish close to the surface. As with any landing, if sufficient fuel is available and conditions permit, a planned low-approach followed by a closed pattern allows the pilot to assess conditions and mitigate risk during the full-stop attempt.

Crosswind Techniques. Two primary techniques may be used for cross-wind landing: a wing-low forward slip or crab and kick.

A forward slip to landing requires the pilot to align the fuselage (longitudinal axis) with rudder and apply aileron in the direction of the cross-wind to establish a slip. The pilot should anticipate a slight increase in descent rate and angle when applying cross-controls. Depending on magnitude, this may require a simultaneous pitch and/or power adjustment to maintain desired approach angle. The slip is maintained throughout the flare and landing, although it is generally necessary to modulate control input to accommodate changing conditions as the ground is approached. Touchdown of the upwind main gear should occur first, and the downwind gear should be flown on to the runway.

The crab and kick method delays the application of cross-wind controls until just prior to touchdown. Although fuselage alignment is accommodated with the rudder kick, it is still necessary to apply aileron in the direction from which the cross-wind is blowing to prevent the upwind wing from rising. This requirement for aileron should be anticipated by the pilot.

After landing, cross-wind controls are maintained as the airplane decelerates. It is generally necessary to increase the inputs as the aerodynamic controls become less effective. In tail-wheel types, some rudder authority is lost as the tail is lowered: Transition to tail-wheel or differential brake steering, as required. ***Maintain positive control until the airplane is stopped.*** The final portion of the landing roll (deceleration phase) presents the greatest hazard when conducting cross-wind landings.

Tail Wheel Considerations. As the aircraft transitions to a tail-low attitude during landing roll out, rudder effectiveness is reduced. Use of fully or nearly fully deflected flight controls during the flare/touchdown phase may mean insufficient control authority remains when transitioning to tail wheel steering. Loss of directional control is most likely to occur during the transition to full tail wheel steering and during the second half (deceleration phase) of the landing roll.

Cross wind landings are practical using either a two- or three-point touchdown technique, or a combination of the two (tail low wheel landing). If the crab method of drift correction has been used throughout the final approach and round out, the crab must be removed before touchdown by applying rudder to align the longitudinal axis (fuselage) with its direction of movement. This requires timely, accurate action. Failure to accomplish this results in severe side loads and ground looping tendencies.

The wing-low method is recommended with the transition from crab to slip on final approach. The crosswind correction (aileron into the wind and opposite rudder) should be maintained and adjusted as necessary throughout the round out, with touch down on the upwind main wheel. During gusty or high wind conditions, prompt adjustments must be made in crosswind correction to assure that the airplane does not drift as it touches down. If control becomes marginal or drift is detected, it is usually safer to go-around than to attempt the touchdown.

Consideration should be given to selecting an alternate runway if directional control is marginal during approach or an attempted landing.

As forward speed decreases after initial contact, the weight of the airplane will cause the downwind main wheel will gradually settle onto the runway. Special attention must be given to maintaining directional control by use of rudder and tail wheel steering during the landing roll-out while keeping the upwind wing from rising by use of aileron. Rudder effectiveness is decreased in a three-point attitude. If rudder authority is insufficient to maintain runway alignment during deceleration, it may be necessary to use differential braking. The airplane will tend to weathervane into the wind as it decelerates with aerodynamic controls becoming less effective as speed decreases. Positive control must be maintained until the aircraft comes to a complete stop.

High Gross Weight Landing

When landing at high gross weight, fly an ON SPEED/V_{REF} approach. Maintain ON SPEED/V_{REF} until landing is assured. Apply pitch inputs to establish normal landing attitude (8-10^{o} pitch) and airspeed desired using power to control vertical velocity (sink rate).

If the high gross weight is also accompanied by an aft CG location, the pilot should anticipate reduced stick forces during landing. The stick force gradient (pounds of pull per G) and stick position required for establishing AOA will change commensurate with CG location. Aft CG will cause lighter stick forces throughout the envelope. In tandem RV-types with a CG well aft, the pilot should apply whatever longitudinal control is required to maintain the desired 8-10^{o} landing pitch attitude during flare and landing. This may mean relaxing back pressure (or even adjusting the stick forward) as the airplane settles into ground effect.

Caution

RV-types equipped with Whitman-style landing gear are susceptible to firewall and/or engine mount damage in the event of a hard landing. If a hard landing is encountered or suspected, a thorough inspection should be conducted to check for damage.

GO-AROUND

1. Mixture – AS REQUIRED
2. Propeller—AS REQUIRED
3. Power – ADVANCE SMOOTHLY

4. Flaps – RETRACT (airspeed increasing)
5. Trim – ADJUST

Make the decision to go around as early as practical. Power should be applied smoothly and sink rate should be arrested as airspeed allows. Do not attempt to adjust pitch or stop rate-of-descent until adequate airspeed is available. ***Abrupt application of power at high angle-of-attack and low airspeed will cause considerable yaw to the left.*** Apply right rudder in conjunction with advancing the throttle. Sufficient power is available to arrest sink rate with full flaps deployed. Be prepared for touchdown to occur during a go-around. As airspeed increases, establish a normal takeoff attitude, retract flaps to the ½ (20^o) position and make an initial trim adjustment. When a positive rate of climb has been established, retract flaps fully prior to passing V_{FE} and adjust trim as necessary. Maintain pitch as desired to control airspeed ($8\text{-}10^o$ pitch for normal climb).

Caution

If the manual flaps are retracted abruptly while airborne, it is possible for a sink rate to develop until power, AOA and airspeed can be adjusted.

AFTER LANDING

1. Flaps – UP
2. Boost Pump – OFF
3. Mixture – LEAN AGRESSIVELY FOR GROUND OPERATION
4. Lights – AS REQUIRED

Flaps may be retracted any time after touchdown to assist with transferring weight to the main gear, if desired. Do not compromise directional control retracting flaps during landing roll out. If wheel landing (or tail-low wheel landing) a tailwheel type and the tail is still up in the air, abrupt flap retraction (e.g., manual flaps) may cause the tail to drop quickly to the runway surface. If this occurs, smoothly apply aft stick, as required, to transition to tailwheel steering.

SHUT DOWN

1. Avionics – OFF
2. Lights – OFF
3. Lead Scavenging Run-up – AS REQUIRED

Lead Scavenging. Prior to engine shut-down, the engine speed should be maintained between 1000 and 1200 RPM until the operating temperatures have stabilized (thermal stabilization). At this time, the engine should be increased to approximately 1800 RPM for 15-20 seconds, then reduced to 1000-1200 RPM and shut-down immediately using the mixture control. ***A lead scavenging run-up is generally not required if the engine is leaned aggressively for ground operations before and after flight.*** As with any ground operation, monitor prop blast effect if a lead scavenging run-up is conducted prior to shut down. Do not conduct a run-up if prop blast will be a hazard to aircraft, personnel, equipment or structures on the ground.

4. Mixture – IDLE CUT-OFF
5. Ignition Source – OFF
6. Electrics – OFF

<u>TAKEOFF AND LANDING AT HIGH ELEVATION AIRPORTS</u>

Normally aspirated engines perform and react to density altitude. For example, a typical Lycoming engine at takeoff from an airport with an indicated altitude of 3000 feet and ambient temperature of 85^{o}F would be operating at a density altitude greater than 5000 feet. The engine would lack 13-15% of its rated power (or more) and may also run rough because of a rich mixture.

When operating from high density altitude airports (3000 feet or greater), a typical Lycoming engine requires leaning on the ground for efficient takeoff performance. Engine roughness may be noted if the engine is operated full rich at or above 5000 feet density altitude and wide open throttle. ***The pilot can compensate for an over-rich mixture by leaning, but cannot compensate for the loss of power as a result of high density altitude.***

> **Caution**
>
> ***When leaning for high density altitude operation, the engine should only be leaned enough to obtain smooth operation, not peak EGT.*** Detonation margin is reduced in Lycoming engines when leaning at power settings above 65%.

Approximate density altitude effects on takeoff performance can be determined by referencing the Koch Chart. Expect approximately 75% power to be available when operating up to a density altitude of 7000-8000 feet. Takeoff should be planned accordingly after setting the mixture control. In addition to decreased performance, higher elevations also result in higher TAS (and thus groundspeed) for takeoff and landing.

Ground Operations. Same as normal operation.

Takeoff. Lean to maximum RPM prior to takeoff when the density altitude is 3000 feet or greater. Limit operation at full throttle on the ground to minimum time.

Climb. Same as normal operation.

Descent/Landing Pattern. Regardless of the field elevation of intended landing, the descent from cruise altitude to traffic pattern altitude should be made with the engine leaned for smooth engine operation. Richen slightly as required to maintain a smooth engine during descent. To use EGT (if equipped) to assist with leaning during descent, note the EGT at the top of descent and advance the mixture (richen) as required to maintain EGT at this value. The exact value is not important, only relative change to the temperature noted at top of descent. Landing at airports at or above 3000 feet density altitude, the mixture should be leaned to maximum RPM during traffic pattern flight and landing to prevent an excessively rich mixture. ***Anticipate higher than normal touchdown and roll-out ground speeds.***

Go-around. Select FULL RICH and then adjust for target EGT or peak RPM.

After Landing. Same as normal operation.

EMERGENCY PROCEDURES

One of the challenges faced by operators of EAB aircraft is development of suitable emergency techniques and procedures. Unless prepared by the builder, no pilot's operating handbook is available (nor is one required under current regulations), and there is a wide variation of equipment, power plants, propellers and system configuration even in aircraft of the same type. In some cases, no or little specific information is available. Additionally, the quantity and quality of test data available will vary widely. The primary consideration is that upgrading pilots and instructors in RV type aircraft should never assume anything, unless they are familiar with the specific aircraft to be operated.

The syllabus contains a list of emergencies that should be discussed/addressed during situational emergency procedures training (SEPT). Unless specific checklist, handbook, and/or flight test data is available, a generic approach may be required to assist upgrading pilots developing necessary emergency techniques and procedures. This section addresses all of the topics listed in the situational emergency procedures training and offers a starting point for developing specific techniques and/or procedures that may be applicable to the RV type operated for training. Emergencies will be addressed in phase-of-flight order: Ground operation, takeoff, in-flight and landing. Generic checklists are provided that may be modified at the discretion of the instructor and/or upgrading pilot and provide a starting point if aircraft specific information is not available. *Not all cases are applicable to all RV-types, and all cases will require critical review and careful consideration by the instructor and/or upgrading pilot to determine whether or not they may be applied to the specific RV-type operated for training, and, if so, what modifications must be made for suitability.* ***In any case, if specific builder's or manufacturer's guidance is available, it should be followed in lieu of any information presented in this guide.***

GENERAL EMERGENCY CONSIDERATIONS

The most important step in any emergency or abnormal situation is to maintain aircraft control. The subsequent actions are to analyze the situation, then decide on an appropriate course of action and execute it while continuing to maintain aircraft control. It is always safer to fly into the ground under control than to lose control under low energy conditions. If a parachute(s) is/are worn, a timely bail-out decision should be made to exit the aircraft above minimum computed bail-out altitude. A bail-out attempted below this altitude will increase risk, and if the airplane is not out-of-control, it is generally safer to transition to a forced landing. Consideration should be given to bailing out as opposed to attempting a forced landing at night or under instrument meteorological conditions. Tail wheel equipped RV-types are inherently unstable in a three-point configuration during ground, takeoff and landing operations. Regardless of gear configuration, the pilot must maintain positive directional control at all times and make adequate allowance for prevailing wind conditions.

PRIORITIZE

Aviate, navigate and communicate—<u>always</u> in that order. Under no circumstances should pilots become rushed under emergency conditions. This may take a great deal of self-control and is best accomplished by focusing on maintaining aircraft control (including proper flying speed/AOA) and concentrating at the task at hand. If equipped, use of an autopilot can assist with maintaining control when accomplishing checklist or other cockpit tasks. Deliberate action, commensurate with time available, will reduce risk and increase the likelihood of successful outcome when dealing with abnormal/emergency conditions. Do not let someone outside of the aircraft in which you are in command assume command of the situation (e.g. ATC, etc). During an emergency situation, it may be necessary to tell ATC "negative, unable" if under positive control and tell them what you your intentions are. If task management limits your ability to accomplish anything other than maintaining aircraft control and dealing with the emergency, then act accordingly and do not attempt to add navigating or communicating to your current task load. Generally, once you develop a plan of action, it is best to stick with it.

SQUAWK EMERGENCY

By setting the transponder to 7700 the "communicating" step has been started with minimal pilot action and distraction from the primary task at hand of maintaining aircraft control, analyzing the situation and taking the appropriate action. If an off airport landing is to be made, and the RV-type is equipped, a remote mounted ELT may be actuated via remote cockpit switch. During training, the instructor should point out to the upgrading pilot that taking these steps will assist with task management during a critical emergency.

LANDING

As a general rule, if landing as a result of emergency or abnormal condition is anticipated, it is best not to pass up a suitable landing surface, when available. There may be exceptions, notably weather considerations and availability of emergency equipment; but proximity and suitability should always be considered carefully. The nature of the emergency will dictate whether "land as soon as practical" or "land as soon as possible" is warranted.

Land as soon as possible. This means landing at the closest suitable landing surface as quickly as circumstances and task loading permit. Few emergencies are so critical that landing must be conducted as soon as possible. Examples include fire or medical emergency. Depending on the severity of the emergency an off airport (emergency or precautionary) landing may be required.

If a generic checklist item recommends landing as soon as possible, use of a prepared landing surface is implied but pilot judgment may dictate an emergency and/or precautionary landing off-field as a more prudent option. Under extreme emergency conditions, if equipped and sufficient altitude is available, consideration should be given to bailing out in lieu of attempting landing.

Land as soon as practical. This means landing should be conducted without undue delay, but not necessarily as quickly as possible.

GROUND OPERATION EMERGENCIES

<u>EMERGENCY GROUND EGRESS</u> (Aircraft Upright)

1. Fuel – OFF
2. Mixture – OFF
3. Ignition – OFF
4. Master Switch/Electrical Equipment – OFF

If circumstances permit, effort should be made to secure the engine and turn the fuel OFF prior to egressing the aircraft during an emergency. Turning the master switch off will cut off power to electrical equipment, and may reduce fire risk. Mixture should be selected to idle cut-off and the ignition source should be selected OFF. Depending on electrical system configuration, it is also desirable to secure the alternator switch (if so equipped).

5. Harness – RELEASE

If a parachute is warn, it is generally quicker to retain the chute during egress. To leave the chute behind, it is necessary to un-do the leg straps and chest strap (which may or may not be equipped with quick disconnects) and "swim out" of the parachute harness. Any headsets should also be "jettisoned" prior to egress. The objective is to be expeditious and avoid any sort of entanglement that could impede egress. Even in an extreme condition, it is still better to "slow down and get there faster."

6. Canopy – OPEN

The canopy should normally be retained throughout the egress sequence until the last step to provide protection. If there is a passenger or second crew member, coordinate egress prior to opening the canopy.

Warning

If there is any indication of fire, ensure both occupants are ready to egress before opening the canopy as the canopy may provide additional protection in the event of fire.

Aircraft flip-overs (regardless of landing gear configuration) during mishaps are not uncommon. Be sure to consider egress options in the event of aircraft flip over, including use of canopy breaker tools, etc. If the aircraft has come to rest inverted, releasing the harness will result in a fall. This should be anticipated and the occupants should attempt to brace to the extent possible to preclude or minimize injury.

NO OIL PRESSURE AFTER START

If minimum oil pressure is not indicated within thirty seconds of start, shut down and investigate.

> **Note**
>
> In cold conditions, oil pressure will be slower to initially rise after start. Specific time lag will vary as a result of lubrication system and monitoring configuration.

INDUCTION FIRE DURING START (Carbureted Engines)

It is necessary to quickly analyze a fire in the induction system during the start sequence to effectively control the situation. If there is any doubt or confusion about the nature of the fire, or the ability to control the situation, the Fire During Ground Operations procedure should be accomplished. Starting fires are usually the result of over-priming the engine. If equipped with a carburetor temperature system, consider monitoring this during initial start sequence.

> **Caution**
>
> If the RV-type operated is equipped with an engine priming system, it is generally not necessary to prime a warm engine. Under-priming is less risky than over-priming. If the airplane is not equipped with a priming system, caution should be exercised when utilizing the accelerator pump in the carburetor to assist with start. Excessive throttle "pumping" should be avoided.

External Indication of Induction Fire and/or Carburetor Temperature Rapidly Increasing (if equipped)

1. Starter – CRANK
2. Throttle – OPEN
3. Mixture – OFF
4. Fuel – OFF

If the pilot determines a fire in the carburetor is likely, it is preferred that the starting sequence be continued in an effort to draw the excess fuel into the induction system. If the engine hasn't started, select the mixture to idle cutoff and open the throttle while continuing to crank. If the engine starts, it will run momentarily on residual fuel and pull the fire into the induction system. If the engine has already started, continue to operate long enough to pull the fire into the engine. In either case, if evidence of fire persists or if in doubt:

5. Ignition – OFF
6. Master Switch/Electrical Equipment – OFF
7. Ground Egress

Carburetor Temperature Considerations (if equipped). Prior to start, the temperature displayed will be the temperature of the carburetor body. If the engine becomes flooded and fuel starts to drip from the carburetor, the unit may display a drop in carburetor temperature as the fuel starts to evaporate. If the engine backfires and fire starts in the venturi, the unit will display a rapid rise in carburetor temperature. Check the manufacturer's technical information for the behavior of displayed carburetor temperature in the event of induction fire for specific information.

BRAKE MALFUNCTION

The most likely cause of a brake malfunction is a hydraulic fluid leak or air in the system causing a lack of braking action. The left and right brake systems are independent (each pedal is equipped with a master cylinder), but may share a common reservoir. Lines are fitted from the master cylinders in the cockpit (mounted on/connected to the pilot's rudder pedals) to the brake actuators on each main wheel. When working normally, each pedal should provide good resistance when depressed. A spongy pedal or one that rotates forward freely indicates a lack of fluid or presence of air on that side.

Brake malfunction may be caused by a malfunctioning wheel brake assembly. The calipers on the main wheels are designed to float, and damage to the caliper, disk or interference can result in abnormal caliper movement and cause a dragging brake. Without cross-wind, the airplane should track straight on the ground. Any turning tendency not attributed to cross-wind should be investigated.

Brakes should be checked prior to start (pedals equally firm, depressed an equal amount) and immediately after start. A "brake check" should be conducted prior to taxi (momentarily release the brakes and re-apply at very low speed). If at any point, abnormal or lack of braking action is noted, the following procedure should be applied:

1. Stick – MAINTAIN FULL AFT

2. Tail Wheel/Rudder Steering – AS REQUIRED
3. Mixture – OFF (If required)
4. Fuel – OFF (If required)

For tail wheel equipped airplanes, full aft stick will supply maximum tail wheel traction and increase steering effectiveness. For nose wheel equipped aircraft, any residual brake capability may assist with differential steering. If a loss of braking action is encountered, reducing power and turning off the engine will limit forward velocity. The tail wheel steering, rudder steering or residual differential braking may be used to generate a controlled ground loop rather than colliding with a hazard.

Caution (Tail Wheel Airplanes)

In general brakes shouldn't be used to control yaw for the purpose of taxi, takeoff or landing. They should be used at minimum speed or in the event that aerodynamic control is in doubt. Caution should be exercised if the rudder is deflected and it becomes necessary to simultaneously apply brake. If this is the case, it is necessary to maintain rudder pressure while sliding your toes up the rudder pedal. Under some conditions, even a momentary relaxation of rudder to allow brake use may be sufficient to cause a loss of directional control.

Brake Fire. In the event of a brake malfunction or if excessive braking is applied, brake overheating, and potentially fire, may be encountered. A brake fire may not be immediately apparent as the landing gear is not visible from the cockpit. A brake fire occurs when a brake assembly overheats, a caliper O-ring or other component fails (e.g., b-nut, solid line crack, etc.) and may be exacerbated if brake fluid is present (i.e., the hydraulic fluid may begin to burn when its flash temperature is exceeded). Other combustibles in the landing gear assembly include tires, wheel pant and fairing assemblies. A primary danger associated with a brake fire is proximity to the fuel tanks, including quick drains and vents which can be a source of raw fuel in the event of a leak or fuel expansion. If a brake fire is suspected, the airplane should be stopped and an emergency ground egress should be considered.

FLOODED ENGINE DURING START

> **Caution**
>
> - ***Do not over-prime*** (if equipped).
> - Do not exceed starter limitations when attempting to start a flooded engine: individual starter and/or engine manufacturers will specify starter limitations. In general, cranking attempts should be limited to 10 seconds with sufficient cool-down between attempts.

Follow the engine manufacturer's recommendations for starting a flooded engine. Unless a malfunction exists, the key is to avoid flooding in the first place. Avoid the tendency to over-prime, or, if equipped with a carburetor, excessive use of the throttle actuated accelerator pump. A fuel odor may be noted during a flooded start. If flooding occurs and time permits, wait for the excess fuel to evaporate and then attempt re-start. This technique will minimize engine wear and is the single best way to ensure induction fire risk is reduced and likelihood of normal start is increased. If it is necessary to continue with the start and sufficient time is not available to allow excess fuel to evaporate, *and* specific engine manufacturer's guidance is not available, select the mixture control to idle cut-off, open the throttle and crank. When the engine starts, immediately reduce power, advance the mixture control and continue with a normal warm-up. Be alert for signs of induction fire during a flooded start attempt.

FIRE DURING GROUND OPERATIONS

The following procedure may be applied for any type of fire when operating on the ground. It is not necessary to ascertain the type or source of the fire when operating on the ground. Prompt action to secure the engine, fuel supply and electrical system prior to egress is the only action required.

1. Fuel – OFF

Turning the fuel supply OFF will result in engine stoppage. At low power settings typically associated with taxi considerable amounts of "residual fuel" will remain after the fuel valve is selected off (e.g., the engine will continue to run for some time at idle power after the fuel valve is turned OFF). Residual fuel amounts will vary from airplane to airplane and are easily tested by securing the fuel valve with the engine at IDLE and using a stop watch to determine subsequent run-time. It is not uncommon for RV types to have over 1 minute and 30 seconds of residual fuel at IDLE power.

2. Mixture – OFF

If prompt action is taken to proceed with step 2 (Mixture – OFF), then it is likely that some fuel will remain in the lines before it has been drawn into the induction system or has a chance to burn. Selecting the mixture lever to idle cut-off is generally the quickest means to safely shut down the engine under all conditions. ***Do not delay selecting the mixture to the idle cut-off position in an attempt to allow residual fuel to burn out.***

3. Ignition – OFF

If properly installed and functioning, turning the ignition source OFF will also cause the engine to shut down. A switch malfunction or wiring problem (e.g., failed p-lead for a conventional magneto equipped engine) may allow the engine to continue to operate if the fuel supply to the engine is not shut off.

4. Throttle – OPEN
5. Master Switch/Electrics – OFF

Turning the master switch(s) OFF (if equipped and installed correctly) will cut off power to all electrical equipment. If time is critical, electrics may be ignored during the emergency ground egress sequence.

6. Ground Egress

If a fire extinguisher is available, it is recommended that if circumstances permit, the pilot should consider its use.

Warning

A cockpit-mounted, hand-held fire extinguisher (if available) may be of limited or no use against a well-developed fuel fire. If a fire continues to burn, an explosion may occur. If in doubt after exiting the aircraft, the crew should move as rapidly as possible to a safe distance away from the burning aircraft.

TAILWHEEL EQUIPPED AIRPLANES: LOSS OF DIRECTIONAL CONTROL (GROUND LOOP)

A ground loop is an uncontrolled turn during ground operation that may occur while taxiing or taking off but is most prevalent during the deceleration phase of the landing roll out. It is not always caused by drift or weathervaning, although this may cause the initial swerve. Careless use of the rudder (or brakes), an uneven ground surface, or a soft spot that retards one main wheel of the airplane may also cause a swerve. Generally, the initial swerve tends to cause the airplane to ground loop.

Since the airplane is unstable directionally on the ground, the forces that cause a ground loop increase as the swerve increases. The initial swerve develops inertia and this, acting at the CG (located ***behind*** the main wheels), swerves the airplane even more. If allowed to develop, the force produced may become great enough to tip the airplane until one wing strikes the ground.

If the airplane touches down while drifting or in a crab, the pilot should apply aileron toward the high wing and stop the swerve with the rudder. Brakes should be used only when rudder is inadequate, and care must be taken to move the foot up the rudder pedal to apply brake without taking out the rudder input. Caution must be used when applying brake, because it is easy to over-control and aggravate the situation. If brakes are used, sufficient brake should be applied on the low-wing wheel (outside of the turn, opposite the direction of swerve) to stop the swerve. When the wings are approximately level, ***the new direction must be maintained momentarily (zero yaw rate) until correction can be applied***. ***After yaw rate is stabilized, use caution not to over-correct.*** If sufficient runway is available, adding full power and taking off may be the safest course of action since full power substantially increases rudder authority. If sufficient runway is not available, a momentary burst of power may still be appropriate to assist with increasing rudder authority.

TAKEOFF EMERGENCIES

LOSS OF DIRECTIONAL CONTROL

1. Throttle – IDLE
2. Stick – FULL AFT
3. Brake – AS REQUIRED
4. Yaw Rate – STABILIZE

REJECTED TAKEOFF/TAKEOFF ABORT

In general, if sufficient runway remains, it is desirable to reject/abort takeoff rather than attempt flight with degraded systems or engine. For minor system malfunctions, it is generally safer to takeoff, climb to a safe altitude, analyze the situation and take appropriate action rather than attempting a high-speed reject/abort. For Day/VMC operations, the pilot should consider rejecting/aborting the takeoff if there is an engine malfunction, directional control is in doubt, airspeed system failure occurs or a runway hazard exists. Good acceleration performance results in a brisk takeoff roll, so reaction time for rejecting/aborting the takeoff is limited. In the event the pilot decides to discontinue the takeoff, the following procedure should be applied:

1. Throttle – IDLE
2. Stick – TRANSITION TO FULL AFT AS AIRSPEED ALLOWS

For tail wheel equipped airplanes, the pilot needs to use caution while applying aft stick as rapidly as deceleration permits due to elevator effectiveness. If the tail has already been raised or at high speeds in the 3-point attitude, there is sufficient elevator authority to lift the nose if full aft stick is applied too quickly. Conversely, failure to apply aft stick in a timely manner will not transfer as much weight as practical to the tail wheel and will limit steering effectiveness.

3. Directional Control – MAINTAIN

As with any high-speed situation on the ground, maintaining proper directional control is of primary importance. Tail wheel equipped airplanes are directionally unstable on the ground, particularly in a 3-point attitude. Regardless of gear configuration, in cross-wind conditions, use of aileron to assist in drift control will likely be required. The light weight, low wing loading and vertical surface volume of RV-types makes them susceptible to upsets in gusty wind conditions. The pilot must react to gust effects and should be cautious when operating on a runway under cross-wind conditions with structures on the upwind side of the runway that may cause turbulence. Gusts will affect directional control throughout the deceleration phase and will continue to effect control even at taxi speeds.

4. Brakes – APPLY

Brakes should be applied cautiously and only when required to ensure stopping or maintain directional control. A rapid application of brake at high speed can result in a nose-over and/or flip over. Misapplication of differential braking can result in a swerve and/or loss of directional control.

ENGINE FAILURE/MALFUNCTION DURING OR IMMEDIATELY AFTER TAKEOFF

Pilots should be prepared for the possibility that the engine will lose partial or total power during the take-off and climb-out; or at any other time during flight. If there is even a suspicion something is not quite right during the initial ground run or the engine falters (even if it subsequently picks up), and sufficient runway is available, the reject/abort procedure should be applied.   A take-off should not be attempt if the pilot is not fully confident about engine behavior or aircraft/systems performance.

Power Loss during Takeoff Roll

1. REJECT/ABORT

2. Fuel – OFF

Ergonomic consideration. Depending on cockpit configuration and equipment, it may not be possible for all pilots to reach the fuel valve in all airplanes if the shoulder straps are properly tight. Unless sufficient time exists to allow the pilot to properly tighten the straps before touchdown, omit step 2 above and proceed to step 3 below:

3. Mixture—OFF
4. Ignition—OFF
5. Master Switch/Electrics – OFF
6. Ground Egress (If Required)

Power Loss Immediately After Lift-off

1. Land Straight Ahead
2. Fuel – OFF

Ergonomic consideration. Depending on cockpit configuration and equipment, it may not be possible for all pilots to reach the fuel valve in all airplanes if the shoulder straps are properly tight. Unless sufficient time exists to allow the pilot to properly tighten the straps before touchdown, omit step 2 above and proceed to step 3 below:

3. Mixture – OFF
4. Ignition – OFF
5. Master Switch/Electrics – OFF

***On-field Landing Considerations*.** When total or near-total power loss occurs after lift-off it is imperative to maintain positive control and safe flying airspeed. This initially implies either immediately transitioning to landing or quickly and smoothly getting the aircraft into the right glide attitude, allowing airspeed to stabilize as desired and trimming to maintain a stable AOA/airspeed condition. If the airplane has already reached climb speed, the low-drag and good glide characteristics of RV-types may allow some zoom capability, if desired. If an immediate landing is attempted, these same characteristics will cause floating as the AOA is increased during deceleration. Avoid obstructions and be prepared for a heavy landing and, possibly, the need to perform an intentional ground loop in lieu of hitting obstacles. A slightly fast landing and intentional ground loop may be preferable to attempting a tail-low full-stall landing and catching the gear on an obstacle (perimeter fence, etc.). The amount of time to react will be very limited, and once a course of action is selected, it's generally best to continue on the course rather than risk loss of control as a result of indecision.

Power Loss at Low Altitude (e.g., Below 1500 Feet AGL, Below Minimum Safe Turn-back Altitude, Below Minimum Controlled Bail-out Altitude, etc.)

Warning

Primary attention must be on maintaining proper aircraft control in the event of power loss at low altitude. Minimum time exists to troubleshoot a malfunction or attempt corrective action. It is always safer to accomplish a forced landing under control than it is to lose control due to channelized attention and/or task saturation. The highest priority in this situation is to maintain sufficient flying speed/AOA.

1. Glide – BEST RANGE or MINIMUM SINK SPEED
2. Landing Site – SELECT
3. Auxiliary Boost Pump – CHECK ON
4. Fuel Selector – SWITCH TANKS

If no restart is obtained

5. Fuel – OFF
6. Mixture – OFF
7. Ignition – OFF
8. Master Switch/Electrics – OFF
9. Should Harness – TIGHTEN
10. Airspeed – MAINTAIN
11. Anticipate Forced Landing

<u>Off-field Landing Considerations</u>**.** When transitioning from climb to glide attitude, the nose may have to be pushed down. Due to the high climb angles that RV-type aircraft are capable of generating, this may feel excessive if the aircraft was trimmed for a nose high, slow climb speed. A rule of thumb that may be helpful is "angle equals angle," in other words, if climbing out at 10 degrees nose up, initially transition to 10 degrees nose low until airspeed stabilizes or increases, as desired. Depending on pilot reaction time and initial attitude, airspeed may decay during the transition. At low climb speeds and aft CG loadings, RV-types exhibit fairly light stick forces and reduced static margin, so smooth positive control is required to set the proper pitch angle for glide AOA. Set speed/AOA for maximum endurance or range, as desired. Trim.

If some energy (altitude and/or airspeed for zoom) is available, but there is no possibility of landing on the airfield, then an off-field landing is mandatory. Analyze the area ahead and to the sides. If sufficient energy exists, it may be practical to maneuver to a better site or avoid obstacles by using a 30^{o}, 45^{o} or even 60^{o} of heading change at moderate bank angles. Bank angle should be proportionate to airspeed: low airspeed = limited bank. Wind direction should be considered, and if in doubt land into the wind in an area with minimum obstacles.

Do not choose a site at a marginal distance. Close is better—available energy can be used for maneuvering to the best approach position. Adequate altitude can compensate for misjudgment, adverse wind shift, sinking air, vertical gust and other unforeseen events. This altitude can be compensated for by use of flaps and sideslip.

Warning

- Side slip with full flaps can cause high sink rates. Safe airspeed should be maintained throughout maneuvering and the sink rate should be arrested before touchdown.
- Bail-out below computed minimum controlled bail-out altitude is not recommended and carries higher risk than a forced landing attempt.

IN-FLIGHT EMERGENCIES

ELECTRICAL MALFUNCTION

Note

- There is more variation amongst electrical/avionics systems than any other RV-type sub-systems. Each aircraft should be treated as unique in this regard and proper understanding of the electrical system as installed is imperative for safe operation of the aircraft. If a handbook or builder's data is not readily available, ensure adequate research is conducted to develop sufficient knowledge of system operation under both normal and emergency conditions. Depending on circumstances, instructors may need to assist upgrading pilots.
- 3 basic emergency conditions are presented for consideration: High and Low Amperage conditions and Electrical Fire. There may be other malfunctions pertinent to the specific aircraft to be operated for training not addressed.

Caution

- Failure to detect a charging system failure in a timely manner may cause unintentional depletion of the battery and total DC electrical failure without warning in some aircraft.
- Exact operating time for batteries cannot be assured, nor should exact times in manufacturer's data should be assumed. In the event of electrical malfunction, the pilot should, generally, land as soon as practical.

Low Amperage Condition (Conventional System Configuration)

One of the most common in-flight electrical malfunctions is the failure of the charging system (e.g., alternator). This could be caused by a mechanical fault, a belt failure (if equipped), regulator malfunction, internal electrical malfunction within the alternator, or other wiring problem. Although not likely, alternator failure can also be caused by over-heating. In the event of charging system failure, all components will be powered by the main aircraft battery. Many modern avionics components (e.g., EFIS displays, AHRS, etc.) may also include an internal battery, independent of the primary electrical system(s) that will function in the event of a complete electrical failure. It is necessary to consult component equipment manufacturer's data to determine specific system voltages and battery capacities. In any case, ***depending on equipment and electrical system configuration, establish the means of determining that the charging system has failed. Develop a technique or procedure for load shedding if a checklist does not exist and become familiar with the means to utilize any internal back-up battery capacity available in installed equipment.*** An electrical load analysis should be performed or component manufacturer's literature should be consulted to determine length of aircraft battery power time and any additional back-up power available.

1. Load—SHED
2. Battery Voltage(s)—MONITOR (if equipped)
3. Establish VMC (if practical) and anticipate battery failure

High Amperage Condition (Conventional System)

A high amperage condition is less likely than a low amperage condition. If the voltage regulator is properly adjusted and the over-voltage relay is working normally (upper limit contacts open), the most likely cause of a high amperage condition is either a faulty regulator, a shorted cell in the battery or a loose/broken ground wire between the regulator and the alternator. If a high amperage condition and high voltage (generally greater than 14.5 volts in a 12-volt system) exist simultaneously, the battery has suffered an internal short. This condition may be cyclical. If this occurs, consideration should be given to isolating the battery and not attempting power up any equipment unless required for continued safe flight. If a back-up power source is available, it should be utilized.

1. Charging Source—OFF
2. Avionics—OFF

Caution

Electronic equipment is most sensitive to an over-voltage condition and it should, generally, be secured as rapidly as possible to avoid damage through the most expeditious means practical (e.g., avionics master switch, etc.).

3. Electrical Equipment and Avionics—AS REQUIRED FOR SAFE FLIGHT (load shed)
4. System Voltage/Amperage—MONITOR (if equipped)
5. Establish VMC if practical and anticipate battery failure

ELECTRICAL FIRE

The initial indication of an electrical fire is usually the distinct odor of burning insulation. If an electrical fire is suspected, the pilot should attempt to identify the faulty circuit by checking circuit breakers, instruments, avionics and lights. If smoke, fumes or other evidence of electrical fire persist:

1. Electrics—OFF (e.g., master switch, battery etc.)
2. Charging Source—OFF
3. All Switches—OFF
4. Cabin Heat and Vent—OFF

> **Warning**
>
> Any materials ignited by the initial fault may continue to burn after power is secured. Ventilating the cabin may increase likelihood of open flame developing. If toxic odor is suspected, the pilot will need to make a determination which poses a greater risk.

If Fire Persists

5. Anticipate Forced Landing or Bail Out

VMC Fire Extinguished

5. Cabin – VENTILATE
6. Remain VMC and Land as soon as possible

IMC / Night Fire Extinguished

At night or under instrument conditions, electrical power may essential for emergency continuation of the flight long enough to attempt landing if bail-out is not practical. In this case the following procedures should be applied. When powering up required equipment, the pilot should begin by restoring systems which are equipped with internal back-up batteries (e.g., attitude source, GPS, etc.). Next in priority is equipment powered by the aircraft battery. Required systems should be powered up one at a time. When powering up systems, the pilot should pause and check for signs of odor, smoke or sparks before proceeding to the next system. Only the minimum systems required for safe flight should be powered up.

5. Cabin—VENTILATE

6. Required systems powered by internal battery—ON
7. Battery (e.g., master switch, etc.)—ON
8. Electrical Equipment—AS REQUIRED (One system at a time)
9. Battery Voltage—MONITOR (if equipped)
10. Charging Source—AS REQUIRED
11. Land as soon as possible

OIL SYSTEM MALFUNCTION

An oil system malfunction is recognized by drop in oil pressure, a complete loss of pressure, or excessive oil pressure with or without abnormal oil temperature indications. A steady rise in temperature accompanied by a drop in pressure is a particular sign of engine lubrication system trouble. Cross-check CHT reading(s) (if equipped) to validate oil temperature trend.

A wide variation in engine monitoring systems and indicators will be encountered throughout the RV fleet. Oil temperature and pressure indicators of some type are required for air cooled engines by FAR, so all conventionally powered RV-types should have at least minimal indications. Additional annunciator lights, warnings, etc. are not required; so in a basic installation, mechanical (or electric) gauge readings may be the only information available to monitor the proper functioning of the oil system. In this case, failure to monitor the gauge could result in system failure without warning.

For aircraft not equipped with an inverted oil system, oil venting under negative G conditions will occur. Venting occurs through the crankcase breather (conventional Lycoming power plant) and begins at approximately zero G. The amount of oil lost is proportional to the magnitude and duration of negative G load. Venting can occur quickly, even in the event of a short excursion. Slip stream effects may carry oil to any part of the airframe, including the canopy.

Oil temperature is inversely proportional to oil volume. As the amount of oil in the engine decreases, oil temperature will increase. Cockpit indications of low oil quantity are decreased oil pressure and increased oil temperature. The relationship between temperature and pressure behavior may assist the pilot in making a determination whether an oil system malfunction exists or there is an indicator problem. The pilot should assume an oil system malfunction exists if in doubt. Continued operation with a known bad indicator should be avoided.

Consult engine manufacturer's or builder's data for oil temperature and pressure limits. It may be necessary for instructors to assist the upgrading pilot with proper operation of engine monitoring systems (if equipped).

Although the full-flow FAA-approved aircraft filter (when equipped), oil cooler and suction screen are fitted with bypass features that allow remaining oil to circulate in the event of blockage, a mechanical or fitting/component failure can result in loss of engine oil. A partial loss of oil pressure may be an indication of a regulation problem. High oil temperature may be due to decreased oil level, obstruction in the oil cooler (internal or external), damaged baffle seals, a defective gauge or other causes. Depending on the nature of the malfunction, if oil is being lost, the process of may be gradual or rapid. The engine will continue to run for an undetermined period of time until all oil has been lost and seizure occurs.

In the event an oil system malfunction occurs, maintain minimum practical power, avoid high and/or negative G forces and unnecessary throttle movements; and land as soon as possible. Be prepared for imminent engine failure.

1. Power—MINIMUM PRACTICAL
2. Anticipate Engine Failure

ENGINE MALFUNCTION

Two common causes of engine malfunction are interruption of fuel flow or roughness/power loss due to induction system (carburetor) icing. Complete power loss is usually due to fuel interruption. If this is the case, power will likely be restored when fuel flow is restored. Select the appropriate glide speed and a suitable emergency landing location while attempting to restore power by completing checklist actions. If an unexplained decrease in performance is noted (airspeed/RPM/manifold pressure), full carburetor heat (if equipped) or alternate air should be selected and carburetor temperature should be monitored (if appropriate and equipped). Do not delay application of carburetor heat or alternate air source if in doubt. If ice is present and carburetor heat begins to melt it, a further decrease in power and increased roughness may be noted, indicating that the water from the melted ice is being moved through the engine.

> **Note**
>
> For a typical Lycoming installation, carburetor icing is not likely at high (>75%) power settings or when outside air temperature is 14^{o}F or cooler.

If attempting to restore fuel flow or carburetor heat has no effect, a rough engine can also be caused by an improper mixture setting. If the mixture is unintentionally too rich or too lean, engine roughness will result. Switching fuel tanks may mitigate roughness caused by fuel contamination. If the left or right magneto/ignition source provides adequate operation at reduced power with mixture rich, proceed to the nearest suitable airfield and land as soon as practical.

Sudden engine roughness or misfiring may be result of an ignition problem. Switching one ignition system off in turn will identify which one is malfunctioning. Select different power settings and richen the mixture to determine whether continued operation on one or both systems is possible. If the engine quits completely when selecting Left or Right ignition source, pull the mixture control to idle cut-off, wait ten seconds, select the good ignition source and advance the mixture control to re-start the engine. This procedure will prevent backfire.

Engine Failure / Loss of Power

1. Glide—MAXIMUM RANGE or MINIMUM SINK
2. Landing Site—SELECT
3. Fuel Quantity—CHECK
4. Engine Instruments—CHECK
5. Boost Pump—ON
6. Fuel Valve—AS REQUIRED
7. Mixture—AS REQUIRED
8. Carb Heat/Alternate Air Source—AS REQUIRED
9. Ignition Source—CHECK LEFT / RIGHT / BOTH
10. Primer (if equipped)—LOCKED

If Engine Fails to Start

11. Fuel—OFF
12. Mixture—IDLE CUT-OFF
13. Ignition Source—OFF
14. Charging Source—OFF
15. MAYDAY Call (if time/circumstance permit)
16. ELT—ON (if remote cockpit control is available)
17. Electrics—OFF
18. Shoulder Harness—SECURE
19. Airspeed/flying AOA—MAINTAIN
20. Anticipate Forced Landing or Bail Out

<u>Engine Fire</u>

An in-flight engine compartment fire is usually caused by a malfunction of the fuel or oil systems. This may be caused by a mechanical failure of the engine itself, an engine-driven accessory, a defective induction or exhaust system, a malfunctioning fuel-delivery system (carburetor or fuel injection system component), a broken line, hose or loose connector. Engine compartment fires can be indicated by smoke and/or flames coming from the engine cowling area. They can also be indicated by discoloration, bubbling and/or melting of the engine cowling in cases where smoke or flames may not be visible. Abnormal cockpit temperature or flames and/or smoke coming through the cabin ventilation system may also indicate a fire is present. By the time the pilot becomes aware of an in-flight engine compartment fire, it is usually well developed.

1. Fuel—OFF
2. Mixture—IDLE CUT-OFF
3. Charging Source—OFF
4. Ignition Source—OFF
5. Throttle—IDLE
6. Cabin Heat and Vent—CLOSED (if applicable)
7. Airspeed to Extinguish—DIVE AS REQUIRED
8. Glide (if/when appropriate)—MAXIMUM RANGE / MINIMUM SINK

If the fire is oil-fed, thick black smoke will be present, as opposed to a fuel-fed fire (which produces bright orange flames). For fixed pitch propeller equipped aircraft, the pilot should consider stopping the propeller rotation by raising the nose and slowing the airplane after the engine is secured. This procedure will stop an engine-driven pump from continuing to pump flammable fluid which is feeding the fire. To accomplish this, the pilot must quickly stall the airplane and smoothly re-establish a high speed dive in an attempt to blow out the fire. Stopping a controllable speed propeller can be problematic. If there is any doubt, it is best to increase dive speed immediately and not be concerned with propeller rotation.

9. MAYDAY CALL (if time/circumstances permit)
10. ELT—ON (if remote cockpit control is available)
11. Electrics—OFF

Unless a fire is electrical in nature, turning off the electrical equipment (e.g., master switch) should be delayed to allow for communication and emergency transponder squawk during the emergency.

12. Anticipate Forced Landing or Bail Out

> **Warning**
>
> No attempt should be made to restart a secured engine after a fire.

PITOT/STATIC MALFUNCTIONS

Indication of Pitot Blockage. The pitot tube is particularly sensitive to blockage, especially by icing. Even light icing not visible from the cockpit can block the entry hole of the pitot tube. This will affect the ASI and any advanced systems that utilize pitot input (e.g., AHRS, EFIS etc.). If the RV-type is equipped with advanced instrumentation, airspeed indications may revert to GPS ground speed. If the pitot tube becomes blocked, the mechanical ASI (and pitot portion of the EFIS, if equipped) displays inaccurate speeds. How the airspeed indication will be effected depends on the type of pitot tube fitted and configuration of the pitot system. If the airplane is fitted with a simple pitot tube (e.g., a bent stainless or aluminum tube) without any sort of drain, at the altitude where the pitot tube becomes blocked, the ASI may remain at the existing airspeed and won't reflect actual changes in speed. If altitude changes are made with a blocked pitot tube, the ASI may behave like an altimeter in this case. If the airplane is fitted with a pitot tube that has a drain, indicated airspeed may bleed to zero in the event of blockage (depending on whether or not the drain remains clear). If the airplane is equipped with advanced instrumentation, the first sign of pitot icing may be reversion to GPS ground speed. If the RV-type operated has advanced instrumentation, the upgrading pilot should be familiar with reversion cues/warnings. Regardless of the cause of blockage, failure of indicated airspeed in flight can be insidious and can be only be verified by proper cross-check of other instruments.

The most common cause of pitot malfunction is failing to remove the pitot tube cover before flight. The pitot tube on most RV-types is not visible from the cockpit. If the "malfunction" is simply a cover left in place, this should be detected during initial takeoff roll at approximately 25-30 KTS. If airspeed is "not off the peg" as the airplane accelerates, consideration should be given to aborting/rejecting the takeoff.

If erroneous airspeed indications are suspected in flight, cross-check available instrumentation to assist with maintaining aircraft control (e.g., AOA or GPS derived ground speed). If equipped properly functioning and calibrated, AOA is always a suitable substitute for indicated airspeed. Depending on system configuration, however, AOA indications may or may not be correct (especially systems that share a single pitot tube). ***In the event pitot blockage is suspected, the best course of action is to apply a known pitch and power setting to obtain desired performance.***

Table 3-3: Example Pitch/Power Settings[1]		
	Pitch	**Power**
Cruise Climb	+3 to +5^{o}	WOT
Level Cruise	0 to +1^{o}	55-75%
Cruise Descent	-2 to -3^{o}	15" MAP (1500 RPM)
Approach	-3^{o} (VVI = GS x 5)	12-13" MAP (1800 RPM)
[1]***Actual pitch and power settings for a specific RV must be determined by flight test.***		

Warning

- Airframe, pitot icing or other blockage may cause a loss of pitot pressure. Exact behavior of indicated airspeed cannot be predicted due to variation in configuration between RV-types, but indicated airspeed IS NOT RELIABLE. At the altitude where the pitot source becomes blocked, the indicated airspeed may remain at the existing airspeed and not reflect actual change in speed, or the indicated airspeed may go to zero or some intermediate value.
- Pitot icing may occur without other visual indications of ice build-up.
- If the RV-type is equipped with pitot heat, it should be selected on any time OAT begins to approach freezing (OAT ≤4^{o}C/39^{o}F), or ANYTIME airspeed becomes suspect, regardless of OAT.

Indication of Static Blockage. While less common that pitot blockage, static blockage may also occur. The most common cause of static blockage is liquid water trapped in a static line that subsequently freezes. Some aircraft may be equipped with an alternate static source. If the airplane is equipped with conventional mechanical pitot/static instruments of any type (e.g., airspeed indicator, altimeter, or VVI), whether primary or back-up, breaking the glass on any of these instruments will provide an alternate static source. Traditionally, the VVI is the "least dear" of these instruments (if equipped).

The trapped pressure in the static system causes the altimeter to remain at the altitude where the blockage occurred and the VVI will remain at zero. If normal pitot is still available, the airspeed indicator continues to operate, but is inaccurate. The CAS will be lower than actual if the airplane climbs above the altitude at which the static block occurred, and will be higher than actual if the airplane descends. To restore airspeed, altimeter and or VVI functions with blocked static ports, the pilot should select the alternate static source or break the glass on a pitot static instrument (e.g., VVI). Use of an alternate static source will affect the accuracy of displayed information as cockpit static pressure is lower than ambient static pressure outside of the aircraft. Correction data from flight test may or may not be available. Additionally, if equipped, GPS derived altitude and ground speed can be used as a reference. In some aircraft so equipped, the AOA indicating system is separate from the pitot static system and may continue to function normally in the event of a pitot/static malfunction.

CONTROLLABILITY CHECK

During any in-flight emergency except engine failure, when structural damage or any other failure is known or suspected that may adversely affect handling characteristics, a controllability check should be performed. The check should be performed at a suitable safe altitude. The pilot should establish the desired landing configuration (flaps as desired) and slow the aircraft to determine the airspeed that produces acceptable approach and landing handling characteristics. If there is any doubt as to the structural integrity of the flaps or the flap extension system, they should not be used. Approach and land no slower than minimum control airspeed determined during the controllability check. For tail wheel equipped airplanes, if suitable airspeed for round-out and flare in a three-point attitude is not practical, a wheel landing must be performed.

CANOPY UNITENTIONALLY OPEN DURING FLIGHT

Numerous fatal mishaps in various types of aircraft have been attributed to doors or canopies opening unexpectedly during takeoff or flight. Inevitably, the most likely cause of the door or canopy opening was the pilot failing to secure it prior to takeoff. Mishaps occur when the pilot becomes startled and fails to maintain aircraft control. ***All RV-types can be safely landed in the event a canopy is improperly secured or even lost (See CANOPY LOSS DURING FLIGHT). As with any emergency, the most important task is to maintain aircraft control.***

RV-types have three standard canopy configurations: clamshell (forward hinged, RV-6, -7 and -9); flip-over (RV-3 and -4 and some -8) and sliding (RV-6, -7, -8 and -9). Due to the curved shape of all RV canopies, they tend to lift aerodynamically as the airspeed increases. In the case of flip-over types, they may separate completely from the airplane if takeoff is continued with an unsecured canopy. Clamshell types will lift along the trailing edge of the canopy and sliding canopies will tend to lift on the rail. If a canopy is unintentionally opened or not properly secured, it may not be possible to close it in flight. Slowing the aircraft may allow the pilot to secure a canopy, or it may be necessary to return to the field and land.

Maintain normal approach and pattern flying speed/AOA in the event of an unsecured canopy. Fly a normal approach and landing.

CANOPY LOSS DURING FLIGHT

Flip-over type canopies may be jettisoned by opening the canopy handle. Air loads will lift the canopy and the piano hinge on the right side of the cockpit will tear away. An unintentional or inadvertent canopy loss is possible if there is a malfunction of the locking mechanism. To prelude this, the pilots operating RV-types with flip-over canopies should visually confirm that the forward and aft canopy pins are properly secured prior to takeoff. ***The most common cause of flip-over canopy loss in flight is failing to properly secure the canopy before takeoff.***

Clamshell canopies may be jettisoned by pulling the jettison lever (if so equipped). Sliding canopies may or may not be jettisoned, depending on configuration. Aerodynamic loads can make opening some sliding canopies questionable in flight. Aerodynamic loads are reduced with airspeed and at a minimum at/near stall speed. Auto-rotation (spins) occurs at low airspeed and although the aircraft has a very high descent rate, actual air loads on the canopy are low in this condition.

Regardless of type of canopy fitted, it may be necessary to simultaneously bump or push up on the inside of the canopy with a closed fist to assist with release when jettisoning.

In the event of canopy loss, structural damage to the tail may occur.

If flight is necessary without a canopy, significant air loads will exist at high speed. The airplane should be slowed to minimum practical speed for recovery. Fly normal approach and landing speeds (AOA). Absent severe structural damage as a result of canopy strike, the aircraft are fully controllable without the canopy although significant wind loads will be present.

COCKPIT VENTILATION/HEAT MALFUNCTION

Cockpit heating and ventilation system configurations and controls vary widely. Information in this section should be considered general in nature.

Under hot weather conditions, there is quite a bit of ambient cockpit heat in most RV-types and if inadequate ventilation exists, it may be necessary to adjust cruise altitude to cooler air or make a precautionary landing.

Cockpit heat is typically provided by a muff attached to one or more exhaust pipes in the engine compartment. A ram air intake of some type is usually fitted to allow air to enter the muff and be heated by the exhaust pipe. The heated air is usually delivered to a small plenum chamber attached to the fire wall. A cockpit lever controls the adjustable valve in the plenum that mixes heated air with ambient air and delivers it to the cockpit. A mechanical malfunction of this type of system could result in no heat, 100% heat or heat stuck in an intermediate position. If excessive cockpit temperature occurs and cannot be adjusted, a precautionary landing may be required.

Elevated Carbon Monoxide Level. Carbon Monoxide (CO) is odorless and colorless. If there is an exhaust system leak, it is possible that heating or ventilation systems could allow CO to enter the cockpit. CO should be suspected any time exhaust odor is present in the cockpit; however, dangerous levels of CO may be present even if no exhaust odor is detected. The pilot must be alert to symptoms of CO poisoning at all times. Symptoms of CO poisoning include headache, blurred vision, dizziness, drowsiness and/or loss of muscle power. CO levels greater than 15 part per million (PPM) are considered elevated. Concentrations of 100 PPM or greater are considered dangerous. Trace levels of CO (1-10 PPM) are common in many aircraft. A mechanical means of CO detection is recommended and is far more accurate than depending on feeling symptoms of CO poisoning.

If carbon monoxide is suspected or detected by mechanical device, the cabin should be ventilated, supplemental oxygen worn (if equipped/available) and the airplane should be landed as soon as practical.

Note

Depending on system configuration, when maintenance is performed, it may be possible to reverse SCAT ducting that delivers fresh and heated air to the cockpit. If ducting is reversed, heated air may be delivered via normal ventilation outlets and vice versa. Very hot air delivered out of a ventilation duct may be misinterpreted as a fire or other malfunction in the event ducting is unintentionally reversed during maintenance.

FUEL ODOR IN THE COCKPIT

There are multiple causes for fuel odor in the cockpit. In general, any odor should be investigated to determine whether a leak is present; however due to fuel vent configuration and proximity to the cockpit, fuel venting may occur under some maneuvering flight conditions. Generally, this type of venting will only occur under low G conditions, aerobatics or during post-stall maneuvering (e.g., auto-rotation). Fuel stains on the leading edge and upper surface of the wing root are indicative of fuel venting during maneuvering flight (assuming the vents are located in the standard, Van's recommended position).

Consider landing to investigate if fuel odor is detected during non-maneuvering flight.

FUEL LEAK

The most likely source of a fuel leak is an improperly secured or worn fuel cap. The pilot may note fuel flowing from the cap area or blue stains during flight. If the fuel cap is not lost, the amount of fuel that leaks in this manner is generally negligible. If the pilot or ground crew fails to properly secure the cap and it is lost, fuel from that tank will rapidly vent over board and be lost. The pilot must be prepared to switch tanks (if required) and be prepared for a heavy wing due to fuel imbalance.

> **Note**
>
> To properly secure the standard Van's fuel cap, the O-ring should be lubricated with fuel and the compression nut on the bottom must be properly adjusted. To secure the cap, it is necessary to hold the front of the cap down while pushing on the butterfly lever. Not all RV-types are fitted with standard fuel caps, so a different means of checking or securing them may be required. ***Regardless of type fitted, fuel caps should always be visually confirmed secure prior to engine start.***

In a typical RV installation, the fuel lines run from the wing roots through the cockpit. Vents are (generally) fitted to the lower fuselage floor just forward of the spar. Exact configuration will vary from airplane to airplane. The fuel lines are, generally, solid aluminum and utilize AN fittings although flexible lines may be fitted. An electrically powered auxiliary fuel pump is (generally) installed in the cockpit and an engine-driven mechanical fuel pump is mounted on the accessory drive of the engine (typical Lycoming installation). A gasocolator(s) may be fitted (location varies but typically fitted to the lower firewall or an alternate low point in the wing root). Fuel lines forward of the firewall should be protected by suitable fire sleeve material.

There should be no fuel odor or staining in the cockpit area if the fuel system is functioning normally. In the event fuel odor is detected during non-maneuvering flight, the cockpit should be ventilated and a landing made as soon as practical. Care should be exercised in the presence of raw fuel to avoid any fire hazard.

If the leak can be associated with a particular side, left or right, the fuel selector valve should be set to draw fuel from the good, non-leaking side. Fuel pressure should be checked, but if the engine is producing normal power, use of the auxiliary boost pump should generally be avoided with a leak present.

FUEL TRANSFER MALFUNCTION

Engine-driven pump diaphragm failure. The RV-type operated for training should be checked to ensure that a vent line is attached to the port on the AC-type engine driven pump and properly run over-board. If a line is not fitted to the vent, a fire hazard will exist if the pump diaphragm fails and fuel begins to weep out of the vent. The diaphragm vent line should be checked for fuel during the pre-flight inspection. The location of the engine driven fuel pump drain varies from airplane to airplane. Any fuel present is a sign that the diaphragm has failed (usually due to age) and the engine driven pump must be replaced. The vent is fitted to allow graceful degradation of the pump function in the event of diaphragm failure. It is safer to properly vent the leaking fuel overboard than it is to allow it to mix with and dilute engine oil.

Engine-driven or auxiliary pump failure. If the engine driven fuel pump fails and the auxiliary pump is OFF, the engine may stop. If a mechanical failure of the pump occurs and the pilot is not actively monitoring fuel system pressure, reduced engine power or failure may be the first indication of a problem. Turning the auxiliary pump ON should supply sufficient fuel for restart and continued operation. If the aux pump fails, the only cockpit indication will be a drop in fuel pressure. ***At least one operating pump is required to ensure engine operation. With wing tanks only, fuel cannot be supplied to the engine by means of gravity.***

Blocked Fuel Vent. The most common cause of a blocked fuel vent is failing to remove the vent covers prior to flight. The fuel vents are not visible from the cockpit. Another possible source of blockage is insect intrusion. This may or may not be detectible during preflight inspection. If blockage is suspected, it can be confirmed by removing the fuel cap and gently pressurizing the vent. If there is any blockage, resistance to flow will be noted. The fuel vent (should) terminate at the fuel cap in each wing tank.

In the event a vent line becomes blocked on the tank supplying fuel to the engine, structural deformation of the tank will occur before fuel flow is interrupted. This deformation will become visible from the cockpit, and the other fuel tank should be selected, if fuel is available. A blocked fuel vent may eventually cause cessation of fuel flow to the engine, evidenced by reduced power or engine stoppage.

Running a Tank Dry. If a fuel tank is run dry (for whatever reason) and a restart is necessary, change the fuel selector valve to the other tank and select the boost pump momentarily. It is not necessary to adjust mixture or throttle, especially at altitude. It is possible at altitude to provide an excessively rich mixture during air start if full rich is selected. If flooding is suspected during air start, IDLE CUT-OFF should be selected until the engine fires. If a tank is run dry and sufficient fuel remains in the other tank, a normally functioning engine will restart.

> **Warning**
>
> Do not assume that a restart in the event of running a tank dry will always be affected by simply changing tanks. This must be demonstrated in flight test. Improper fuel system installation or other unique requirements of an individual installation may preclude this. There can be variation amongst RV systems and no assumptions should be made.

ADVANCED INSTRUMENTATION MALFUNCTION (if applicable)

Transition to stand-by instrumentation. Follow component manufacturer's guidance.

FLIGHT CONTROL MALFUNCTION

The airplane is equipped with simple, manual flight controls. The linkage to the elevator and ailerons are controlled by a series of push/pull tubes connected to the control stick assembly. Low friction bearings are utilized. The rudder is controlled by cables that run from the rudder pedals, along the cockpit walls, through the aft fuselage and exit through fairings above the tail wheel spring. Other than interference caused by an occupant, a foreign object interfering with motion or component failure, the odds of a flight control malfunction are slight in a properly installed, secured and inspected system. ***The most common cause of control problems in this class of airplane is failing to remove any control locks prior to attempting takeoff.***

If primary elevator control is lost for whatever reason and the elevator still retains some range of motion, the trim tab can serve as a servo (control) tab to move the elevator and provide some degree of pitch control. The trim tab is highly effective and may have sufficient range of motion to establish a stabilized pitch condition. Only minimal bank angle should be used if some pitch control can be maintained using the trim tab.

Sufficient roll control for landing will remain with a single aileron inoperative. If both ailerons are inoperative, the roll trim (if fitted) may or may not provide a servo function, depending on configuration (a simple spring system that biases the stick position to provide roll trim will not work if the aileron pushrod becomes disconnected). RV-types do not exhibit much dihedral effect at low AOA, so rudder can be used to control roll, but control is fairly limited unless AOA is increased. Rudder may provide sufficient roll and heading control for an emergency landing if bank angle is minimized and cross-wind conditions are avoided.

Any emergency landing with compromised flight controls should be made into the wind to the maximum extent practical using the widest runway or suitable landing surface available.

The most likely rudder failure would be a single cable failure. In this case, rudder control still exists to one side, however directional control after landing will be difficult. If landing is attempted, any cross-wind must be opposite the side with the "good rudder." Every attempt should be made to land into the wind, even if this means using a diagonal path across the runway surface available. For tail-wheel equipped airplanes, a three-point landing should be flown. After touch-down, a rudder cable failure will also cause a failure of tail wheel steering, so judicious use of differential braking may be required to maintain directional control. Depending on circumstances, it may be safer to accept a new heading after a correction than to attempt another correction in the opposite direction. An intentional ground loop in direction of the "good" rudder may be an option if collision with an obstacle appears likely.

Depending on circumstances, consideration should be given to bailing out (if equipped) vs. a landing attempt in the event of a primary flight control malfunction.

See CONTROLABILITY CHECK.

TRIM MALFUNCTION

Sufficient manual flight control authority is available to over-power a malfunctioning trim system; however it may be necessary to apply force in an abnormal direction to obtain the desired attitude.

FLAP MALFUNCTION

Flap actuating systems vary from aircraft to aircraft. Flaps may be actuated manually or electrically. They may have fixed positions, or, in the case of electrically operated systems, multiple settings. The flaps are actuated by a common welded tube assembly controlled by a lever (manual systems) or electric motor. The most common problems associated with manual flap actuation are inadvertent retraction (usually due to failing to ensure the flap lever is properly secured in the desired detent or unintentional switch actuation) and passenger interference. Electric flaps may suffer from actuator or other electrical malfunctions. A no-flap and/or partial flap landing is practical under all circumstances, so in the event it is not possible to extend or retract flaps normally, a no-flap or partial flap landing should be made.

If manual flaps inadvertently retract, a loud "bang" may be noted by the crew when they retract rapidly due to air load, and some increased sink rate may be noted. If this occurs at low altitude, it may not be practical to arrest sink rate before touchdown occurs. In this case a bounce is more likely and the pilot should be prepared to react by maintaining a normal landing attitude and applying power, as required. A go-around may be appropriate.

Electric flaps may fail in any position. Do not exceed V_{FE} with flaps extended.

Failure of a single flap can only occur if the welded tube actuator or flap push rod assemblies fail. Although not likely, this could occur at any time flaps are being used. If a single flap fails, a noticeable rolling motion will be imparted. The pilot must counter this by use of aileron and rudder and retract the flaps as quickly as practical. A no-flap landing should be made after control is regained.

GLIDE PERFORMANCE

Aircraft specific glide performance can only be determined through flight test. As a rule, RV-types exhibit good glide performance due to low drag characteristics of the basic design, however the propeller fitted will have a significant effect on power-off performance.

The Glide ratio is the distance of forward travel divided by the altitude lost in that distance. The glide ratio is affected by all of the four fundamental forces that act on an aircraft in flight: lift, drag, weight and thrust. If all these factors remain constant, the glide ratio will not change.

Wind is a very important practical influence on gliding distance over the surface. With a tailwind, the glide distance achieved will be increased because of increased groundspeed whereas with a headwind, it will be reduced because of the consequently slower groundspeed. If equipped, some GPS units or advanced flight instrumentation may display glide ratio and distance available for glide adjusted for ambient wind conditions. Glide time is not affected by wind.

Variations in aircraft weight do not affect the glide angle provided that the correct airspeed is flown. L/D ratio determines the gliding range, weight will not affect it. Weight does affect the indicated airspeed associated with L/D_{MAX}, however (CAS for maximum endurance glide will decrease with weight). AOA for L/D_{MAX} remains constant, regardless of weight.

Glide ratio is based only on the relationship of the aerodynamic forces acting on the aircraft. The only effect weight has is to vary the *time* the aircraft will glide. The heavier the aircraft is, the higher the airspeed must be to obtain the same glide ratio. If two aircraft have the same L/D ratio but different weights and start a glide from the same altitude, the heavier aircraft gliding at a higher airspeed will arrive at the same touchdown point in a shorter time. Both aircraft will cover the same distance but the lighter one will take a longer time to do so.

The greatest contributor to differences in engine-out glide performance amongst RV-types is the type and dimensions of propeller fitted. The lowest drag is a light-weight, fixed-pitch propeller pitched for cruise performance or a controllable speed propeller in course pitch (low RPM). Some RV-types may have glide ratios well in excess of 10:1. With a fixed-pitch (especially a light weight wood or composite design) propeller, glide performance may also be increased by conducting a prop-stopped glide (assuming engine failure occurs at an altitude at or above approximately 4000-5000 feet AGL). To stop the propeller, it is generally necessary to approach the stall and then re-adjust speed and/or AOA to that desired for L/D_{MAX}. Light weight propellers have low inertia, and will generally stop rather quickly as speed approaches stall or a low G condition is established. ***In no case should aircraft control be compromised in an attempt to stop the propeller, and <u>there is little benefit in terms of glide distance if this is attempted at low altitude</u>.*** Metal fixed-pitch propellers may also be stopped for glide; however, they possess higher inertia than wooden or composite propellers and may not stop as readily.

Glide performance with hydraulically controlled constant speed propellers will vary with the type of propeller fitted and whether or not oil pressure is available for propeller control after engine failure. Two types of propeller are generally used: non-counterweighted oil-driven types and oil-counterweighted types. Some controllable-pitch propellers are fitted with light weight composite blades while others have metal blades. The blade material will affect inertial characteristics. The important difference between the two types of controllable-pitch propellers is how they will behave when oil pressure is lost or reduced. The non-counterweighted propellers (the most typical type fitted to RV's) will fail to a "fine" pitch condition, i.e., flat blades (low AOA) and high RPM. Oil-counterweight types will fail to a "course" pitch condition, high blade AOA and low RPM. The later type of propellers is also referred to as an "aerobatic" propeller (as they are designed to protect the engine from over-speed in the event of loss of oil pressure). What is important to understand is the effect of a wind milling propeller in "fine" vs. "course" pitch. ***Regardless of the type of constant speed propeller fitted, <u>if sufficient oil pressure is available</u> to allow engine-out propeller control, glide performance can be improved by selecting a course pitch (low RPM) setting*** (i.e., reducing propeller drag). If insufficient oil pressure is available, then the non-counterweighted type will fail to a high-drag, high RPM, fine pitch condition. The oil-counterweight (aerobatic) type will fail to a low-drag, low RPM, course pitch condition.

Some RV-types may be equipped with electrically controlled propellers. If this is the case and propeller control is possible after engine failure, selecting a course pitch (low RPM) setting will improve glide performance.

Warning

An intentional prop-stopped glide condition with a constant speed propeller may be difficult to achieve and is not recommended unless flight test data exists and an adequate technique has been developed to reliably achieve this condition under emergency conditions.

Regardless of propeller type fitted, if oil pressure is lost completely, the engine will seize and the propeller will stop. ***In no case should aircraft control be compromised in an attempt to minimize propeller drag, regardless of technique utilized.***

Drag increases if the flaps are extended, and the airspeed will then decrease unless the pitch attitude is reduced. When pitch is reduced, the descent angle increases and the distance traveled decreases.

As a rule of thumb, maximum endurance glide is approximately equal to V_X and maximum range glide is approximately equal to V_Y. If specific test data does not exist, L/D_{MAX} can be crudely approximated by flying a speed equal to 1.4 times indicated stall speed as configured. L/D_{MAX} will provide maximum endurance glide.

Altitude Lost in 360^o Gliding Turn. It is helpful to determine how much altitude is lost in a descending 360 degree turn while gliding. This will assist in managing energy in an emergency landing by providing data to determine appropriate AGL altitudes for high and low key. ***For planning purposes, most RV-types have sufficient glide performance to make 500-700 feet of altitude lost per 180 degrees of turn a suitable rule-of-thumb for planning power-off spiral descents.***

OUT-OF-CONTROL

> **Warning**
>
> - ***Equipment variation and load will greatly affect handling characteristics by affecting weight and balance/static margin. Additionally, differences in rigging or construction could result in RV's of the same type having different handling characteristics. When maneuvering, approach each airframe as unique. Handling characteristics must be validated by flight test***.
>
> - Conduct of a stability check and basic stall/recovery characteristics testing should be completed and the aircraft should be loaded in accordance with designer's limits prior to conducting any maneuvering flight which could potentially lead to an out-of-control situation.
>
> - Unintentional spins are most likely in takeoff, departure, landing and maneuvering phases of flight. During maneuvering flight, pilots tend to be more attentive to control loss. When conducting takeoff, departure and landing operations, pilots should not become complacent or distracted and exceed critical AOA. This can lead to an out-of-control situation at an altitude that recovery is difficult or impossible.
>
> - The low drag characteristics of all RV-types make energy management a critical skill when the velocity vector transitions below the horizon (See HANDLING CHARACTERISTICS, MANEUVERING FLIGHT).

An out-of-control condition can occur unexpectedly. RV-types generally provide aerodynamic warning (buffet, uncommanded yaw, reduced stick force, etc.) prior to loss of control. In most cases, RV-types will recover quickly if the controls are smoothly neutralized and sufficient altitude exists to effect recovery. The pilot must use caution when recovering from any subsequent unusual attitude if the velocity vector is below the horizon, since speed will build up rapidly in a nose low attitude. An out-of-control condition is most likely to be encountered during attempted aerobatic maneuvering, takeoff, departure or landing, but may be encountered any time an uncoordinated condition exists and critical (stall) angle of attack is exceeded. The airplane will stall in any attitude or at any airspeed if the critical angle of attack is exceeded.

There is no sharp demarcation line below which the aircraft suddenly becomes uncontrollable or above which the pilot can completely disregard longitudinal stability considerations. If loaded within designer's recommended limits, the RV-types are stable in all attitudes, with some variation in static margin as pitch angle and power setting increase. If the airplane is loaded in a condition where the CG is beyond the aft limit, pilot reaction time may be too slow to counter a pitch change and post-stall handling characteristics and performance (including the ability to avoid or recovery from a spin) are unknown. The aerobatic aft CG limit has been established for some RV-types to maintain an adequate margin of stability when conducting post-stall maneuvering (e.g., spins, etc.), but this margin can be affected by aircraft attitude: margin tends to decrease at high climb angles and high power settings. If buffet or a nose-rise (light stick) is encountered, AOA should be reduced and lateral (aileron) inputs should be minimized. Reduced stability should be anticipated at high/low nose attitudes, low speed/high power and/or high AOA with aft CG. Smooth, positive control inputs should be made to establish desired attitude until such time as airspeed begins to increase and the airplane unloads. Uncommanded yaw (evidenced as nose slice) should be countered with appropriate rudder inputs, instruments (turn needle/turn rate [non-gimbaled] gyro) should be referenced as necessary. Due to engine and propeller effects, insufficient aerodynamic control may remain at low speed to counter roll if coordinated flight is maintained. The magnitude of these effects increase proportionately as power is increased and is minimized at IDLE power. (See HANDLING CHARACTERISTICS, ENGINE AND PROPELLER EFFECTS).

1. Power – IDLE
2. Controls – NEUTRAL

"Idlize and Neutralize." HOW the controls are moved to neutral is important: ***first neutralize aileron input, and then neutralize elevators. The rudder should be centered simultaneously. Do not release the controls. Maintain smooth, positive control***. If necessary, ***visually confirm neutral controls*** by looking at the stick. At this point, the pilot must ***pause and assess*** what further action is required. If the airplane is not yet in a steady-state (developed) spin, sufficient inputs have been made to effect recovery (i.e., it may be only necessary to maintain neutral controls and establish a low-G condition and allow the airplane to continue in a "ballistic" manner until it is unloaded and airspeed has begun to increase). ***Patience while maintaining neutral controls is required*** since cycling the controls or making a pre-mature anti-spin input can simply aggravate an out-of-control condition. ***Immediate aircraft response to neutral controls may not be apparent to the pilot***.

Note

If the airplane is unloaded (0 to positive ½ G) and airspeed is increasing through 100 MPH / 90 KTS, it is no longer out-of-control (although it may be transitioning to or in an unusual attitude).

3. Rudder – OPPOSITE YAW (IF REQUIRED)

Depending on conditions, it may be difficult to determine the direction of yaw. ***Sighting down the nose is the best indication of yaw. The only reliable yaw instrument is the turn needle/turn rate gyro (if equipped)***. These instruments remain accurate since they are rate gyros only and do not have gimbals. Review appropriate instrument indications that may assist the upgrading pilot in the RV-type to be operated for training. Behavior of advanced instrumentation and sensors may require research, including flight test, to determine behavior during out-of-control/spin conditions (if equipped). When the first rudder application does not counter yaw as intended, then it's possible that incorrect input has been made, in which case, switching to opposite rudder may be appropriate.

4. Elevators – PAST NEUTRAL (IF REQUIRED)

Opposite rudder and neutral elevator will, generally, be sufficient to assist with recovery during out-of-control or incipient spin recovery in most RV-types under typical loading conditions within designer's specified limits; however it *may* not be sufficient for recovery from fully developed or aggravated spins. In this case, it may be necessary to apply elevator to assist with rudder effectiveness and stall recovery. The need for forward elevator is more pronounced in upright spins than elevator aft of neutral for inverted recovery (due to the configuration of the tail—the rudder is more effective inverted than upright due to less blanking effect created by the horizontal stabilizer and elevator when inverted).

In the case of an upright spin, the elevators should be moved smoothly and aggressively forward of neutral, as required to affect recovery. The stick should not, however, be "jammed" forward to the stops as this could result in transitioning from an upright spin to an inverted spin. In the case of an inverted recovery, it may be necessary to move the elevators *aft* of neutral to recover.

It is impossible to provide precise guidance on how to apply elevator in all out-of-control conditions. The general rule that applies is that elevator should be applied, as required, to establish a 0 to ½ positive G condition.

5. Unusual Attitude – RECOVER

The pilot must be prepared for the unusual attitude that will likely result after a successful out-of-control recovery. In many cases, this will be a nose-low, airspeed increasing condition. The low drag characteristics of all RV-types makes it imperative that this condition should be anticipated and proper dive recovery/unusual attitude recovery techniques be applied. Exercise caution to avoid secondary stall and/or over-G conditions.

Other Considerations

Bailout. ***When an out-of-control situation is encountered, check the altimeter. If equipped with parachute(s) and a jettisonable canopy, the pilot will have to make a bailout decision in a timely manner.*** Minimum out-of-control bailout altitude should be computed and adhered to. Time is extremely limited due to the very high descent rates that can occur during an out-of-control situation. Time should not be wasted once a decision has been made to abandon the aircraft.

Human Factors Considerations. It is likely under the stress of an unanticipated out-of-control situation that the pilot may experience time (temporal) distortion: where time is perceived to be passing about five times faster than it really is (i.e., the brain perceives in "slow motion"). This misperception can cause the pilot to *not* maintain proper recovery inputs long enough to be effective, or, worse, to apply incorrect inputs too quickly (i.e., move flight controls so fast that they don't have a chance to take aerodynamic effect). Perceived seat-of-the-pants cues can be incorrect in an out-of-control situation. Instrument indications should be understood and utilized. The only accurate *visual* yaw information can be obtained by sighting directly down the nose. Loose restraints (harness/lap belt) can make control inputs difficult when out-of-control, keeping lap belts and harnesses as tight as practical can assist.

Control Inputs. The pilot's natural tendency usually will be contrary to necessary and proper control application, primarily in the use of ailerons. For example, when experiencing a wing drop or roll during departure from controlled flight, the pilot's instinct is to counter uncommanded roll with aileron, which induces adverse yaw, aggravates the departure and can lead to a spin. All control use/position must be done deliberately to ensure they are properly placed and the pilot should visually check all of the controls for correct position.

Engine Operation. Other than selecting IDLE power, engine operation during an out-of-control event is a secondary concern. Until the airplane recovers, primary attention must be on proper application of flight controls. During an out-of-control event, the engine may or may not continue to run. In the event the engine fails, the propeller may or may not continue to turn. If the airplane is not equipped with an inverted oil system, oil may escape overboard through the oil breather if sustained zero G or a negative G transient condition occurs. After recovery from an out-of-control event, the pilot should check the engine instruments and restart if necessary.

If the propeller has stopped (more likely for a light-weight, fixed-pitch propeller), a restart will generally occur faster if the starter is used rather than attempting a windmill restart. If oil was lost, consider landing as soon as practical to check and service the engine, as required.

Spins

Warning
Unless flight tested, precise spin characteristics (including recovery) for a specific RV-type airplane are unknown.

Accidental spins can result from a variety of conditions in which asymmetric wing lift is induced post-stall. Since the airplane must be stalled for a spin to occur, the most likely flight conditions in which a spin may be unintentionally encountered include maneuvering (aerobatic) flight, takeoff, departure and landing. Spins normally are caused by improper rudder usage coupled with a stall (including accelerated stalls). Non-coordinated rudder causes yaw which results in asymmetric wing lift and, if not corrected, rotation. ***If an uncoordinated stall is avoided, an accidental spin is less likely.*** When loaded within design limits, RV-types are generally hesitant to spin (i.e., they exhibit good spin resistance) and will generally recover from an incipient spin when controls are neutralized.

Two conditions are required for an airplane to spin: the wing must be stalled (Critical AOA exceeded); AND yaw must be present. If only one condition is present, then the airplane will not spin. The airplane will pass through an "out of control" condition (undamped roll) transitioning to the spin (incipient phase) before stabilized autorotation occurs. The aerodynamics associated with a spin are complex. A basic definition of auto-rotation is that at least one wing is stalled and both wings are operating at different AOA. This is depicted in Figure 3-10. Note that as critical AOA (stall) is exceeded, the coefficient of lift drops off while the coefficient of drag increases. The difference in AOA between the two wings that results in auto-rotation is caused by yaw. Yaw can be caused by deliberate or unintentional pilot input to the rudder, adverse yaw, engine power effects, inertial effects or gust load. Spins are low G, high drag maneuvers, this means that speed will generally stabilize at a relatively low and constant value. Descent rates; however, will be extremely high during a spin.

The turn needle/turn coordinator (if equipped) will always indicate the direction of a spin, even when spinning inverted. The slip indicator (inclinometer or ball) portion of the turn and slip indicator will give no useful information when spinning. Behavior of advanced instrumentation will vary by type and manufacturer and may, or may not provide a reliable source of spin direction. The only reliable VISUAL indication is to sight directly down the nose. The airspeed indicator during a spin is not accurate since the pitot tube is not aligned with the relative wind. Due to the wide variation in the types and locations of pitot tubes fitted to RV-types as well as variation in pitot/static configurations, no general rule of thumb is applicable to all airplanes regarding airspeed indications in a spin, however, in an erect (upright) spin, indicated airspeed may indicate low and (if equipped) AOA should indicate high. The aircraft stall warning may also be going off during a spin (if equipped).

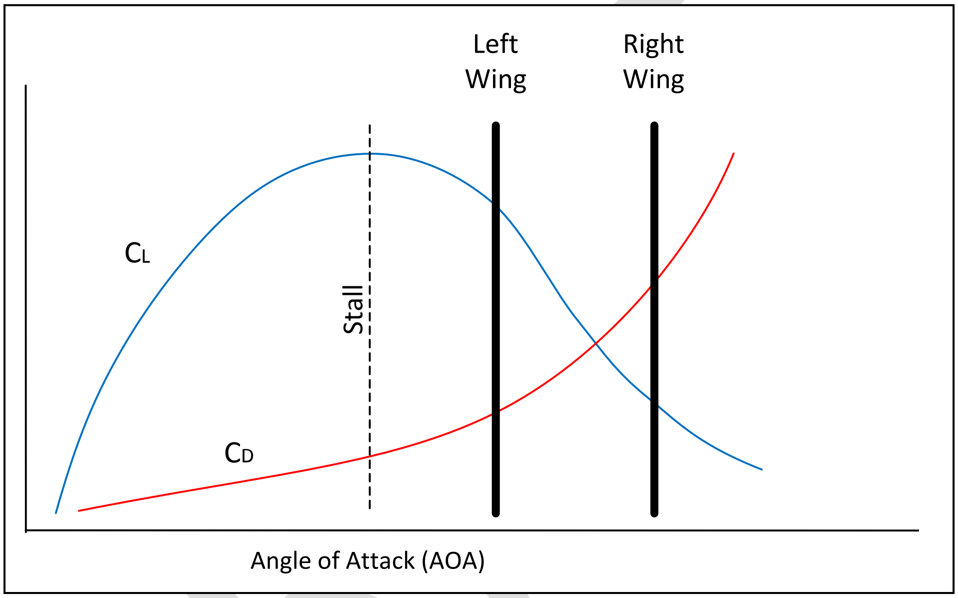


Figure 3-10: Spin Forces

The out-of-control procedure will generally recover the aircraft from a spin if the CG is within design limits. Approximately 300-500 feet is lost per turn in a developed spin. If opposite rudder does not have any effect after 1 ½ to 2 turns, reverse the input as it is likely that the pilot has improperly analyzed the direction of rotation. If the aircraft has unloaded to 0 to ½ positive G and airspeed is increasing above 100 MPH CAS (90 KCAS), the airplane is no longer in a spin. Recovery from a developed spin requires proper application of flight controls no later than approximately 1500' AGL and a maximum performance dive recovery. There is no margin for error. If there is any doubt about recovery and spinning through minimum out-of-control bail-out altitude, bail out. Delaying the bailout decision will reduce or eliminate the chance of survival. ***Spins at or below pattern altitude are likely to be non-recoverable.***

Inverted Spins. In order to enter an inverted spin, the stall must be at a negative AOA and yaw must be present. Generally, an inverted stall is more difficult to enter than an upright stall.

Depending upon rigging and CG location, elevator authority may be sufficient to induce the required negative load to cause an inverted stall. In the more typical case, the airplane has fallen out of a botched maneuver (e.g., hammerhead entry that resulted in a tail slide) or has transitioned to an inverted spin from an upright spin as a result of excessive forward elevator applied during attempted recovery (this later case is sometimes referred to as a "cross-over" spin). ***Inverted spins tend to be more disorienting than erect/upright spins since the direction of yaw tends to be opposite that of roll***, and pilots tend to be more sensitive to motion about the longitudinal axis (roll) than about the vertical axis (yaw)—thus they may interpret the direction of spin to be in the direction of roll, rather than yaw. Instrument indications during inverted spins will depend on cockpit configuration. Like an upright spin, accurate *visual* assessment of yaw can only be made by sighting down the nose line and only turn *rate* instruments (turn needle/coordinator) remain accurate when inverted (if equipped).

Due to the configuration of the tail, recovery from inverted spin is more prompt that recovery from an erect/upright spin. The out-of-control procedure is designed to assist with recovery from any spin mode, including inverted.

Fuel Asymmetry. The fuel tanks are located close to, but not coincident with the airplane center of mass so any differential fuel levels will cause asymmetric weight differences to exist throughout flight as fuel is burned. Depending on circumstances, if departure from controlled flight occurs, it is possible that unsymmetrical fuel weights can impart a minor destabilizing effect. The airplane will tend to yaw away from the heavy wing.

Depending on the configuration of the fuel pick-ups within the tank selected and actual fuel load, it is also possible in an out-of-control situation for a fuel pick-up to "unport." In this case, the remaining fuel in the tank has sloshed away from the pick-up and an interruption in fuel supply/engine operation may result.

Spiral Dive

A high-speed spiral dive is characterized by a nose low attitude, high roll rates and rapidly increasing airspeed. It may be confused with a spin if the pilot relies solely on visual references or seat-of-the pants cues. If a spiral dive is misinterpreted as a spin, it is unlikely that anti-spin inputs will result in successful recovery.

The cockpit indications of a spiral dive differ from those of a steady state, upright spin. The aircraft is not stalled in a spiral dive; therefore airspeed will be above stall speed and increasing dangerously quickly. AOA, if equipped, will be in the normal range. The rate of descent will be eventually greater than in a steady state spin, due to the high airspeeds attained in a spiral dive. If equipped with a turn rate instrument (needle/coordinator), it will be deflected in the direction of roll. The key to a safe recovery from a spiral is expeditious recognition of the flight condition. The pilot must be able to accomplish a proper analysis of the flight instruments (airspeed and AOA [if equipped] in particular) and not rely solely on outside references. If the CAS in increasing above 100 MPH/KTS, then the aircraft is probably in a spiral dive. Recover immediately by reducing power, rolling the wings parallel to the horizon and smoothly applying G. See EMERGENCY DIVE RECOVERY.

BAIL OUT

1. Altitude—NLT XXXX' AGL UNDER CONTROL / NLT XXXX' AGL OUT-OF-CONTROL

> **Note**
>
> See EMERGENCY EGRESS Section for assistance with computing controlled and uncontrolled bail-out altitudes.

2. Canopy—JETTISON
3. Harness—RELEASE

Post Bail-out

4. Rip Cord—PULL IMMEDIATELY AFTER CLEARING PLANE
5. Parachute/Suspension Lines—CHECK
6. Steer as required
7. Assume proper parachute landing fall position NLT 200' AGL

> **Caution**
>
> - Don't attempt parachute corrections below 200' AGL.
> - After landing, collapse the canopy by either pulling on a riser or disconnecting the harness as rapidly as possible.

1500 feet AGL is minimum recommended bail-out altitude if the airplane is controllable. Pack opening should occur no later than 1000 feet AGL to ensure a fully-deployed chute prior to hitting the ground. If the airplane is out of control, it may be descending at a rapid rate. Exiting an auto-rotating or tumbling aircraft may be difficult. A developed spin will produce descent rates of 117-150 feet per second. For example, attempting egress at 2000' AGL in a spin will allow approximately 4-5 seconds for egress and 2-3 seconds for chute deployment prior to reaching 1000' AGL, i.e., there is no margin for error. As a general rule, bailout should be conducted at the lowest practical airspeed. If bailout is the result of fire, there is some likelihood that the intensity of the fire may increase when the canopy is jettisoned and additional airflow is introduced to the cockpit area. The primary cause of unsuccessful bailout attempts is delaying the decision to bail out.

For a typical pilot emergency parachute (round canopy), fastest manual chute deployment occurs at 100 MPH. 2-3 Seconds is required for a full chute. Altitude lost during deployment at terminal velocity is 200-500 feet (i.e., distance required for deployment/opening). Parachute steering may be accomplished by means of toggles installed on each riser. To turn right, pull down on the right toggle, to turn left, pull down on the left toggle. The forward speed of the chute is 3-5 MPH. Forward speed may be used to maneuver away from obstacles; however it should be minimized for landing by turning into the wind prior to touchdown. Rate of descent will increase during turns, and turns/corrections should not be attempted below 200' AGL. Passing 200' AGL focus on the horizon and assume a proper parachute landing fall position: eyes on the horizon, feet and knees together, knees slightly bent and toes pointed down. Arms should be up, holding the risers (unless landing in trees). After landing, roll in direction of motion at touchdown and immediately disengage from the chute by utilizing the quick disconnects and "swimming" clear of the harness as expeditiously as practical to avoid being drug in the event the canopy does not fully collapse after landing.

If a tree or power line landing appears imminent, leg position remains the same as a normal landing fall, but your head should turn sideways for a power line landing to present minimum frontal area. If landing in the trees, your head should be turned sideways or alternatively, hands should be placed over your face with thumbs extending along your jaw with your chin firmly clenched against your neck. This position serves to protect your face and neck area when descending through the branches. For water landings, a downwind landing is recommended (so the parachute lands in front of you and not on top of you). Always assume a normal landing body position when landing in the water, since the depth of water may not be known. If a floatation device is worn, it should be inflated prior to a water landing.

PASSENGER INCAPACITATION

The most likely cause of passenger incapacitation in motion sickness. The effects of motion sickness can be mitigated by minimizing maneuvering flight (and/or slowing to maneuvering speed if encountering turbulence), maintaining VMC, opening cockpit vents ensuring a good supply of fresh air and directing the passenger to focus their attention on an object well away from the airplane.

The passenger should be briefed on how to perform a proper Valsalva maneuver to avoid discomfort during descent. He/she should also be told to notify the pilot immediately if any discomfort is encountered. It may be necessary to adjust descent rate to accommodate passengers. Consider carrying an emergency “blow down” bottle of Afrin (or a similar product designed to rapid clear sinus and nasal passages in the event of congestion) in the aircraft to assist with emergencies involving inability to properly clear the ears during descent.

Another cause of passenger incapacitation is anxiety. ***Be alert for signs of nervousness or fear*** and adjust flight parameters accordingly, or consider landing.

Be extremely cautious sharing the flight controls with passengers.

Caution

- An incapacitated or frightened passenger may interfere with the controls and/or flap actuator (depending on configuration).
- The passenger should be advised and the pilot should use caution not to stow items in the cockpit that could interfere control movement or with rudder cable movement along the cockpit sides. Passengers should be advised to secure personal items during flight.
- If passenger rudder pedals are fitted, the pilot should brief (and cross-check during flight) that the passenger’s feet do not interfere with the pedals, especially during takeoff, landing and ground operations.

EMERGENCY DESCENT

If an immediate, rapid descent is required from cruise and conditions allow, roll the airplane into 45 degrees of bank or more (60-80 degrees desired) and apply 2-3 G’s while simultaneously reducing the power to idle. Maintain a maximum of computed maneuvering speed (V_A) during the spiral descent, adjusting the lift vector as required to achieve desired descent rate maintaining desired airspeed by application of G. Fixed-pitch “cruise” type propellers (when fitted) will provide very little drag at idle power. Operating at or near C_{LMAX} will increase induced drag and assist with increasing descent rate and controlling airspeed. Increasing bank angle effectively “spills” the vertical component of lift, allowing the airplane to fall in rapid descent (in excess of 3000 FPM) under control. If practical, slow below V_{FE}, lower full flaps and maintain 2 G’s maximum, or buffet onset, whichever occurs first. Do not exceed V_{FE} with flaps deployed.

High speed emergency descent is not recommended. If a descent is started from an altitude greater than approximately 8000 feet MSL, high true airspeed may significantly reduce or exceed flutter margin. Although depicted on the airspeed indicator as "red line", V_{NE} is a function of true airspeed. Even a moderate descent from altitude is capable of generating true airspeeds in excess of TAS associated with V_{NE}. Maximum structural cruising speed should not be exceeded except in smooth air.

Additional Considerations

Airspeed. Conventional and advanced instrumentation utilizes dynamic pressure for airspeed indications. Stall speed, maximum structural cruising speed and maneuvering speed are a function of dynamic pressure (i.e., indicated airspeed). Never exceed speed is a function of TAS and is thus only marginally represented by the red line depicted on conventional airspeed indicators. Some advanced displays may incorporate a central air data computer and display TAS as well as CAS. Even a moderate descent angle from altitude at normal cruise power is capable of generating true airspeeds in excess of design V_{NE}. Whenever operating at speeds in excess of V_{NO} (maximum structural cruising speed/top of the green arc on a properly marked airspeed indicator), the pilot must be aware of true airspeed. The difference between flutter and current speed is referred to as flutter margin. As TAS increases, flutter margin decreases, eventually reaching critical flutter speed.

Flutter. Flutter is the result of interaction between aerodynamic inputs, the elastic properties of the structure, the mass or weight distribution of the various elements and airspeed (dynamic pressure). Flutter can rapidly destroy or seriously damage an airframe. A properly constructed and tested RV-type has sufficient flutter margin when operated at true airspeeds below "red line." TAS increases with altitude. Any RV-type is easily capable of exceeding red line TAS when descending from altitude. Catastrophic flutter can occur without warning.

Flutter Margin. It is impossible to accurately determine available dynamic flutter margin without advanced sensors and telemetry (i.e., it can't be done by feel). Van's aircraft has performed ground vibration tests to demonstrate good flutter margins through the design envelopes of the various RV-types. A properly constructed airframe with properly installed and balanced control surfaces and systems should not exhibit signs of flutter at TAS below red line.

Unintentional Flutter Encounter. Like a stall, flutter can actually be encountered at any airspeed. A rigging, construction or maintenance error could result in encountering flutter at speeds well below red line. Flutter may manifest itself as a high frequency airframe vibration with the stick shaking a commensurate amount. If this phenomenon is encountered, it is imperative to slow down immediately. Power should be reduced and a gentle maneuver performed to establish a wing's level condition. The velocity vector should be positioned above the horizon to assist with slowing (i.e., establish a shallow climb). Maintain TAS at or below that which any flutter effects were encountered and conduct a post-flight maintenance inspection of the airplane to ascertain whether or not the encounter caused any damage. Consider landing as soon as practical after a suspected flutter encounter to assess damage.

LANDING EMERGENCIES

LANDING WITH KNOWN FLAT MAIN TIRE

1. Turf runway recommended
2. Offset touchdown opposite bad wheel
3. Tail wheel types—TAIL-LOW, 3-POINT LANDING
4. Anticipate swerve / ground loop in direction of flat tire as aircraft decelerates

Perform an off-set touchdown biased toward the side of the landing surface coincident with the good wheel, i.e., if the left wheel is blown, touchdown to the right of the centerline. Directional control will become more difficult as the airplane decelerates after touchdown approaching taxi speed. Anticipate the need for careful differential braking. Depending on circumstances, the drag of a blown tire with simultaneous heavy differential braking on the good side could potentially cause a nose-over so the preferred method is to allow some drift toward the bad wheel while applying judicious brake on the good side with full aft stick during deceleration. A controlled, slow speed ground loop or swerve toward the bad tire is preferable to nose-over/prop strike/flip-over.

EMERGENCY LANDING PATTERN

One type of useful emergency landing pattern is a 360 degree overhead pattern. This pattern is designed to simplify energy management and position the aircraft for landing when the possibility of a power loss exists, partial power failure has occurred or no power is available. This pattern is depicted in Figure 3-11. Although some pattern planning is required when flying this type of approach, flying through the basic "hoops" of "high key" and "low key" at proper glide speed will allow the pilot to achieve a stabilized approach to a desired TDZ while compensating for ambient conditions (density altitude and wind). It may be necessary to experiment to determine specific glide performance when assisting the upgrading pilot with calculating and/or validating proper high and low key altitudes. Although specific glide performance will vary from airplane to airplane (especially if the prop is windmilling) planning to lose 500-700' per 180 degrees of turn during a spiraling descent is a good rule of thumb until test data or experience is gained. Taking into consideration winds aloft, a spiral descent over the TDZ utilizes the same skills as a turn-around-a-point or 1020 degree steep spiral and allows for a controlled descent with sufficient energy to establish a normal high key, low key and stable final conditions.

1. Glide—BEST RANGE (L/D_{MAX}) or MAXIMUM ENDURANCE (V_{REF}/ON SPEED)

For RV-4/6/7/8 types, best range glide is obtained at a speed slightly greater than L/D_{MAX} (approximately 105-110 MPH/91-96 KTS CAS [≈8^o AOA], flaps up). Maximum endurance glide speed occurs roughly coincident with V_{REF} (defined as 1.3 to 1.4 V_S). Due to the "flat drag curve" characteristics of RV-types, glide performance does not change appreciably over a relatively wide speed band (L/D_{MAX} ± 25 MPH/20 KTS), so adjusting speed and AOA for maneuverability required is practical. Maximum glide performance for airplanes equipped with controllable propellers occurs at low RPM. As a rule of thumb, airplanes equipped with controllable propellers generally exhibit more drag than fixed-pitch equipped airplanes. If a range of speeds or altitudes is given, airplanes with controllable propellers should operate at the higher end of that range and airplanes with fixed-pitch propellers should operate at the lower end until experience is gained. If specific flight test data is not available for a particular airplane, V_{FE} for half flaps is roughly coincident with maximum range glide speed. The top of the white arc can serve as a reference to assist with approximating best range glide speed in this case. At High Key (1500-1700') AGL or if sufficient energy exists, begin to slow to V_{REF}/ON SPEED (or specific maximum endurance glide speed or associated AOA if known and displayed) for the remainder of the emergency pattern.

2. Harness—SECURE

If the engine is not producing power, it should be secured well prior to touchdown. Ensure the throttle is IDLE, Mixture Control is IDLE/CUT-OFF, Ignition Source is OFF, Boost Pump is OFF and the Fuel Selector Valve is OFF. All electrical switches (if time and circumstances permit) should be OFF before landing to minimize the chance of post-landing fire. If the engine is producing partial power, the pilot should exploit the power available, but should consider turning the Fuel Selector Valve OFF, select IDLE/CUT-OFF on the Mixture Control and turn the Ignition Source OFF when landing is assured (field made point). Loose objects in the cockpit should be stowed. If landing on an unprepared surface, the canopy should be retained to afford additional protection in the event of post-landing flip-over or fire.

> **Warning**
>
> If equipped with parachutes, the pilot should weigh the risks associated with landing on an unprepared surface before descending below minimum controlled bail-out altitude. If equipped with parachutes, the pilot should consider bail-out at night or when operating in instrument meteorological conditions in lieu of attempting a forced landing without visual reference. The risk associated with controlled bail-out increases substantially if attempted below 1500’ AGL.

Once committed to landing:

High Key

3. 1500-1700 Feet AGL over intended landing point
4. Glide—BEST RANGE (L/D_{MAX} Flaps UP)

Note wind conditions when passing high key.

Low Key

Under most conditions, a 1000’ AGL low-key will allow sufficient energy to reach the intended landing point. The base turn may be delayed or started early according to conditions to allow for a stable 5-6^{o} final approach. Under no-wind conditions, a 300’ AGL final, 3000’ from the intended touchdown point should provide sufficient energy to allow a stabilized final approach from which a smooth transition can be made to minimum touchdown speed.

5. 1000 AGL abeam intended landing point
6. Flaps—AS REQUIRED

Flap deployment should be delayed if low key is reached below the recommended AGL altitude, if in doubt about ability to reach the planned TDZ, or significant head wind exists in the intended touchdown area. The first half of flap travel provides improved lift, while the second half provides more drag than lift. If there is any doubt about the ability to reach the intended touchdown point, flaps should be left UP or deployed no more than the HALF FLAP position.

Base Turn to Final

7. Glide—V_{REF}/ON SPEED Minimum

The greatest risk in any emergency landing situation is incorrect AOA control during the final phase of flight. In no case, should airspeed be sacrificed in an attempt to stretch glide distance. A properly applied slip or partial slip (inside aileron and top/outside rudder) can be highly are selected and undesired sink is noted during the base turn, do not hesitate to retract flaps to the half position to reduce drag. Use caution to maintain V_{REF} [ON SPEED] – V_{APP} . Avoid application of skid controls (inside rudder and outside aileron). An intentional or inadvertent skid combined with critical AOA will cause a rapid departure from controlled flight that will likely be unrecoverable at low altitude. If an over-shooting wind exists during the base turn, it is safer to accept the overshoot and the subsequent angled final than to attempt excessive or improper correction during the turn.

Prior to establishing a stabilized final approach, it is difficult for the pilot to judge velocity vector from the cockpit. The best technique is to put the airplane into a position where sufficient energy exists (i.e., a combination of known altitudes and airspeeds) and then make corrections, as necessary. Generally, slightly high and/or fast is preferable to low and/or slow. Glide performance is relatively unchanged at V_{REF} - V_{APP} (approximately 80-85 MPH/70-74KTS) and standard turn rates or L/D_{MAX}/BEST RANGE GLIDE (approximately 105-110 MPH/91-96 KTS) and up to 40^o of bank. If additional bank is required to maneuver for final, the pilot should lower the nose (reduce AOA) to allow airspeed to increase proportionately with bank angle. Any bank angle can be used for maneuvering, *provided the airplane is sufficiently unloaded (i.e., AOA reduced)*. In some cases, a steeper bank/quicker turn may be more appropriate than a minimum sink, shallow bank. A slip on final approach can be effective to assist with depleting excess altitude. If excess airspeed is carried through the turn to compensate for bank or uncoordinated flight (slip), it will be necessary to deplete excess energy during the transition to final.

In general, it's desirable to keep some energy "in the bank" and spend it in small increments during the base and final. A bit high and/or slightly fast, deploying/delaying full flaps, using "inside" slip and/or increasing AOA can help "spend" this energy in a controlled manner. Base leg may be shortened to assist. If sufficient energy exists at low key (i.e., 800-1000' AGL and airspeed at or above V_{REF}/ON SPEED), there is sufficient energy to reach the runway if base and final are properly flown.

On final, the pilot can approximate the velocity vector (touchdown point) by noting the point on the windscreen that does not shift up or down once a stabilized descent angle has been established. Under no-wind conditions, a 300' AGL roll-out 3000' from the touchdown point should provide adequate energy for a stabilized final and transition to touchdown. If the area of intended landing begins to rise in the wind screen (velocity vector moving down or short of the intended TDZ), transition to an alternate area short of the original intended spot and continue to maintain control and adequate flying speed. ***It is always safer to fly into the terrain/trees/water under control than to stall and lose control prior to touchdown.***

Touchdown

8. Airspeed—XX-XX KTS/MPH (V_{S1} + 5-10) / SLIGHTLY SLOW (AOA)
9. Attitude—TAIL LOW

Note

1.3-1.4 V_{S0} = XX-XX MPH/KTS CAS; 1.3-1.4 V_{S1} = XX-XX MPH/KTS CAS. In a forced landing, the slowest possible touchdown speed is best, but the pilot must ensure an unintentional stall does not occur prior to touchdown. The spring steel landing gear is less tolerant of bounces and unarrested impacts.

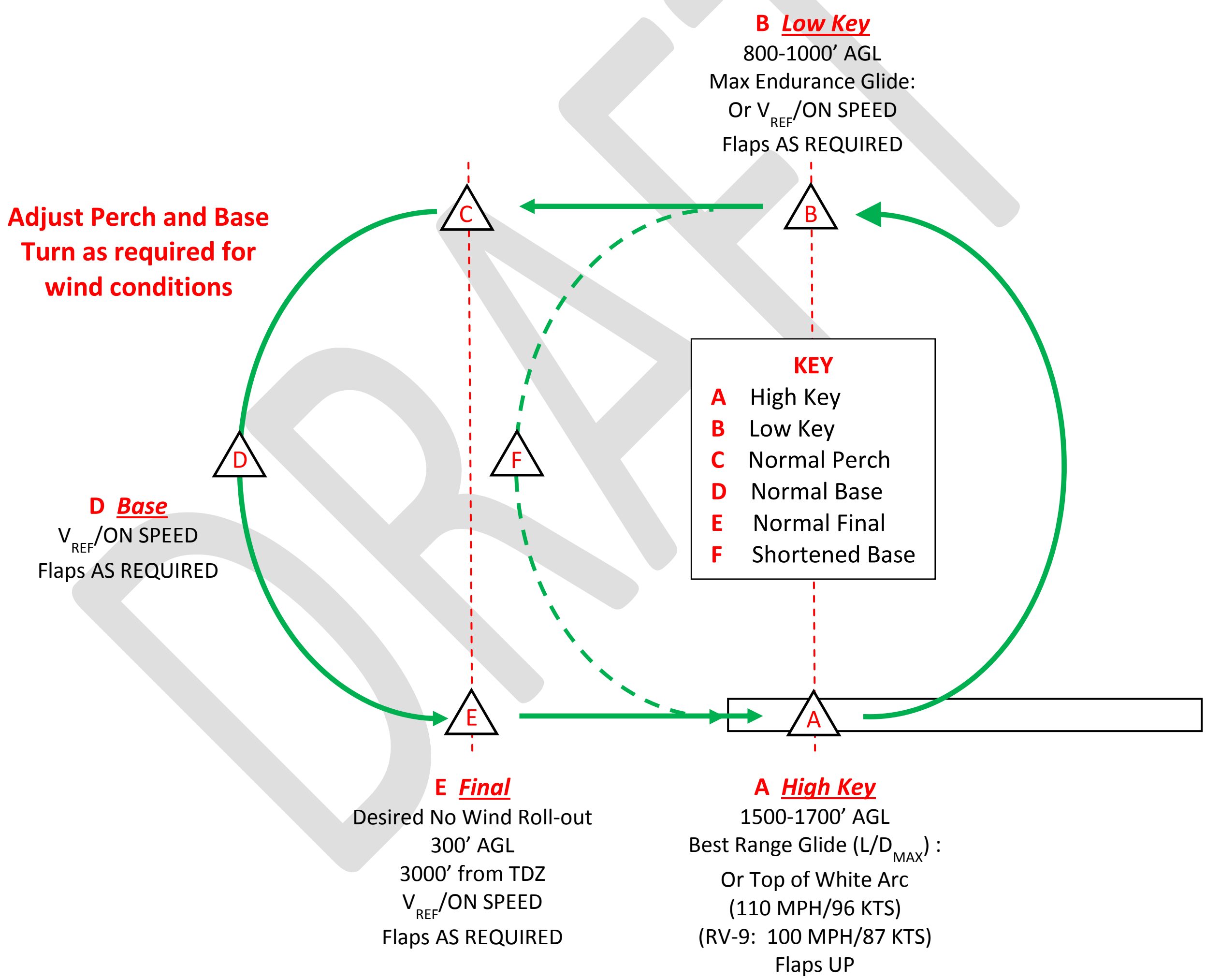


Figure 3-11. Emergency Landing Pattern.

Landing on an Unprepared Surface. The objective when landing on an unprepared surface is to touchdown at minimum airspeed in a tail-low attitude. Impact forces (energy) increase in proportion the square of groundspeed. Due to the gear configuration and pitch performance of the airplane, a true full-stall landing can only be achieved in a tail low attitude. Typical RV-type V_{REF}/ON SPEED for landing is 1.3-1.4 V_S. When landing on an unprepared surface, it is desirable to slow to 1.2 V_S (or less) on short final and then transition to a tail-low attitude as speed is decreased to just above the stall. Full flaps should be used (if practical) to reduce V_S. The transition to touchdown should mimic a normal landing to the extent practical, and the round-out should be performed within a half wing-span or less of the ground to preclude a sudden break (stall) to a nose-low attitude end game. It's far safer to hit the ground under control at flying speed. Transition to and maintain full aft stick as soon as practical after touchdown.

Be prepared for a severe jolt. It may be difficult to keep feet on the rudder controls. Brakes may be used, as required but keep in mind that heavy breaking can exacerbate nose-over tendency. If accomplishing an off-airport landing, the primary objective is preserving the integrity of the crew compartment.

Assuming sufficient directional control exists, an intentional ground loop can be used to shorten roll-out distance, if required. If landing on an unprepared surface, a flip-over post touchdown may occur. The cockpit roll bar/canopy bow is designed to protect the crew in the event this occurs. Cockpit egress post-crash will depend on conditions and canopy condition. If the aircraft comes to rest inverted and the canopy remains intact, a canopy breaker tool (if equipped) may be used to assist with egress. If not equipped with a dedicated tool, it may be necessary to improvise a canopy breaker (e.g., fire extinguisher, control stick, etc.) or kick to break the canopy. If unstrapping with the aircraft inverted, be prepared for the subsequent fall when the harness is released. Neck injury is highly probable if sufficient bracing cannot be accomplished prior to releasing the harness.

If attempting a landing in a forested area, it may be possible to aim the fuselage between trees, allowing the wings to absorb the brunt of the impact force (do not attempt to fly the airplane between the trees if still airborne). If forced to land into a tree canopy, controlled tail-low flight into the trees is safer than a stall at or above the top of the canopy.

<u>AIRSPEED INDICATOR FAILURE</u>

In the event of complete airspeed failure, GPS ground speed (when equipped) may be referenced to assist with determining approximate airspeed, however the primary source of a high AOA condition is the onset of buffet or other stall warning. If the aircraft is equipped with an independent AOA system, that should be referenced. Known pitch and power settings should be flown and allowance made for a slightly fast approach in the event of complete airspeed failure. A suitable runway should be selected to allow for extended float during the round-out prior to touchdown.

Other than instrument failure or malfunction, the most likely cause of an indicated airspeed malfunction is a blocked pitot tube. If a proper airspeed check is conducted during the initial takeoff run, the likelihood of suffering a blocked pitot tube in non-icing conditions is remote.

See PITOT STATIC MALFUNCTION.

DITCHING

> **Note**
>
> A well-executed water landing generally involves less deceleration violence than a poor tree landing or a touchdown on rough terrain.

1. Harness—SECURE
2. Flaps—UP

A flaps up configuration is recommended for ditching to preclude a nose drop in the event of an unintentional stall immediately prior to touchdown. A flaps-up stall will produce better aerodynamic warning and less severe pitching moment than a flaps down stall.

3. Glide—L/D_{MAX} (V_{REF}/ON SPEED)
4. Approach

- High Wind/Heavy Sea: INTO WIND
- Low Wind/Heavy Swell: PARALLEL TO SWELL

5. Canopy—OPEN or JETTISON (When practical) PRIOR TO TOUCHDOWN

Opening or jettisoning the canopy prior to touchdown is recommended, since structural damage during the water landing could make opening the canopy difficult or impossible after landing.

6. Touchdown—TAIL LOW V_{S1} + 5
    a. Maintain sufficient airspeed through a tail-first landing in the water. If the airplane is allowed to stall with the flaps extended, it may pitch down nose first into the water.
7. Harness—RELEASE

The crew must egress as rapidly as possible as the aircraft will likely sink quickly after touchdown. If the aircraft does not sink immediately, the crew should assume that it may sink rapidly at any time without warning.

ALL WEATHER OPERATION

COLD WEATHER OPERATIONS

Information in this section conforms to Lycoming Service Instructions 1505 and 1148C (current Lycoming Service Information should be consulted). It is generally applicable to RV-types equipped with a Lycoming engine. If specific engine manufacturer's or builder's guidance is available for cold weather operations, it should be followed and supersedes information in this guide.

The end of the oil breather should be checked for ice during pre-flight inspection. If this becomes blocked, it will cause a loss of engine oil. It is critical to ensure that the engine has been properly serviced with the correct grade of oil commensurate with ambient temperature. As air cools, density is increased and more fuel is required for proper starting. More priming may be required at cooler temperatures. In general, the engine should be pre-heated, if required, started at idle power and allowed to warm up slowly. Plan a sufficient amount of ground operation time before takeoff to allow for engine warm-up prior to starting the takeoff run. ***A Lycoming engine is sufficiently warm for takeoff when the power can be advanced without engine hesitation.*** If the engine is equipped with a carburetor, the accelerator pump will add fuel at the carburetor to assist with starting. Caution should be exercised when using an accelerator pump (i.e., pumping the throttle) to assist with starting, as this can lead to an induction fire if misapplied, as can over-priming airplanes equipped with priming systems.

In extremely low temperatures, oil congeals, battery capacity is lowered, and the starter can be over-worked. Improper cold weather starting can result in abnormal engine wear, reduced performance and decreased time between overhauls, or failure for the engine to operate properly. ***The use of pre-heat will facilitate starting during cold weather, and is required when the engine has been allowed to drop to temperatures below +10°F/-12°C.*** Be sure that the engine oil is in compliance with the recommended grades. Some aircraft may be equipped with instrumentation that allows the pilot to determine engine block temperature prior to start; this can be helpful determining whether or not it is desirable or necessary to pre-heat the engine. Additionally, some aircraft are equipped with an engine pre-heating system.

In cool or cold weather, extra care should be taken prior to attempting takeoff with a cold engine and cold oil. To prevent possible power loss, a proper warm-up should be conducted. After initial start and warm-up at idle, maintain a minimum of 1000-1200 RPM during ground operations to the maximum extent practical (to avoid spark plug fouling and assist with warning the engine and lubricating oil). Oil pressure may be as high immediately following start, but should fall into the normal range as the engine reaches normal operating temperatures. If in doubt about power output, a brief, smooth full-throttle check is recommended. If the engine power can be advanced without roughness or hesitation noted, the engine is warm enough for takeoff.

Caution

- The engine may not be warm enough for takeoff if there are indications of engine roughness; low, high or surging RPM; high, low or fluctuating oil pressure; high or low fuel flow; and/or excessive manifold pressure.
- Airplanes equipped with oil-actuated controllable pitch propellers will require a sufficient supply of suitably warm oil to ensure proper propeller operation.

Exercise care when doing a high-power run-up on the ground. The RV-types are capable of achieving flying speed with power settings as low as 1700-1800 RPM (typical run-up RPM). Taxiway or runway conditions could be degraded in cold temperatures if ice and snow are present, resulting unintentional sliding when power is advanced. If in doubt, it's best to simply spend the time on the ground allowing the engine to warm up.

Caution

- The use of a heated dipstick is not recommended by Lycoming because heat is not distributed throughout the engine, and concentrated heat may damage non-metal engine parts. Proper pre-heat requires a thorough decongealing of all oil.
- If an engine is started cold without pre-heat, the high viscosity of the oil unseats the bypass valves and unfiltered oil flows through the engine.

High-volume Heater Use

Caution

Direct hot air carefully to avoid heat damage to non-metal parts. If operating in extreme cold weather, a blanket should be placed over the top of the cowl to aid in heat retention.

1. Apply hot air directly to the oil sump, external oil lines, cylinders, air intake, oil cooler and oil filter in 5-10 minute intervals. Between intervals, feel the engine to be sure that

it is retaining warmth. Also check to be sure that there is no damaging heat build-up. During the last 5 minutes, direct heat to the top of the engine.

2. Immediately after pre-heating, start the engine according to the normal starting process. Avoid cranking for more than 5 seconds each start attempt.

Note

Rapid battery discharge during cranking should be anticipated when the battery is cold (ambient temperature < 20^{o}F).

3. Avoid rapid acceleration after a cold start. Do not exceed idle RPM, recommended in the engine Operator's Manual, until oil pressure is stabilized above the minimum idling range. Depending on instrumentation, oil pressure may require up to one minute to stabilize. If some oil pressure is not indicated within 30 seconds of start, shut down the engine and determine the cause. If no leaks or damage is found, repeat the pre-heat before restarting.

4. Allow the engine to warm up at idle speed until oil pressure and temperature are stabilized within normal limits and proceed to normal ground operations.

5. After completing the ground check, and before attempting takeoff, check oil pressure, oil temperature, and cylinder head temperature to be sure that all are well within their normal operating ranges.

6. Insure that when takeoff power is applied smoothly, oil pressure, fuel flow, manifold pressure, and RPM are steady. Surges or fluctuations may indicate that the engine is not warm enough for takeoff.

Carbon Monoxide Considerations. If the RV-type operated is equipped with a cabin heat system consisting of a muff around an exhaust pipe (or pipes), any exhaust leak could induce dangerous amounts of carbon monoxide (a combustion by product) into the cabin environment. Exhaust and cabin heat systems should be inspected regularly for signs of exhaust gas leakage.

Carbon monoxide is colorless and odorless. It cannot be detected except by mechanical means. Care should be exercised when using the cabin heat system to be alert for symptoms of carbon monoxide poisoning. Symptoms of CO poisoning often include drowsiness and, perhaps dizziness or reduced visual acuity. If the airplane is equipped with a CO detector, any warning or evidence of excessive amounts of CO should be treated as real. In this case, the airplane should be ventilated and landed as soon as practical (See EMERGENCY PROCEDURES, COCKPIT VENTALATION/HEAT MALFUNCTION).

Induction System Icing. In flight, formation of induction ice will cause a loss of engine power. This loss of power may be detected as a reduction of RPM (fixed pitch propeller), manifold pressure, or reduction in EGT/CHT if the airplane is equipped with advanced engine instrumentation. In some cases, a loss of airspeed or altitude may be the first sign that power has been compromised—especially for aircraft with minimal instrumentation. This loss of power may sometimes be accompanied by vibration or engine roughness. It may also be quite insidious. To detect power loss in flight, a good technique is to note manifold pressure and/or RPM at level-off after the throttle and mixture have been adjusted for cruise. If the airplane is properly trimmed, any reduction in power will be evident by loss of airspeed/altitude and the pilot may note a "heavy" stick. If a controllable pitch propeller or auto-pilot is fitted, use may initially mask symptoms of induction system icing. Pilots must be alert for signs of icing when meteorological conditions are conductive to icing formation.

Carburetor Icing

Ice can form in the venturi of the carburetor throat with any outside air temperature from -7^{o}C (20^{o}F) to +38^{o}C (100^{o}F). It is most likely in the -1 to +15^{o}C (30-60^{o}F) range. The higher the relative humidity, the higher the probability of carburetor ice forming (e.g., temperature dew point spread 3^{o}C or less). It may form with relative humidity as low as 50-60%. Visible moisture need not be present, but on damp, cloudy, foggy or hazy days, be alert for power loss (e.g., visibility 1 SM or less, ceiling at or below 1500' AGL or other visible moisture present).

Warning

- Visible moisture and low temperatures are not required for the formation of carburetor ice. Warm temperatures and high humidity can be conducive to the formation of carburetor ice.
- The Carburetor can be almost completely occluded with ice before signs of carburetor icing are observed.

Carburetor ice forms more readily when the engine is at low power settings. It may form during ground operations and taxi. It is important to check engine power before takeoff and to remove ice, if necessary.

Carburetor Heat

Not all RV-types equipped with carbureted induction systems are equipped with carburetor heat. A typical carburetor heat installation is a muff around an exhaust pipe (or pipes) that provides heated air to the carburetor. This is best applied as an *anti*-icing system, i.e., it is designed to *preclude* ice formation by maintaining carburetor throat temperature above freezing. It *may* melt ice that has formed if accumulation isn't too great, but its primary purpose is to *prevent* ice formation. Generally, the carburetor heat will be plumbed inside the air filter, i.e., providing a bypass source of induction air in the event the filter becomes clogged; but individual installations will vary. Some airplanes are equipped with carburetor temperature indicators, assisting with proper application of carburetor heat. If equipped, carburetor heat should be checked for proper operation during the engine run-up.

Any time power loss is suspected in flight, carburetor heat should be selected immediately. This may cause a further 10-15% power reduction and some engine roughness. The additional power loss is caused by heated air injected into the induction system. This richens the mixture and melts the ice, which then goes through the engine as water. The throttle may be advanced and the mixture may be leaned to help get some of the lost power back, but immediately after the application of carburetor heat, the pilot must be patient and keep the airplane flying until the ice as completely melted and normal power returns. How long this will take depends on the severity of the icing, but the pilot should expect a delay of 30 seconds to several minutes. Do not deselect carburetor heat if ice is suspected.

In conditions where carburetor ice is likely to form, the pilot may use heat during cruise to prevent the formation of ice in the carburetor. It is also appropriate to use full carburetor heat, if needed, to prevent icing when operating at low power settings for descent, instrument approaches or in the traffic pattern. If carburetor ice is suspected, full carburetor heat should be applied immediately. If ice is present, the use of partial carburetor heat or leaving carburetor heat on for an insufficient period of time may aggravate build up. If installed, the carburetor temperature gauge is useful in determining when to apply carburetor heat.

> **Caution**
>
> If carburetor heat is selected during approach and a go-around becomes necessary, it should be deselected prior to advancing power. Failure to do so could result in a loss of power during a critical phase of flight.

Whenever the throttle is closed during flight, the engine cools rapidly and vaporization of fuel is less complete than if the engine is warm. If carburetor icing conditions are suspected and closed-throttle operation is anticipated, turn carburetor heat on prior to closing the throttle and leave it on during closed throttle operation. Carburetor heat will aid in fuel vaporization and help prevent ice formation in the carburetor throat. It may be beneficial to periodically open the throttle smoothly for a few seconds to keep the engine warm and provide sufficient heat to help prevent icing.

Unless the engine manufacturer or builder recommends otherwise, do not use carburetor heat during takeoff or climb. It is not necessary at high power settings for a typical Lycoming installation and may cause detonation to occur. At ambient temperatures of -10°C (14°F) or below, carburetor heat is not required since any moisture in the air is frozen.

Alternate Air Source

If the RV-type operated is equipped with fuel injection, an alternate air source should be available for the induction system. Alternate air system plumbing will vary, but an alternate air system should bypass the primary source in the event it becomes obstructed. Selection of alternate air may be manual or automatic, depending on installation.

Fuel injected airplanes are, generally, less susceptible to induction icing than airplanes equipped with carburetors; however impact (airframe) icing is still a possibility. Any time unexplained power loss is encountered or icing is suspected, alternate air should be selected (if the system is not automatic).

Pitot Heat. If equipped, pitot heat should be selected on when OAT is 6° C (43°F) or less and temperature/dew point spread is 3°C or less or inflight visibility is less than 1 mile.

Mixture Adjustment. Cold ambient temperature/OAT results in a leaner mixture for a given mixture lever setting. Lean in accordance with engine manufacturer's or builder's recommendations (See NORMAL PROCEDURES).

Airframe Icing

Pre-flight Considerations

Planning. Flights should be planned to avoid known or suspected/forecasted icing conditions. Conditions can change rapidly. Generally, structural icing is an IMC phenomenon. It is normally encountered in clouds any time the temperature drops below freezing and super-cooled water is present. If flight in clouds or visible moisture is avoided or minimized, the risk of icing diminishes.

Warning

Icing may be encountered in any season, at any geographic location at any altitude up to 18,000 feet (and sometimes higher).

Pre-flight Inspection/Aircraft Preparation for Flight. Prior to flight, make sure that all frost and snow are removed from the aircraft. Even a small amount of frost or snow adhering to flying surfaces may decrease lift by up to 33%, and at times may even prevent the aircraft from becoming airborne. At ambient temperatures at or below +5^{o}C (40^{o}F), all flying surfaces and the propeller should be thoroughly checked for evidence of frost or ice prior to flight.

<u>In-flight Considerations</u>

Flight in icing conditions should be avoided. Icing should be considered if OAT is below 6^{o}C, visible moisture is present, and/or temperature and dew point are within 3^{o}C of each other, ceiling is at or below 1500 feet and/or visibility is less than 1 SM. If icing is encountered, keep in mind that structural icing is a condition that can only get worse. Therefore, during an inadvertent icing encounter, it is important the pilot act to prevent additional ice accumulation. The first course of action should be to leave the area of visible moisture and immediately return to an area where there wasn't any ice. This might mean descending to an altitude below the cloud bases, climbing to an altitude that is above the cloud tops, or turning to a different course. If this is not practical, then the pilot must move to an altitude where the temperature is above freezing. If icing conditions are encountered, the pilot should consider making occasional, controlled pitch inputs to ensure that ice build-up between the end of the horizontal stabilizer and the elevator counterweight does not occur.

Tailplane Icing. If icing is unintentionally encountered, the pilot should visually check the leading edge of the horizontal stabilizer for ice accumulation (as practical). Even short encounters and small buildups of ice on aircraft can drastically affect the performance and handling qualities of the airplane. The horizontal stabilizer, which has a smaller leading edge radius than the wing, will accumulate ice at a faster rate than the wing. It is estimated that ice accumulates 3-4 times faster on the stabilizer than the wing. Sufficient ice accumulation on the horizontal stabilizer and elevator surfaces may result in a tail stall. Generally, a tail stall will occur immediately after extending the flaps, or, once the flaps are extended, after airspeed changes, power increase or nose-down pitch commands. The downward force applied by the horizontal tail increases when the flaps are deployed, airspeed is increased (with the flaps down), power is increased (with the flaps down) and the pilot commands pitch down with forward application of the control stick. Symptoms of tail icing include: elevator pulsing, oscillations, or vibrations; abnormal nose-down trim change; reduction in loss of elevator effectiveness; sudden change in elevator force; sudden uncommanded nose-down pitch; or any unusual or abnormal pitch anomalies. If any of these symptoms occur, the pilot should immediately retract the flaps, increase airspeed appropriately and slowly apply sufficient power for aircraft configuration and conditions. Nose-down pitch changes should be made slowly.

If icing conditions are encountered, primary attention should be focused on aircraft control. The airplane should be flown manually (if auto pilot equipped). It may not be practical or possible to maintain altitude. Turn cabin and carburetor heat on or select alternate air source, as appropriate. Monitor carburetor temperature, if appropriate and equipped. Monitor OAT, if equipped. Communicate the state of your situation to air traffic control and clearly state the urgency of the situation. Do not delay taking action to fly out of icing conditions. When requesting altitude changes, advise ATC that you will accept a heading or course change to expedite the altitude change. Do not accept delay in coordinating with ATC, declare an emergency, as required to expedite handling and take the appropriate action required to mitigate icing effects.

Warning

Be alert for signs of ice formation when operating in IMC with the auto pilot engaged (if equipped). A properly functioning autopilot may handle initial accumulation and may mask any handling cues associated with ice formation, possibly to the point where control is compromised when the auto-pilot disconnects or is disconnected.

<u>Icing Considerations</u>

1. All icing encounters are potentially fatal. The type, amount and rate of icing accumulation aren't predictable.
2. If ice is encountered, immediately return to where there wasn't any. Regardless of the course of action selected, immediate action is required if icing is encountered. Turn, climb (if tops are known) or descend below cloud bases and attempt to leave visible moisture. If nothing else, move to an area where the temperature is above freezing. Consider diverting or returning to the departure airport if conditions are worse than forecast. Declare an emergency if the safe outcome of flight is in doubt. Do not delay taking action.
3. Disengage the autopilot (if equipped) and do not use flaps. Avoid/delay power reduction to the maximum extent practical.
4. Use carburetor heat or alternate air source (as appropriate). If equipped, use carburetor heat frequently. Signs of carb icing (e.g. power loss) may not occur until substantial ice has already built up in the carburetor throat. Induction icing is most likely at low power settings. Carburetor heat is most effective when applied before reducing power.

5. Never takeoff with snow or frost on the aircraft. Even barely visible accumulations can significantly degrade performance. RV-types should be inspected visually and by touch to determine if frost is present on a flying surface.
6. Any forecast or PIREP should be considered appropriately. Neither one is a guarantee that icing isn't present or won't be encountered. Icing can be an extremely localized phenomenon. Any information other than what you observe real-time should be considered advisory only.

Caution

- If the airplane is not fitted with a heated pitot and/or pitot heat is not turned on, the first sign of icing may be a loss of pitot pressure. In this case, the airspeed indicator will become unreliable. If equipped, advanced instrumentation systems may provide annunciation of a loss of pitot pressure (See EMERGENCY PROCEDURES, PITOT STATIC MALFUNCTION and AIRSPEED INDICATOR FAILURE).
- Depending on fuel vent configuration, it is possible for ice to accumulate on the fuel vents. If a fuel vent ices over, the fuel tank may begin to collapse before the flow of fuel to the engine stops. A collapsed fuel tank can be detected by visually monitoring the condition of the fuel tanks. In RV-types, the fuel vent systems are separate. If deformation is observed for fuel flow interrupted, the other tank should be selected.
- Pitot, fuel vent and/or oil breather icing may occur without other visual indications of ice build-up.

Warning

- If there is visible ice accumulation on the airplane, a no-flap approach and landing should be flown.
- A controllability check ***should not*** be performed with ice on the airframe. The airplane should be decelerated slowly and any buffet or uncommanded pitch cues should be respected—***do not attempt further deceleration.*** Higher than normal speeds for approach and landing should be expected.

Cold Weather Altimeter Error

The pressure altimeter indicates true altitude MSL when operating at standard pressure and temperature (International Standard Atmosphere [ISA]). Non-standard pressure conditions are corrected by applying the correct local area altimeter setting. Temperature differences from ISA (15^{o}C or 59^{o}F) result in true altitude being lower than indicated altitude whenever the temperature is colder than ISA. True altitude variance under conditions of colder than ISA temperature could pose the risk of inadequate obstacle clearance. ATC-assigned altitudes should not be corrected, but correction may be applied to charted IFR approach altitudes (e.g., procedure turn, FAF crossing, etc.). ATC must be advised if applying correction.

Note

If temperatures are well below standard, induced altimeter error may be significant.

Table 3-4 shows how much error can exist when the temperature is extremely cold. To use the table, find the reported temperature in the left column, and then read across the top row to the height above the airport/reporting station (e.g., subtract the airport elevation from the altitude of the FAF). The intersection of the column and row is the amount of possible error. Note that the altitude error is proportional to both the height above the reporting station elevation and the temperature at the report station. For instrument approaches, the reporting station elevation is assumed to be airport elevation.

Example #1: The reported temperature is -10^{o}C and the FAF is 500 feet above the airport elevation. The reported current altimeter setting may place the aircraft as much as 50 feet below the altitude indicated by the altimeter.

Example #2: The reported temperature is -20^{o}C and the airplane is on downwind at 1000 feet. True altitude is 140 feet below indicated altitude. Notice that the amount of indicated error will decrease throughout the final segment.

Notes

- Correction is based on the reported temperature at the station, not OAT.
- Correction assumes the RV-type operated has had the altimeter properly calibrated and tested.

Table 3-4. ICAO Cold Temperature Error Table

Reported Temperature C°	Height Above Airport in Feet														
		200	300	400	500	600	700	800	900	1000	1500	2000	3000	4000	5000
	+10	10	10	10	10	20	20	25	20	20	30	40	60	80	90
	0	20	20	30	30	40	40	50	50	60	90	120	170	230	280
	-10	20	30	40	50	60	70	80	90	100	150	200	290	390	490
	-20	30	50	60	70	90	100	120	130	140	210	280	420	570	710
	-30	40	60	80	100	120	130	150	170	190	280	380	570	760	950
	-40	50	80	100	120	150	170	190	220	240	360	480	720	970	1210
	-50	60	90	120	150	180	210	240	270	300	450	590	890	1190	1500

Note

In some cases, minimum temperature for the conduct of baro-based GPS approaches is specified and should be observed.

RAIN AND SNOW

Propeller Erosion. Depending on propeller type, erosion of the leading edge can occur when encountering rain, snow or ice pellets in flight. Metal blades are generally impervious to moisture effects, but wooden and composite blades without leading edge protection may erode. If the airplane is equipped with a wooden or composite propeller without leading edge protection and heavy precipitation is encountered, consideration should be given to reducing power to 2200 RPM (if practical) to minimize the chance of propeller damage.

Hydroplaning. Hydroplaning can occur if landing in standing water whose depth exceeds the depth of the tread on the tires. When brakes are applied, there is a possibility that a brake will lock and the tire will ride on the surface of the water. When the tires are hydroplaning, directional control and braking action is virtually impossible. Hydroplaning speed can be estimated by multiplying the square root of the tire pressure by 9. Based on nominal RV-type tire pressure, dynamic hydroplaning is likely to occur at speeds of 45-50 MPH/ 40-45 KTS. If landing on a wet hard-surfaced runway, a firm touchdown should be flown at normal speed and flaps retracted as soon as practical. If hydroplaning is encountered, brakes should be released; aerodynamic control maintained and then brakes should be re-applied.

Contaminated Runway Effect on Takeoff and Landing Performance. Runway surface type, condition and ambient conditions affect takeoff and landing performance; in some cases significantly. Generally, specific takeoff and landing data derived from flight test is not available for most RV-types. Table 3-4 contains safety factors that may be applied to estimate takeoff and landing performance with a contaminated runway.

Precise airspeed control is more critical when operating from a contaminated runway. Although basic RV-type takeoff and landing performance is excellent, ***a contaminated runway can significantly impact takeoff and, particularly, landing performance; especially if multiple factors must be considered, e.g., contaminated runway with a tailwind, etc.*** A stabilized final approach should be flown at V_{REF}/ON SPEED. Final approach and touchdown techniques appropriate for a short field/maximum performance landing may be appropriate when landing on a contaminated runway (See NORMAL PROCEDURES, SHORT-FIELD APPROACH and LANDING).

Be alert for signs of hydroplaning (See HYDROPLANING) during deceleration at approximately 50 MPH / 45 KTS if the runway is wet. Utilize aerodynamic control and minimize cross-wind to the maximum extent practical (the ability to handle cross-wind, particularly in the later portion of the landing roll during deceleration can be greatly reduced on a contaminated runway.

Table 3-5. Contaminated Runway Effect on Takeoff and Landing Performance

Condition	**Takeoff** % Increase in Distance to 50' AGL	**Landing** % Increase in Distance from 50' AGL
Wet Paved Surface	Minimal Effect	+15%
Wet Grass (up to 8" on firm soil)	+30%	+35% Note: very short grass may be slippery, landing ground roll distance may increase by up to 60%
Soft ground, mud or snow	≥ +25%	≥ +25%
Ice	Minimal Effect	≥ 100%

BASIC IMC CONSIDERATIONS

The outstanding handling characteristics and limited stability margins of RV-types can result in high pilot work load when operating under instrument meteorological conditions (if equipped). This should be anticipated and proper attention devoted to maintaining aircraft control at all times. If equipped, an autopilot and/or advanced avionics can reduce pilot workload during IMC operations (if the pilot is familiar and proficient with the operation of those systems).

Single-pilot IMC operations in RV-types require skill and concentration; and are likely to impose high workloads and associated mental stress. To facilitate IMC operations (if appropriate) proper flight preparation/planning, organization, cockpit resource management, and prioritization (avoiding distraction) will assist with maintaining situational awareness throughout all phases of flight. It is important to have planned (and updated) contingency options if circumstances change during flight. Charts and other publications (or Electronic Flight Bags) should be organized so that all information is readily available in the anticipated order that it will be required during flight. If carrying a passenger, consider politely adopting a "sterile cockpit" during periods of high workload (usually all phases of flight except cruise). To assist with maintaining situational awareness, know exact position at all times (greatly facilitated by GPS and moving map displays, if equipped) and think ahead to the *next* event that will take place. Maintain awareness of changing weather conditions by monitoring enroute, destination and alternate weather. Monitor fuel consumption and balance. If not equipped with an autopilot, maintaining fuel balance between wing tanks within approximately 6-8 gallons will assist with maintaining heading control.

ROUGH AIR OPERATION / TURBULENCE PENETRATION

Due to the light wing loading and speed capability of RV-types, turbulence can produce an unpleasant, rough ride, depending on atmospheric conditions. At normal cruise speeds, encounters with turbulence can often result in being thrown about the cockpit or contact of the pilot's head with the canopy. Yaw excursions about the vertical axis are typical. If turbulence or rough air is encountered, harnesses should be tightened as snuggly as possible and consideration should be given to slowing down. Turbulence penetration speed (V_B) is not specified for RV-type aircraft. V_B may be approximated by multiplying stall speed (CAS) by 1.7 or subtracting 5-10 MPH/KTS from appropriate maneuvering speed. If moderate or greater turbulence is encountered, the pilot should ***slow to maneuvering speed (V_A) or less and maintain attitude***. Altitude and heading excursions are likely and if operating under an ATC clearance, it may be necessary to obtain an altitude block or deviate from cleared altitude. Turbulence can degrade handling characteristics when the airplane is loaded at aft CG conditions. If operating with an autopilot engaged, be alert for disconnect to occur in rough air. If operating without an autopilot, anticipate high control workload and prioritize accordingly.

CRUISE DESCENT

A three degree instrument descent can be flown by setting 15-17" MAP (approximately 1800-2000 RPM) and adjusting pitch -3^o from cruise. Airspeed should be approximately V_{N0}. If descending from high altitude, do not exceed V_{NE} TAS. When computing top of descent, allow 1 NM to decelerate from V_{N0} to holding speed or 2 NM to decelerate to V_{APP} in addition to distance required for standard 300' per nautical mile descent. VVI will be equal to 5 x groundspeed (when available) for a 3^o descent path. Turn radius will be approximately 1% groundspeed in NM (when available). Be alert for induction icing during descent if visible moisture is present or conditions are favorable for the formation of ice.

HOLDING

Maximum holding duration can be obtained by flying at L/D_{MAX} (ON SPEED). L/D_{MAX} occurs at maximum endurance glide speed (approximately V_X [if known] or 1.4 V_{S1}) . However, due to the relatively flat drag curve of RV-types, recommended holding speed is 120 MPH / 105 KTS. This speed will provide better energy maneuverability for a very moderate increase in fuel flow and is approximately equal to Carson's Number for the RV-4/6/7/8. 40-45% power (approximately 16-17 Inches of manifold pressure at 1900-2000 RPM) and +2.5^o of pitch will establish a 120 MPH /105 Knot holding condition. Fuel flow for a typical Lycoming installation will be approximately .1 gallons per minute at holding speed power setting (e.g., 25 minutes of holding requires 2.5 gallons of fuel). Be alert for induction icing if visible moisture is present or conditions are favorable for the formation of ice during holding.

APPROACH

RV-types are Category A for instrument approaches. Use 90 MPH (80 KTS) and 11-12 inches of manifold pressure, RPM as required with the carburetor heat ON (for airplanes equipped with a carbureted induction system and equipped with carburetor heat) for instrument approach. Vertical velocity (VVI) should be set 400-500 FPM (displayed groundspeed [when equipped] X 5) for a 3^o glide path. For non-precision approaches, use 10 inches of manifold pressure and an 800-1000 FPM descent rate for stair-step approaches, if desired. In general, approach descent rates greater than 1000 FPM should be avoided. If equipped with advanced instrumentation, a constant descent approach (CDA) is desirable to a stair-step. It may be flown by reference to published descent angle or calculated VVI.

A visual descent point (VDP) should be computed (if not published) by dividing published height above touchdown (HAT) by 300 and adding that distance to the end of the runway. Use of a VDP will assist with maintaining a stabilized 3^{o} final approach to landing. A properly flown CDA will ensure the airplane is coincident with VDP approaching minimums.

LOW-LEVEL WIND SHEAR

Wind shear is a sudden, drastic change in wind speed and/or direction. Speed changes of up to 50 KTS and 180^{o} change in direction can be associated with low-level wind shear. For RV-types, severe wind shear may be defined as a change in velocity (either IAS or reported wind speed) of 15 MPH / KTS or more and vertical velocity changes greater than 500 FPM. If equipped with advanced instrumentation, trend displays may provide the first warning of a wind shear encounter (i.e., rapidly increasing/decreasing airspeed or VVI). Other cockpit cues include pitch changes greater than 5^{o}, ± 1 dot deviation on an ILS or LPV approach, and/or an unusually high or low power setting to maintain normal approach speed.

Table 3-6: Causes of Wind Shear Mishaps	
Convective Weather (Thunderstorms, Rain and/or Snow Showers)	65%
Frontal Systems	15%
Low Altitude Jet Streams	5%
Strong or Gusty Surface Winds	5%
All other causes (Temperature Inversions, Mountain Waves, Sea Breeze Circulation and Unknown Causes)	10%

The single best technique for dealing with low-level wind shear is avoidance. Do not attempt takeoff if wind shear is suspected or reported in the local vicinity. Most general aviation wind shear mishaps occur during landing phase, with 50% of these mishaps occurring on the airport. Most non-convective wind shear encountered during VFR operations is associated with frontal activity. Systems with closely spaced isobars are likely to produce strong and gusty winds. Buildings, trees or other obstacles along the runway can cause wind currents to become even more erratic over the runway itself. Microbursts associated with convective activity produce the most dangerous wind shear.

If wind shear is suspected or encountered, an immediate go-around type escape maneuver should be performed. Select wide open throttle in a controlled manner (do not jam the throttle at low airspeed). Establish a normal climb attitude (8-10^{o} nose up), even if descending. If flaps are up or extended 20^{o} or less, do not change flap configuration during a wind shear encounter. Retract flaps (if fully extended) from 40^{o} to 20^{o}. Maintain positive control and avoid ground contact. It may be necessary to increase angle of attack to just below stall if the wind is shearing from a headwind to a tailwind (i.e., performance decreasing shear). Minimize bank inputs to maximize climb gradient capability. Do not stall in an attempt to avoid the ground. RV-types have good power-to-weight ratio and respond relatively quickly to power and control inputs, but wind shear is capable of exceeding aircraft performance.

HANDLING CHARACTERISTICS

Warning

- Information in this section does not pertain to any one specific aircraft. The basic aircraft configuration (side-by-side vs. tandem), engine/propeller combination fitted, empty weight and actual aircraft load condition have a profound effect on thrust available and weight and balance and, subsequently, performance, stability and handling characteristics. Handling characteristics of RV-type aircraft will vary according to type, configuration and loading.
- ***Information in this section is not intended as a substitute for proper flight training.***

STATIC MARGIN

Aircraft flight characteristics represent a compromise between the control response required to achieve desired performance and the stability necessary to keep pilot work load acceptable. As stability increases, responsiveness to control inputs or other disturbances (e.g., turbulence) decreases. As stability decreases, responsiveness to control inputs or other disturbances increases. Longitudinal stability (pitch) has the most critical effect on aircraft performance. A measure of longitudinal stability is static margin, which is the distance, expressed as a percent of the mean aerodynamic chord between the aircraft CG and aerodynamic center (AC or nominal point of lift). If the CG and AC are coincident, the static margin is zero and the aircraft will exhibit neutral longitudinal stability. A neutrally stable aircraft will remain at any angle of attack to which it is displaced by control movement or other disturbance. If the CG is forward of the AC, the aircraft is longitudinally stable. It will tend to return to the trim angle of attack following a control movement or other disturbance. Conversely, if the CG is aft of the AC, the static margin is negative and the aircraft is longitudinally unstable. In this condition the aircraft will continue to pitch in the direction toward which it is disturbed by control movement or other disturbance. There are no sharp demarcation lines below which the aircraft becomes suddenly uncontrollable or above which the pilot can completely disregard longitudinal stability considerations. Beyond the aft CG limit, pilot reaction time may be too slow to counter a pitch change.

Summary. The static margin determines the character of dynamic stability. The lower the margin, the slower the airplane will return to trimmed condition. As static margin approaches zero (CG and center of lift coincident), dynamic stability becomes neutral. In most RV-types, this coincidence occurs at the non-aerobatic aft CG limit. RV-types do not exhibit uniform stability characteristics due to differences in individual aircraft configuration.

STABILITY AND CONTROL

Longitudinal Stability: The tendency to remain at a constant trim speed, and to return to that trim speed after being displaced by a pitch control input. RV-types exhibit positive longitudinal stability when loaded within center of gravity limits as specified by the designer. Pitch stability decreases as CG moves aft and approaches neutral at the non-aerobatic aft CG limit. Some RV-types may exhibit negative stick-free longitudinal stability at low speed and high power. In this case, the airplane will diverge from trimmed speed and may decelerate to the stall if the pilot does not actively control pitch/speed.

Warning

Pitch stability is reduced at low airspeed as pitch is increased and some stick force lightening occurs in all RV-types, especially at high power settings. The aircraft may diverge from trimmed speed at high power and low airspeed at aft CG. The aircraft may decelerate to an unintentional stall with stick pressure relaxed. The pilot must actively monitor pitch/speed during climb in IMC conditions or at climbs at low altitude in any weather conditions.

Lateral (Roll) Stability: The tendency of the bank angle to remain constant or to return to wings level. RV-types exhibit neutral lateral stability and tend to remain at the bank angle to which it was displaced.

Directional (Yaw) Stability: The tendency of an airplane to maintain a directional heading when wings are level (no roll), and to return to a steady heading after release of a yaw input control (rudder). RV-types exhibit positive directional stability.

Proper aircraft response (i.e., stability) is confirmed by performing a weight and balance calculation for existing conditions and conduct of a stability check. A stability check should be flown prior to the conduct of maneuvering flight to confirm proper aircraft response.

CENTER OF GRAVITY CONSIDERATIONS

The aerodynamic center of RV-types is relatively fixed and the CG moves aft throughout flight as overall gross weight decreases due to fuel burn. This results in a decrease in overall static margin as the flight progresses. As the CG approaches the aft limit, the tendency to over-control should be anticipated. The stick force gradient (pounds of pull per G) will decrease and pilot induced oscillations are possible if the pilot over-shoots desired pitch and counters with excess motion in the opposite direction. Maneuvers requiring precise control (including close formation) are more difficult at aft CG conditions. However, adequate positive static margin remains for control if CG limits are observed. If aerobatic maneuvering is conducted, the aft aerobatic CG limit (when appropriate), should never be exceeded. It should be assumed that no static margin exists aft of the designer's recommended CG limit(s).

Warning

The CG of the RV-types moves aft throughout flight as fuel is burned. CG location should be computed for takeoff and anticipated landing conditions. Shift is proportional to initial CG/loading: for forward/light conditions, shift is generally less; for aft/heavy conditions, shift may be greater.

RV-type CG shift in flight is caused by fuel burn. Various conditions should be considered and several examples should be calculated for the RV-type operated for training to assess the magnitude of the shift. The most important consideration is that the actual CG does not move aft of designer's limits during the conduct of a flight.

The effect of gross weight needs to be considered during pre-flight planning and when operating the aircraft. During Phase 1 testing, RV-types should have demonstrated safe performance when operating at maximum allowable gross weight. Some RV-types have operating limitations specifying maximum allowable gross weight in excess of designer's recommendations.

Certified, production aircraft have the CG limits established which (if adhered to) will prevent the airplane from exhibiting characteristics of neutral or negative stability. The same is true of the RV-types, however because the testing of individual aircraft is, generally, not as advanced and thorough as factory testing; and because each RV-type airplane has a different manufacturer (builder), all RV-types do not exhibit uniform stability characteristics. For any airplane flown at or near the aft CG limit, control responses approaching neutral should be expected.

Advanced handling and confidence maneuvers, because of the associated unusual attitudes, are more likely to result in an unintentional out-of-control situation developing than non-maneuvering flight. Maneuvering performed with an aft CG condition can be hazardous both because of the light pitch control forces which can lead to accidental stalls and spins, and because recovery from those stalls and spins will be more difficult because of the aft CG condition. Advanced handling should only be attempted in aircraft with appropriate testing complete and log book annotations/placards/operating limitations issued allowing the conduct of appropriate maneuvers. The aircraft should be loaded within designer's limits for the conduct of maneuvering flight. The aerobatic aft CG limit is forward of the ultimate CG limit to provide static margin and adequate autorotation recovery characteristics.

The airplane is designed to have positive longitudinal stability/adequate static margin when loaded with the CG within designer's recommended limits. It is in equilibrium at design cruise speed. The nose down tendency caused by the CG being forward of the center of lift is balanced by stabilizer down load resulting from the negative incidence angle (relative to the wing angle) of the stabilizer. So, a constant static load is balanced by an aerodynamic force which will vary with airspeed. If the aircraft's nose is lowered, an increase in speed will result, and that will cause a greater download on the stabilizer, which will in turn raise the nose again to bring the speed back to where it started. The opposite will happen if the nose is raised. However, the aircraft will normally overshoot its original trimmed attitude and speed. Thus there are usually several cycles of pitch hunting required to return to stable flight. Each cycle (direction of initial displacement and then movement in the opposite direction) is of decreasing amplitude (altitude variation). ***These pitch cycles are called phugoids and the time required for the airplane to complete a cycle is referred to as deadbeat response.*** This is depicted in illustration 15-1 in Figure 3-12.

Figure 3-12, Illustration 15-2 depicts the airplane loaded to a more forward CG condition, for which an elevator trim force is needed to maintain equilibrium. Generally, a nose heavy airplane is more stable because of the greater difference between the static weight position and the dynamic force of the trimmed elevator. This condition is also referred to as increased static margin. With a positive static margin, longitudinal stick controls AOA and the airplane exhibits conventional handling characteristics.

Figure 3-12 Illustration 15-3 shows the aircraft loaded so that the CG and center of lift are at the same point. Thus, no stabilizing trim load would be required of the tail. But, if there is no trim load, there is no restoring load, and thus no positive stability. In this condition, the aircraft would have neutral stability. It would continue to fly at whatever attitude it is placed or displaced to. RV-types approach neutral stability at the non-aerobatic aft CG limit. At neutral stability longitudinal stick controls pitch rate.

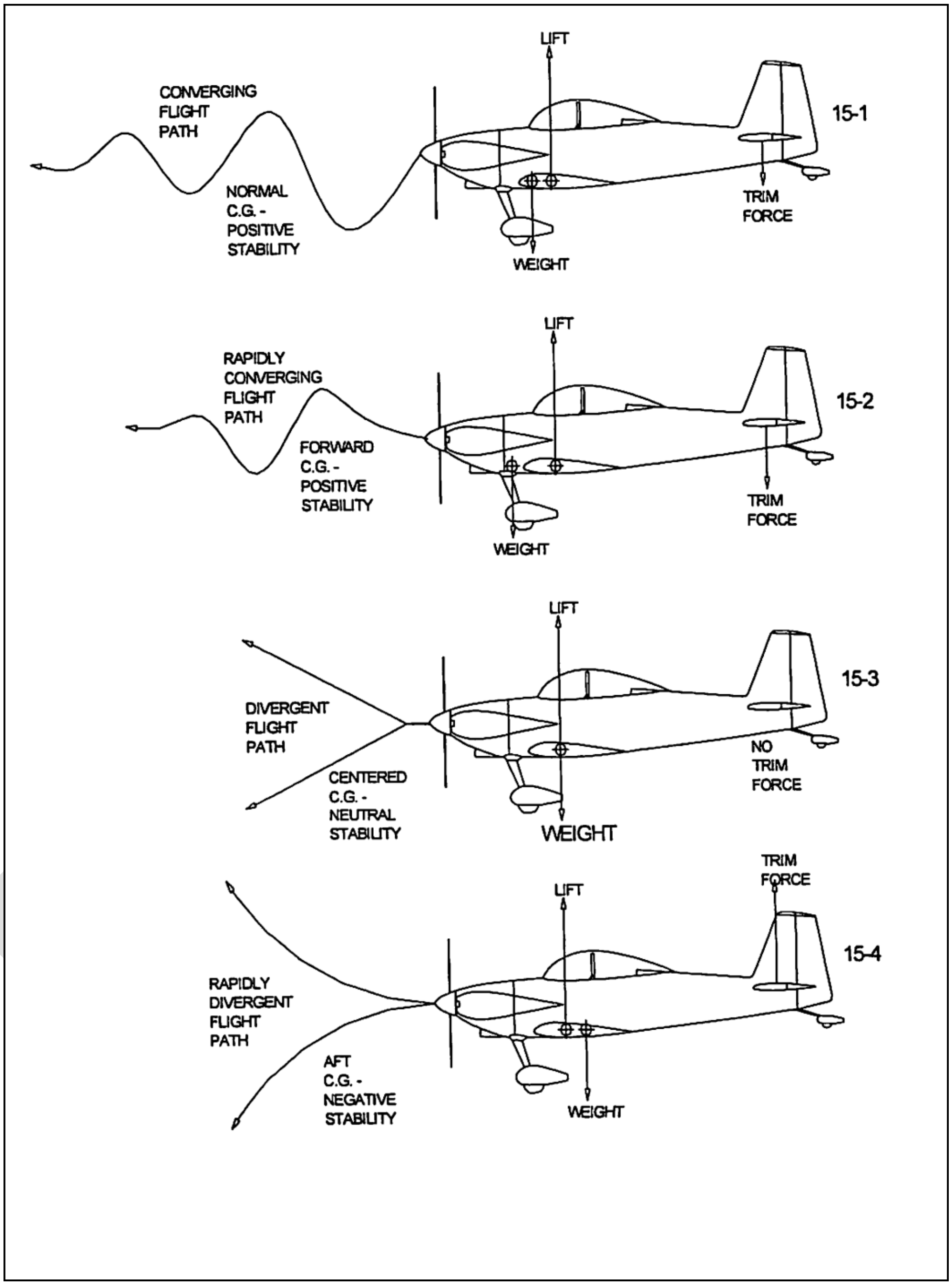


Figure 3-12. Basic aircraft stability.

Figure 3-12, Illustration 14-4 shows the airplane loaded to an extreme where the CG is aft of the center of lift and where the horizontal tail surfaces must produce a lift force to maintain level flight. In this condition, when the nose is lowered, speed will increase and the stabilizer force will increase. But since there is a lifting force or upload on the tail, it will continue to lower the nose and produce more lift and more speed, etc. If the nose was raised and the speed decreased to less than trim speed, the reverse would occur: airspeed would continue to drop until a stall occurred, recover from which would be difficult and spin entry would be probable. This is an unstable condition because the forces acting on the aircraft are destabilizing with a change in speed. This condition is referred to as pitch divergent. When the aircraft is pitch divergent, longitudinal stick controls pitch acceleration. In other words, if a pitch input is made, the nose will continue to pitch up or down at an increasing rate until the pitch input is removed, and then it will ***continue to pitch up or down at the highest pitch rate achieve during the initial control input.*** Control can only be maintained by making small pulsing inputs in both directions: one to start the motion and one to stop it, followed by no input to assess and then the process must be continually repeated. Pilot induced oscillations are highly probable. ***It is extremely difficult to fly an airplane that is pitch divergent and is dangerous.***

Pitch Stability Summary. As the CG moves aft, the aircraft will go from having positive longitudinal stability, to neutral longitudinal stability (CG at or near the non-aerobatic aft CG limit) and then to negative (or divergent) longitudinal stability. The deadbeat response time is inversely proportional to static margin. As the CG moves aft and static margin decreases, deadbeat response time increases and stick force decreases.

Longitudinal (Pitch) Stability. Overall longitudinal stability is satisfactory with the aircraft loaded within prescribed limits. There is a positive linear stick force/G relationship that provides sufficient protection against over-G if proper control technique is utilized. Overall control harmony is good with higher static stability in cruise leading to relatively higher control forces in pitch compared to the ailerons, which remain crisp throughout the flight envelope. Harmony improves and overall handling characteristics become sprightlier as airspeed is reduced, pitch is increased and/or loading moves the CG aft. Overall, side-by-side RV-types exhibit a smaller CG range than tandem types, thus handling characteristics do not vary quite as much with load change.

Note

RV-types exhibit weaker pitch stability as airspeed decreases. As angle of attack increases, the effective distance between the center of lift and the CG decrease, reducing overall static margin.

Static margin is reduced during full-power climbs at low CAS. Pitch stability becomes neutral when maneuvering through 90 degrees of pitch or dive during aerobatic maneuvering. Although RV-types exhibit an acceptable longitudinal stick force gradient throughout the maneuvering range, it varies in overall magnitude with actual CG location, pitch angle and (to a lesser extent) altitude. The best way to limit over-control is to smoothly control the pitch RATE throughout maneuvering. Airspeed DOES NOT affect stick-force gradient, and any perceived lightening is a result of pendulum effect induced by pitch change and actual CG loading, the aerodynamic center remains relatively fixed at all angles of attack up to the stall. Due to the light wing loading and stability of the design, turbulence can effect performance and the pilot should be aware that increased vigilance is required if turbulence is present.

When flying in turbulence, the aft-loaded (less pitch stable) airplane will tend to pitch up or down, and that pitching may intensify in magnitude unless corrected by the pilot. RV-type pitch control forces are light, and any over-controlling will require an opposite pressure to correct. If a pilot induced oscillation is encountered, it is best to relax stick pressure (or freeze the stick momentarily with the velocity vector above the horizon if at low altitude) to damp inputs. RV-types are prone to yaw excursions (perceived as "fish tailing") in turbulence.

Aerobatic Limits. Light pitch control forces, reduced pitch stability and asymmetric control application lead to the possibility of over controlling and over-stressing the airframe during maneuvering flight. The aerobatic aft CG limit is established to provide some static margin during maneuvering. Due to the gross weight and CG limitations of RV-types, the capability to perform aerobatics with passengers aboard can be problematic. Static margin decreases to zero aft the non-aerobatic aft limit is approached. The aft aerobatic limit was established based on factory prototype spin testing and with consideration to maneuvering flight/aerobatics to assist with avoiding out-of-control (e.g., unintentional spin) situations from occurring due to light pitch forces and reduced stability leading to the possibility of over-controlling and/or over-stressing the airframe.

Flight at Aft CG. The design handling characteristics of RV-types relegate stall spin avoidance responsibility to the pilot, especially when operating at an aft CG condition. When operating at an aft CG condition, consider that little or no trim change is required over a wide speed range; stick forces are light and over-control is possible; the nose does not readily drop if the airplane is stalled; there is a tendency for pitch control reversal just prior to the stall; and there is a neutral or negative phugoid at low airspeed.

Note

For tailwheel equipped RV-types, if the tail is raised during the takeoff roll, the amount of effort required to do so can provide some indication of the degree of aft loading. The fact that the tail can be raised at low airspeed also means that adequate elevator control power is available.

Pitch Trim. All RV-type aircraft are equipped with pitch trim. The aircraft are fitted with a servo-tab on the left elevator. Actuation may be mechanical or electric. The tab is highly effective and trim response varies by the type of actuator fitted. Care should be exercised to apply small, precise inputs to avoid over trimming, especially at high airspeeds for aircraft fitted with a manual trim lever. A trim position indicator may or may not be fitted. If specific builder's guidance is not provided, takeoff should be performed with the trim tab set to neutral (i.e., tab aligned with the trailing edge of the stabilizer). If no position indicator is fitted, it may be practical to observe trim tab position on the ground by applying sufficient back stick and looking at the trim tab position to set neutral trim prior to takeoff. In flight, it is also practical to observe the position of the elevator counterweight (except on the RV-3 without balanced elevators) relative to the leading edge of the horizontal stabilizer to ascertain trim setting. Assuming the trim tab is rigged in accordance with design limits, significant amounts of nose-up trim can be required for low-speed, solo operation (e.g., approach and landing at ON SPEED/V_{REF}/V_{APP}) of tandem RV-types. This is normal.

Directional (Yaw) Stability. Strong directional stability and adequate dihedral effect provides a good control harmony in roll and yaw. When yaw is introduced, the damping cycles are rather short period. The airplane exhibits a linear aileron/rudder relationship for sideslip angles up to full rudder deflection with and without flap. Sideslip can be used comfortably on the final approach, with significant effect on approach angle and no pitot/static interference. Excellent rudder authority exists throughout the flight envelope for all RV-types.

Note

Due to limited dihedral effect and excellent directional stability, it is not practical to control the position of the lift vector with rudder input alone. Regardless of AOA, the primary means for rolling the airplane is aileron input coordinated with sufficient rudder to counter any adverse yaw created.

Due to the excellent speed ratio of RV-types (i.e., large range between V_{max} and stall speed), it is not possible to have a single rudder trim setting that will keep the ball centered during all flight conditions. A compromise "feet on the floor" cruise trim setting is, generally, provided by adjustment of the fixed tab on the trailing edge of the rudder. Some aircraft may be equipped with adjustable rudder trim, either manual or electric. For airplanes equipped with a fixed tab, maneuvering flight or speeds other than cruise will require rudder input for coordinated flight. In general (assuming the airplane was built with no vertical stabilizer offset), right rudder input will be required during low airspeed, high power conditions and left rudder will be required during most situations other than cruise and low airspeed, high power. A mechanical or electronic inclinometer (ball) should be referenced to coordinate flight: "step on the ball" as required to center it.

Lateral (Roll) Stability. The airplane exhibits neutral lateral stability. If rolled, it will tend to remain in that bank angle until the pilot applies additional input. The airplane is equipped with balanced Friese-type ailerons that are effective throughout the speed range of the airplane. These ailerons are designed so that the lower edge protrudes below the wing with the aileron is deflected up, thus countering adverse yaw to a degree and somewhat mitigating the need for coordinating rudder in a turn. For a properly constructed and rigged aircraft, the primary cause of any perceived lateral instability or "heavy wing" is a variance in fuel level, with a tendency to roll toward the wing with more fuel in the tank. RV-types may or may not be fitted with roll trim. In general, consider keeping fuel load balanced throughout flight.

STALLS

RV-3/4/6/7/8 types utilize a NACA 23013.5 airfoil section that stalls at 14-15^{o} angle of attack. The RV-9 utilizes a proprietary airfoil that stalls at XX^{o} angle of attack. RV-types exhibit conventional stall characteristics power off or power on. Generally, however, there is little advance stall warning in the form of pre-stall buffet. Buffet which does occur does so within a MPH/Knot or two of a fully developed stall. For typical 1 G level stalls, the airplane will exhibit a nose up attitude prior to stalling, which can be fairly pronounced for power-on stalls due to the low power loading of RV-types. The following discussion assumes a "clean wing" configuration, i.e., no stall strips or vortex generators fitted. Stall strips and vortex generators may change aerodynamic warning and/or stall characteristics, if fitted.

1-G Stalls. An important concept to understand is that for a given gross weight, indicated stall is what it is. In other words, the airplane will stall at that indicated speed, regardless of how accurate the indication is (i.e., how well the system is calibrated). Indicated stall speed is affected by flap position: if flaps are extended, indicated stall speed will decrease. The airplane will *always* stall at critical angle-of-attack, which does not change regardless of load factor, gross weight or aircraft configuration. If the airplane is equipped with a properly calibrated AOA system, that system should serve as the primary instrument reference for determining when critical angle of attack is being approached. Some aircraft may be fitted with a stall warning device, that if properly calibrated may also provide stall warning. If the RV-type operated for training is only equipped with an airspeed indicator (mechanical or electronic), it may be necessary to establish an indicated stall speed commensurate with existing gross weight conditions, as required for reference.

One technique for the performance of 1G stalls is to approach the stall at a constant altitude while decelerating at a rate of 1 MPH / 1 Knot per second. Engine and propeller effects (left rolling tendency caused by torque, p-factor, gyroscopic and slipstream effects) increase as airspeed decreases and the stall is approached. Engine and propeller effects are proportional to power setting (i.e., higher power = more effect), but are evident even at idle power. Most RV-types built in accordance with plans exhibit limited pre-stall buffet. If the rudder is used to control yaw as the stall is approached, no wing drop will occur with a power off stall. If ailerons are utilized to compensate for engine and propeller effects (or applied for any reason at the stall), a wing drop will likely occur post-stall. A typical error when flying a 1-G power-off stall is to unintentionally apply right aileron as the AOA increases and airspeed decreases to control roll caused by engine and propeller effects, this will cause the left wing to drop post stall. If the slip indicator (ball) is closely observed when approaching the stall under these conditions, it will slide slightly to the right if aileron is applied in this manner. Depending on aircraft load and rigging, it may not be possible to stall with precise heading and/or bank control (due to engine and propeller effects) if proper coordination is maintained throughout the stall. As power is increased, engine and propeller effects increase proportionally (See ENGINE AND PROPELLER EFFECTS).

Generally, a more pronounced nose drop and slight left wing drop will accompany a properly coordinated stall with flaps extended. ***Regardless of configuration or power setting, stall recovery is prompt as angle of attack is reduced.*** Ailerons remain effective until the wing stalls, however the rudder should be the primary anti-yaw control at high angle of attack. On tail wheel equipped airplanes, main landing gear fairings destabilize directional stability to some degree and post stall yaw excursions are slightly more pronounced when flying with fairings installed. The size and shape of the gear fairings fitted have an effect as larger fairings (i.e., broader chord than those depicted on the plans) add increased vertical area ahead of the aerodynamic center of the airplane.

Accelerated stalls. ***The airplane can stall at any airspeed and any attitude any time the critical angle of attack is exceeded.*** Critical angle of attack remains constant at all times, it is not affected by weight or G-loading. Most RV-types exhibit increased buffet cues as g-loading increases. A 2 G stall will occur at approximately 130% clean stall CAS, and a 4 G stall will occur at approximately 180% and a 6 G stall will occur at 225%. ***Note that normal pattern operations are conducted at speeds roughly equal to 2 G accelerated stall speed.*** Keep in mind that a level 60^{o} banked turn requires 2 G's, so stall margin for turn of this type performed in the pattern can be considerably reduced (unless the velocity vector is adjusted). Below maneuvering speed, the airplane will stall before reaching G limits, above maneuvering speed, G limits will be encountered before a stall occurs (See MANEUVERING SPEED). Figure 3-13 depicts bank angle effect on stall speed. An accelerated stall may be evidenced by buffet, nose rise (stick force lightening), the nose stops tracking across the horizon (when turning), and/or wing drop (perhaps significant). If back stick is applied abruptly, it can be difficult to distinguish aerodynamic cues prior to the stall and will likely result in wing drop and/or the nose stops tracking through the plane of the turn. If back stick is applied too slowly, the aircraft may decelerate and develop a high sink rate as opposed to a "clean" stall.

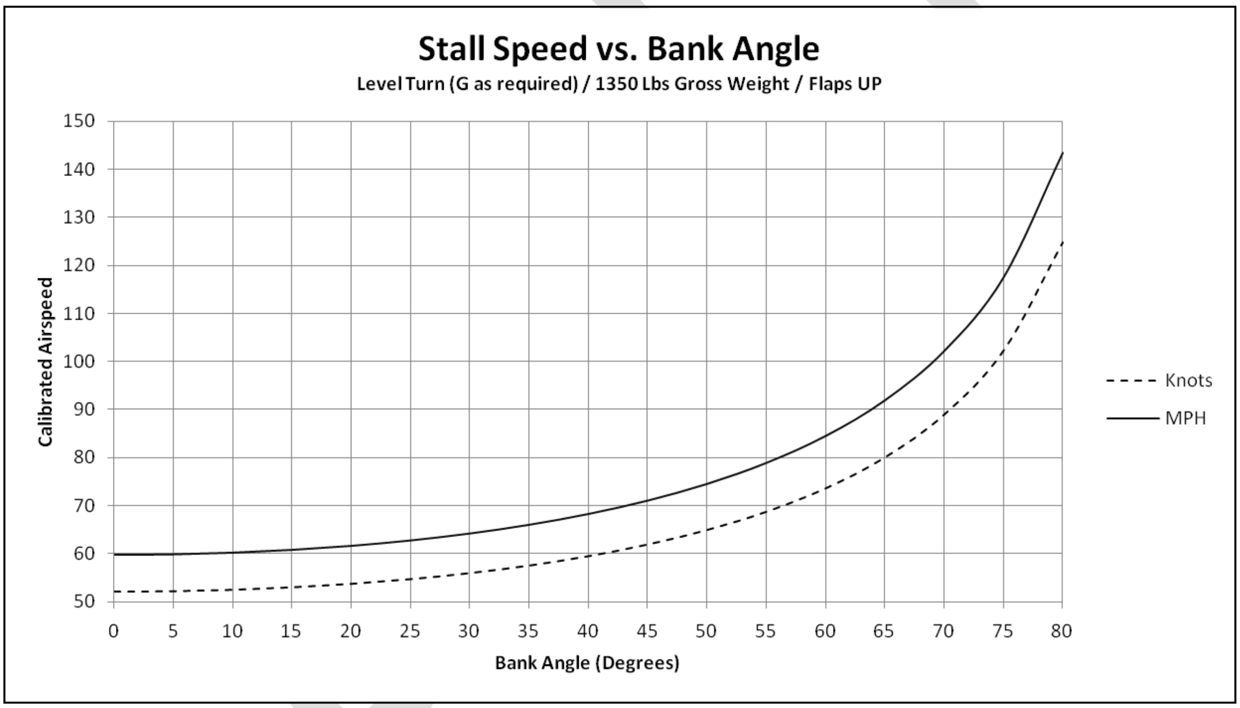


Figure 3-13. Example of Bank Effect on Indicated Stall Speed (1G calibrated stall speed is 60 MPH/53 KTS in this example).

Post-stall behavior. If aft stick is maintained and critical angle-of-attack exceeded, directional stability breaks down but some degree of directional control remains with rudder. Longitudinal behavior (static margin) under these conditions is proportional to CG location. With forward CG, positive stability remains and when an upright stall is performed and full aft stick maintained post-stall, the nose will continue to drop intermittently, decreasing AOA momentarily and allowing airspeed to increase until sufficient elevator authority is restored to stall the wing again. Wing drop (perhaps significant) during post-stall maneuvering is common. As CG moves aft, the positive longitudinal stability decreases. The primary indication of breakdown of directional stability post-stall is yaw (nose slice). This is best perceived by sighting down the nose and looking for left or right motion (yaw). Sufficient rudder authority remains post-stall to control yaw (nose slice) and prevent auto-rotation, however exact heading control is generally not practical. During a sustained deep stall, intermittent horizontal tail buffet may occur.

Cross-Control Stalls.

Slip. Any yaw present at the upright stall will cause roll in the direction of yaw. If the stall is approached while in a slip, the airplane may rudder roll in direction of yaw or, more likely, simply buffet as critical angle of attack is approached/exceeded. If AOA is increased past critical, the airplane *may* depart (auto-rotate/snap roll) in the direction in which yaw is applied. The initial rudder roll is slow or may occur hesitantly as a series of partial (ratcheting) rudder rolls. Post-stall departure/auto-rotation must be forced after rudder roll. Normally, if a stall is encountered in a slipping turn (e.g., base turn), the airplane will simply stall and will recover promptly when AOA is reduced, even if slip inputs are maintained throughout the stall and recovery. If a full cross-control condition is maintained post-stall at speeds below $L/D_{MAX}/V_{REF}$, intermittent significant horizontal tail buffet may occur.

Skid. If the airplane is stalled while in a skid, it will depart immediately in the direction in which rudder is applied as soon as critical angle-of-attack is exceeded. In this case, the airplane will rapidly snap roll in the direction in which rudder is applied, generally “underneath” (through inverted) if the rudder is displaced to the inside of the turn. Recovery is prompt when rudder is neutralized and AOA is reduced. ***A skidding departure, if induced/encountered at low altitude (e.g., during a base turn to final) may be non-recoverable.***

> **Note**
>
> Skids have greater potential for stall/spin loss-of-control than slips. Skidding turns during pattern operations should be avoided.

Recovery. AOA responds nearly immediately to stick input, and directional stability returns as soon as AOA is decreased and airspeed begins to increase. Recovery technique is a function of attitude when the stall is encountered, but as a general rule, once the decision is made to reduce AOA, it should be done by relaxing back pressure/easing the stick forward vs. shoving it forward to the stop. ***In an upright stall, simply easing back pressure and maintaining or re-***

establishing coordinated flight is generally sufficient for recovery. The airplane responds promptly to unloading/AOA reduction. If, however, forward stick is applied before or simultaneously with anti-yaw rudder, the yaw and/or roll may initially increase (due to inertial coupling) until AOA decreases and airspeed beings to increase.

Any stall recovery has the potential to produce an unusual attitude during recovery, especially if yaw was present as the airplane stalled. During recovery close to the ground, pulling on the stick may not be an appropriate post-stall recovery control input. If a skidding stall unintentionally causes a rapid departure (snap/flick roll), the quickest recovery will generally be to allow the roll to continue until an upright attitude is attained. The lift vector must be above the horizon and AOA must be below critical (with airspeed increasing) before executing an upright dive recovery (pull) close to the ground. If the airplane recovers in an inverted attitude close to the ground, and airspeed is sufficient, it may be necessary to push to ensure the velocity vector is above the horizon before attempting an "unloaded" roll to an upright attitude. This may cause engine stoppage on airplanes without inverted systems fitted. If the airplane is upright, but AOA is above critical, failure to reduce AOA (i.e., push) will likely result in loss of control. Use caution to avoid a secondary stall during recovery.

MANUEVERING FLIGHT

> **Caution**
>
> It is important to differentiate between "G-available" and "G-allowable." ***G-available is the maximum G the airplane is capable of generating based on airspeed (dynamic pressure)***—the higher the airspeed, the more G-available. ***G-allowable is the maximum amount of G allowed without exceeding design limitations*** or damaging the airframe and is the operational limit of the airplane. G-available depends on whether or not the airplane is rolling or not when G is applied. When G-available exceeds G-allowable, it is possible to maneuver the airplane in a manner that exceeds G limits. ***G-available exceeds G-allowable at speeds in excess of maneuvering speed (V_A). Maneuvering speed is different if the airplane is rolling vs. a "straight pull" when G is applied. Asymmetric maneuvering speed is always LOWER than symmetric maneuvering speed.*** Since maneuvering speed is not a fixed value, it is not displayed on the airspeed indicator.

Symmetric G Application/Maneuvering. Symmetric maneuvering occurs when only one primary flight control is applied at a time, i.e., maneuvering about a single axis of motion. For example, in a loop, ailerons and rudder remain neutral while elevator (pitch) is applied. Another example is "unload, roll, set lift vector (i.e., stop roll) and pull;" in this case, single-axis maneuvering is occurring sequentially to adjust the direction of the lift vector. An unloaded roll (using aileron), momentary pause followed by application of elevator to increase G-load may also be referred to as a "straight pull." The loop is an example of a straight pull. A simple unloaded aileron roll is another example of a single-axis maneuver. When maneuvering symmetrically, the airplane may be flown to design G limit (G-allowable).

> **Warning**
>
> Structural margin is not specified if full control deflection is made in one direction followed by another full control deflection in the opposite direction, even when operating below V_A.

Asymmetric G Application/Maneuvering. Asymmetric maneuvering is movement around two or more axis simultaneously (e.g., rolling and pitching, rolling and yawing, pitching and rolling, etc.). An example of asymmetric maneuvering occurs when two or more flight controls are applied simultaneously, e.g., barrel roll. ***When maneuvering asymmetrically, design G-limit (G-***

allowable) is reduced 20-33%. Exact reduction is not specified by Van's Aircraft. MILSPEC requirements reduce G-allowable by 20% and FAR requirements reduce G-allowable by 33% when maneuvering about more than one axis simultaneously. It is recommended that pilot's consider using the most conservative value (33%) as a rule of thumb since exact design specifications are unknown. Since asymmetric maneuvering often combines rolling with G-application, it is sometimes referred to as "rolling G."

> **Warning**
>
> Unless care is used in the sequence of application of flight controls, any maneuver may unintentionally exceed asymmetric G limits if improperly executed.

Maneuvering Speed. ***The design maneuvering speed (V_A) is the speed below which you can move a single flight control, one time, to its full deflection, for one axis of airplane rotation only (pitch, roll or yaw), in smooth air, without risk of damage to the airplane.*** This is an example of symmetric G application/maneuvering. Maneuvering speed is a calculated value that depends on G limit (G allowable) and aircraft gross weight. ***Maneuvering speed is NOT a fixed value.*** Maneuvering speed is coincident with "corner velocity" or the speed at which maximum instantaneous aerodynamic turn performance is obtained. ***To calculate maneuvering speed, utilize the following formula: $V_A = V_S \times \sqrt{G\text{-limit}}$.*** V_S is stall speed and G limit is specified by the designer. CAS at which stall occurs increases as gross weight increases, therefore, V_A increases as gross weight increases. To adjust V_A for non-maximum gross weight conditions, either utilize stall speed at operating gross weight to calculate V_A or utilize the following formula to adjust maximum gross weight V_A: $V_{A\ New} = V_{A\ Max\ Gross} \times \sqrt{(\text{operating gross weight}/\text{maximum gross weight})}$. RV-type example maneuvering speeds are depicted in Table 3-7. Due to the wide speed band of RV-types (the ratio of V_{NE} to V_S), most operations are conducted at speeds well in excess of V_A.

> **Warning**
>
> ***Maneuvering speed (V_A) should be calculated for the RV-type operated for training at the gross weight at which training flights are conducted.*** Symmetric and asymmetric speeds should be calculated. Snap maneuvering (if performed) should only be conducted at speeds below asymmetric V_A.

Design Load Limit (G Allowable). ***Design load limit is the amount of G that may be placed on the airplane without causing damage.*** Design load limit is also referred to as "G allowable."

Design load limit varies as a function of weight and designer's limits should be observed at all times. If the RV-type operated has a non-standard maximum gross weight in the operating specifications, design load limit is ambiguous. In this case, the exact structural margin is unknown. When a builder specifies higher gross weight limits or a pilot operates an airplane in excess of designer's limits, he assumes the risk associated with operation with an unknown structural margin. It is possible that structural damage or deformation occurs when the airplane is operated at weights above designer's recommendations even when design G limits are not exceeded. Structural damage may also occur any time G-limits are exceeded (intentionally or otherwise), including the effects of gust load experienced in turbulent air. Experimental aircraft may not be legally operated at a gross weight in excess of the maximum gross weight specified in the operating limitations for that aircraft. As described in ASYMMETRIC G-APPLICATION/MANEUVERING, ***design load limit decreases during asymmetric maneuvering*** (rolling G application).

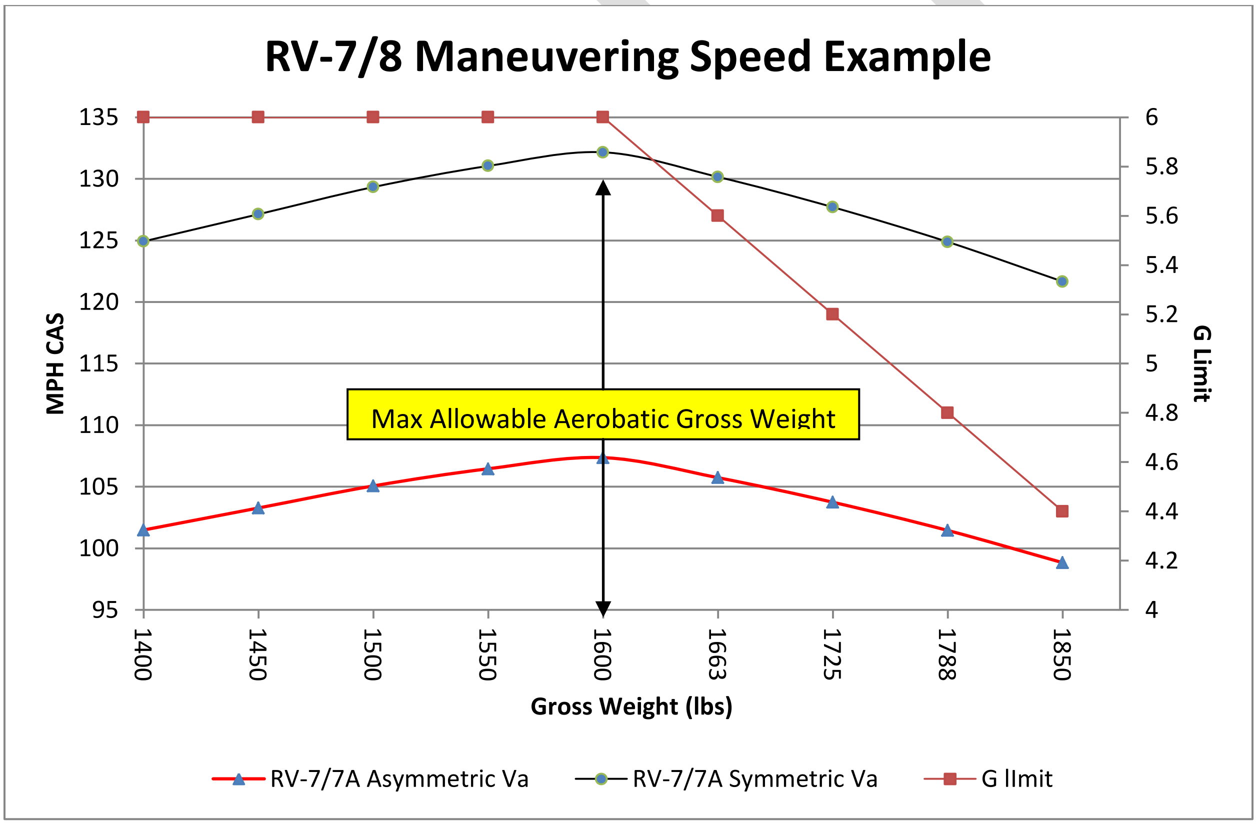


Figure 3-14: RV-7 Maneuvering Speed and G-Allowable (G Limit) vs Gross Weight. Derived from Van's Aircraft published performance data for RV-7/7A. All two-seat RV-types exhibit similar relationships.

RV-types have G-limits specified based on gross weight. *At weights above maximum allowable aerobatic gross weight* (or 1600 lbs for RV-9/9A), *G-limits* (G allowable) *are reduced*. This results in an increase of maneuvering speed (V_A) from minimum gross weight to maximum allowable aerobatic gross weight (or 1600 lbs for RV-9/9A) and a subsequent ***DECREASE*** in V_A as G allowable is reduced at gross weights greater than maximum allowable aerobatic gross weight (or 1600 lbs for RV-9/9A). This basic relationship is depicted in Figure 3-14.

Ultimate load limit is the limit if reached and sustained for more than 3 seconds, at which structural failure can occur (this assumes no structural flaws/building errors, material defects and/or corrosion). It should be noted that structural deformation/damage can occur at *any* load in excess of design load limit. An "over G" condition occurs any time design load limits are exceeded. If an over G condition is unintentionally encountered during maneuvering flight, a post-flight inspection for possible damage or deformation is appropriate.

Table 3-7. RV-Type Example Maneuvering Speeds

RV-Type	Wt (lbs)[4]	+G Limit[3]	V_S CAS MPH[4]	V_S CAS KTS	V_A CAS MPH	V_A CAS KTS	Asym +G Limit[2]	Asym V_A CAS MPH	Asym V_A CAS KTS
4	1160	6.0	48	42	118	102	4.0	96	83
	1375[5]	6.0	52[6]	45[6]	127	111		104	90
	1500	4.4	54	47	113	98	2.9	92	80
6	965	6.0	49	43	120	104	4.0	98	85
	1375[5]	6.0	53[6]	46[6]	130	113		106	93
	1600	4.4	55	48	115	100	2.9	94	82
6A	1650								
7/7A	1400	6.0	51	44	125	109	4.0	102	89
	1600[5]	6.0	55[6]	48[6]	135	117		110	96
	1800	4.4	58	50	122	106	2.9	99	86
8/8A[1]	1400	6.0	51	44	125	109	4.0	102	89
	1600[5]	6.0	55[6]	48[6]	135	117		110	96
	1800	4.4	58	50	122	106	2.9	99	86
9/9A 160HP	1350	4.4	44	38	92	80	2.9	75	65
	1600		50	43	105	91		86	74
	1750	3.8			97	85	2.5	80	69

[1] -1 Wing
[2] Asymmetric G limit not specified by Van's Aircraft. Data assume 33% reduction IAW FAR 23 criteria. Data are for positive G only. Formulas may be applied to negative G limits to determine V_A applicable for negative maneuvering.
[3] Flaps up. Flaps down G limit not specified by Van's Aircraft. FAR 23 flaps down G Limit +2.0 unless AFM notes otherwise.
[4] Van's Aircraft Performance Data.
[5] Van's specified maximum allowable aerobatic gross weight.
[6] Stall speed at maximum aerobatic gross weight not published by Van's Aircraft. Data interpolated from Van's Aircraft published performance data.

G Available. ***G available is a function of flight control authority and dynamic pressure (airspeed).*** As airspeed increases, control authority increases and G available increases. ***At speeds in excess of maneuvering speed/corner velocity, G available exceeds G allowable.*** At speeds below appropriate maneuvering speed/corner velocity, the airplane will stall before design G limits are exceeded. Due to the wide speed band of RV-types (the difference between stall speed and V_{NE}), ***G available at high speed is extreme and well in excess of ultimate load limit.*** Table 3-8 shows G available for an example RV-4 operated at designer's recommended maximum aerobatic gross weight.

Some important values shown in Table 3-8 are 2G stall speed, which equates to stall speed in a level, 60^{o} banked turn (80 MPH CAS in this case), 4G stall speed (maximum asymmetric maneuvering limit assuming reduction in allowable G of 33%) and design symmetric G limit, which occurs at 135 MPH CAS in this example. Of note, ***at V_{NE}, the airplane is capable of generating greater than 14 G's, well in excess of the ultimate load limit of 9 G's at which structural failure may occur.*** A high-speed over-G in any RV-type has the potential to cause catastrophic airframe failure.

Table 3-8. Example RV-4 Aerodynamic G-Available at 1375 Lbs Gross Weight

CAS (MPH)	G	CAS (MPH)	G	CAS (MPH)	G	CAS (MPH)	G
55	1.0	100	3.3	145	7.0	190	11.3
60	1.2	105	3.6	150	7.4	195	12.6
65	1.4	110	4.0[1]	155	8.0	200	13.2
70	1.6	115	4.4	160	8.5	205	13.9
75	1.9	120	4.8[2]	165	9.0[4]	210	14.6
80	2.1	125	5.2	170	9.6	215	15.3
85	2.4	130	5.6	175	10.1	220	16.0
90	2.7	135	6.0[3]	180	10.7	225	16.7
95	3.0	140	6.5	185	11.3	230	17.5

[1] 80% Asymmetric load limit. Van's Aircraft does not specify asymmetric load limit.
[2] 66% Asymmetric load limit. Van's Aircraft does not specify asymmetric load limit. V_A examples in Table 3-1 assume 66% limit.
[3] Design (maximum allowable) G Limit @ 1375 lb Gross Weight. Structural damage can occur at loadings in excess of maximum limit. Aerodynamic limit and G-available are coincident at V_A/Corner Velocity.
[4] Ultimate design load limit. Structure can withstand 9 G's for 3 seconds assuming no corrosion, fatigue, material defects or construction flaws.

Cockpit G. This the G force that the pilot physically experiences and is ***displayed on the G meter*** (when equipped). In level, unaccellerated flight, cockpit G is 1.

Radial G. Radial G is an expression for the centripetal force that turns a maneuvering airplane. It is the ***G force acting in the plane of turn***. This is the actual force generated by the component of lift that turns the airplane. For a level turn, the plane of the turn is coincident with the horizon and we refer to the "horizontal component of lift." This is an example of radial G. In a loop, the plane of turn is vertical and the entire lift component is aligned with the plane of the turn and radial G "turns" the airplane throughout the loop. For non-level maneuvering flight, the plane of turn is roughly coincident with the lift vector (angle of bank).

Lift Vector. When describing maneuvering flight, it is helpful to understand the direction in which lift is working. The "lift vector" refers to the direction that the wing generates lift, roughly perpendicular to the wings. If the pilot is sitting upright in the cockpit, the lift vector is acting in the direction his head is pointing. In a 45^o banked level turn, the lift vector is angled 45^o in the direction of the turn. In a split-S (180^o bank), the lift vector is straight down, conversely at the start of a loop, the lift vector is straight up. Cockpit G is applied in the direction of the lift vector. Roll is the primary means to control lift vector placement. Once the lift vector is positioned with roll, pitch controls the amount of lift generated (as a function of dynamic pressure [airspeed] and AOA). This primary lift vector can be broken down into components that cause the airplane to climb, descend or turn.

Velocity Vector. The term "velocity vector" refers to where the airplane is going. It is also referred to as the flight path vector. These terms are interchangeable. If the RV-type is equipped with advanced instrumentation, flight path vector may be displayed on the EFIS. If the airplane is equipped with traditional instrumentation, velocity vector can only be approximated. An important concept to understand is that where the airplane is going (flight path vector) is not necessarily where the airplane is pointing.

A way to visualize the concept of velocity vector is to consider a 3^o final approach to landing. In this case, the descent angle is 3^o, and the airplane is flying at Van's recommended V_{REF} (ON SPEED [L/D_{MAX}] or 1.3-1.4 x V_S). For the 23000 series airfoil on the RV-4/6/7/8, L/D_{MAX} occurs at approximately 8^o AOA. Assuming 1^o angle of incidence, you can see that 9^o of pitch is required to maintain this flight condition. In other words, the velocity vector is 9^o below where the nose is pointing. Since the velocity vector is coincident with a 3^o approach path in this example, the nose of the RV would actually be 6^o above the horizon in a stabilized condition (9 – 3 = 6). This 6^o is the angle displayed on the artificial horizon (if equipped and properly adjusted). If the airplane is equipped with advanced instrumentation and the flight path vector is displayed, it will be 3^o below the horizon and 9^o below the whiskey line/boresite cue (i.e., where the nose is pointed). If it were necessary to level off, it would be necessary to increase pitch by 3^o (and add power) if L/D_{MAX} is maintained. If the airplane is equipped with advanced instrumentation and the flight path vector is displayed, it will "transition" up to the horizon during the level-off maneuver and the whiskey line/boresite cue will transition to a 9^o nose up attitude (assuming

L/D_{MAX} is maintained) During approach, the velocity vector is coincident with the point in the windscreen that is neither moving up or down.

In the previous example, it's easy to visualize the difference between where the airplane is pointed and the velocity vector since the airplane is in a stable condition. During maneuvering flight, it is not always as straight forward unless you are maneuvering 90^o nose up or nose down, in which case the velocity vector is roughly coincident with the nose. Of course, if a 90^o nose up condition is maintained, the velocity vector is going to rapidly transition to the tail as airspeed decays to zero. Another example is a sustained deep stall. In this case, the airplane is actually "falling" at a fairly steep angle, yet the nose is roughly coincident with the horizon.

A special case of velocity vector management occurs when the pilot establishes a zero G condition. Any time the pilot unloads to a zero G condition, he is actively aligning the nose with the velocity vector and establishing a ballistic condition. For example, if maneuvering resulted in a steep climb angle (say, 70^o), airspeed is going to rapidly decay if that climb angle is maintained since there isn't sufficient thrust in any RV-type to *sustain* a 70^o climb angle. If, however, the pilot neutralizes aileron and rudder input and eases the stick forward to establish a zero G condition, the nose and velocity vector will re-align and the airplane will simply float across a ballistic arc. Airspeed may decay well below 1G stall speed; but will increase as soon as the arc transitions to a nose down condition and the velocity vector drifts below the horizon. This is an important concept and is the key to the "unload for control" concept that allows the pilot to "bail-out" of any condition that could result in stall and subsequent post-stall departure from controlled flight.

One of the most important RV-type handling characteristics to understand is that any time the velocity vector is below the horizon and the nose is down, the airplane will accelerate due to low drag characteristics of the design. Acceleration can occur rapidly, possibly to dangerous speeds. This acceleration should be anticipated, and if excessive airspeed build-up is encountered, the pilot must reduce power, simultaneously adjust G load and reposition the lift vector (if necessary) and velocity vector above the horizon, to prevent a dangerous buildup of airspeed. Note that a fixed pitch propeller will behave like a pinwheel under these conditions and an engine over-speed can also occur.

Maneuvering Summary

Maneuvering is limited by structure and the ability to produce lift and thrust. Designer's limiting load factor and weight and balance limits should be adhered to at all times. G-allowable should be reduced 20-33% when applying asymmetric flight controls (i.e., simultaneous maneuvering about two axis). Fastest roll rates occur during unloaded (0 G) flight. Radial G is the amount of lift (expressed in G's) that acts to turn the airplane. Lift vector is coincident with the plane of symmetry and acts perpendicular to the wings. Any time the lift vector is above the horizon, natural gravity is reducing radial G/turn performance and any time the lift vector is below the horizon, natural gravity is increasing radial G/turning performance. The radius of turn depends solely on velocity (TAS), G and radial G. Turn radius is the dimension of the turn circle. Turn rate is solely dependent on velocity (TAS) and radial G. Turn rate is how fast the nose cuts across the sky and is expressed in degrees per second: the greater the G-available, the higher the turn rate. No other variables (such as wing loading or gross weight) are a factor in turn performance. All RV-types exhibit outstanding turn performance and maneuverability.

TURN PERFORMANCE

Level Turns. The airplane turns as a result of adjustment of the lift vector (bank) to produce a horizontal component of lift (radial G). This produces a centripetal force that causes the airplane to turn. To prevent a loss of altitude, back stick (increasing AOA/C_L) is required increasing the overall magnitude of the lift vector. This is experienced in the cockpit as increased G loading. For medium and shallow bank angles, the G load is low and only a small amount of back pressure is required to maintain altitude. If power is not adjusted in a turn and bank angle (and, subsequently, G) is increased an airspeed "bleed" will occur as angle-of-attack increases and the indicated airspeed will decrease until a new equilibrium is established (or a stall occurs). At medium and shallow bank angles (30 degrees or less), this amount of energy loss (airspeed decrease) is negligible in RV-types. As bank and G increase, the amount of energy loss becomes much greater.

The only factors that affect turn rate and radius for any airplane are radial G and true airspeed. The relationship between bank angle and true airspeed and their effect on turn radius for an example RV-type in a level turn is depicted in Figure 3-15.

Maneuvering may be defined as changing the magnitude and/or direction of the aircraft's velocity vector. Maneuvering is conducted about all three aircraft axes. ***"Unloaded" maneuvering is the application of flight controls in a low G (0 ± ½ G) condition about a single axis at a time.*** An example of unloaded maneuvering is a simple aileron roll—after obtaining entry speed, the pitch is increased, the stick is eased forward to unload and then aileron is applied to rotate the lift vector. ***"Loaded" maneuvering occurs under G when a flight control or controls are applied.*** An example of a loaded maneuver is a high AOA rudder roll. In this case, G is applied in pitch to increase AOA and rudder is simultaneously applied in the direction of desired roll. Yaw/roll coupling causes the airplane to roll slowly in the direction in which rudder is applied. A barrel roll is another example of loaded maneuvering.

The following factors impact maneuvering:

1. Fore and aft stick movement determines the amount of G force that turns the aircraft.
2. Rudder and ailerons determine the plane of turn.
3. The amount of G, along with velocity (TAS) determines the rate and radius of turn.
4. Available thrust (power) produced by the propeller governs velocity available.

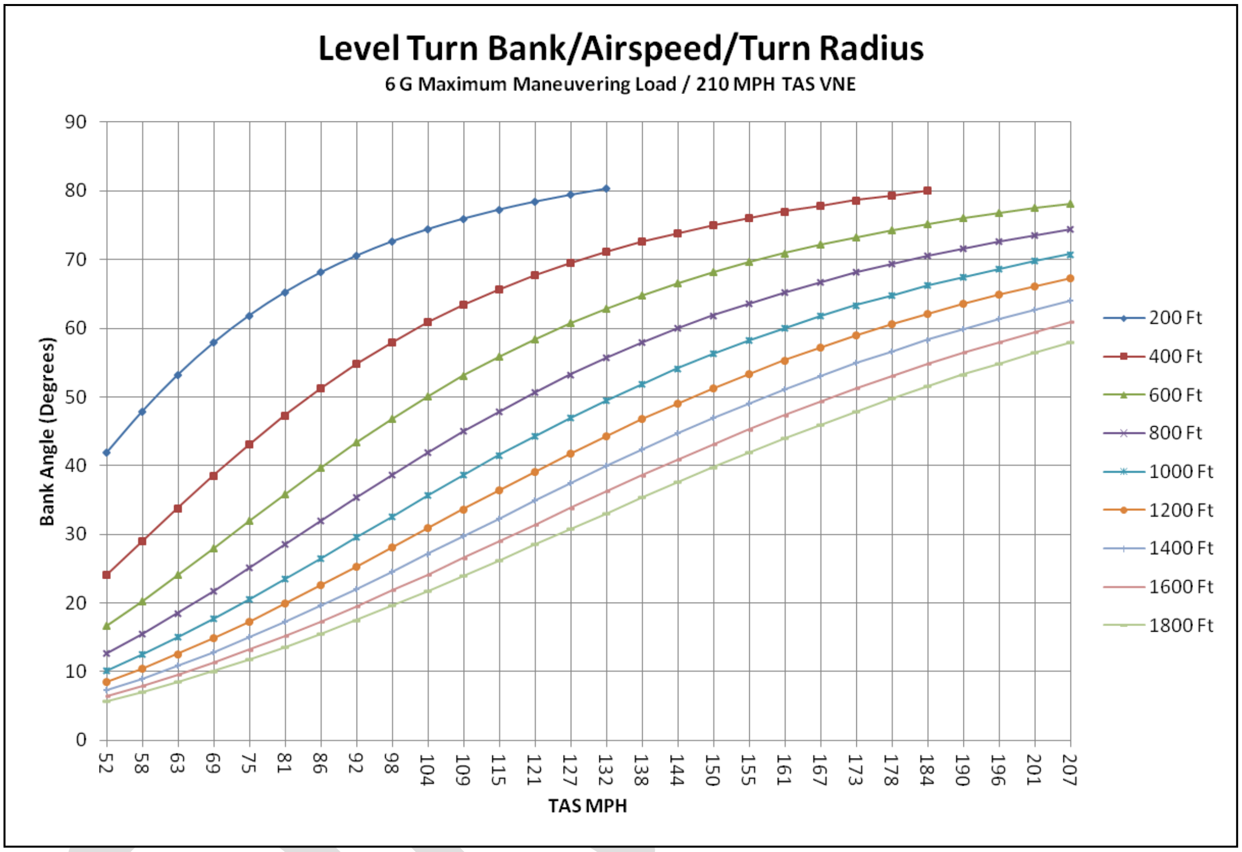


Figure 3-15. Bank and Airspeed Effect on Turn Radius (Level Turn)

Figure 3-16 is a rate/radius plot for an example 160 HP RV-4 fitted with a fixed pitch propeller at mean sea level. This diagram represents a "snapshot in time" and is presented only to show basic relationships. As with climb performance, overall RV-type turn performance is excellent across a relatively wide speed band. Best turn performance is when maximum turn rate (in degrees per second) and minimum radius (in feet) occurs. The solid black line is instantaneous turn rate and the dashed black line is instantaneous turn radius. The solid red line is sustained turn rate, and the dashed red line is sustained turn radius. Maneuvering speed (V_A) is coincident with corner velocity. This is the lowest speed at which maximum G-allowable (design load limit) can be produced by symmetric control application. Below this speed, aerodynamic (lift) limit (i.e., stall) is encountered prior to generating maximum G-allowable. Above this speed, structural limits apply. This chart is for illustrative purposes only, and reflects a non-operational condition. All rate/radius plots are simply a snapshot in time of one particular set of conditions.

Warning

Sufficient elevator authority exists in all RV-types to allow an over-G condition to occur if aft stick is applied too rapidly at speeds above corner velocity (V_A). The flight control system is capable of generating dangerously high G loads at high airspeed with improper control input.

The chart represents theoretical maximum performance capability. The instantaneous plot results in extremely high energy bleed rates that cannot be sustained. Instantaneous corner velocity is the minimum speed at which maximum G-allowable can be obtained, i.e., the quickest, tightest turn. There is insufficient power available to maintain this condition, so airspeed will decay rapidly when performing this type of turn. Furthermore, if G-onset rate (i.e., back stick) is insufficient, maximum allowable G may not be obtained before speed decays to a point that insufficient lift reserve remains to reach maximum G allowable.

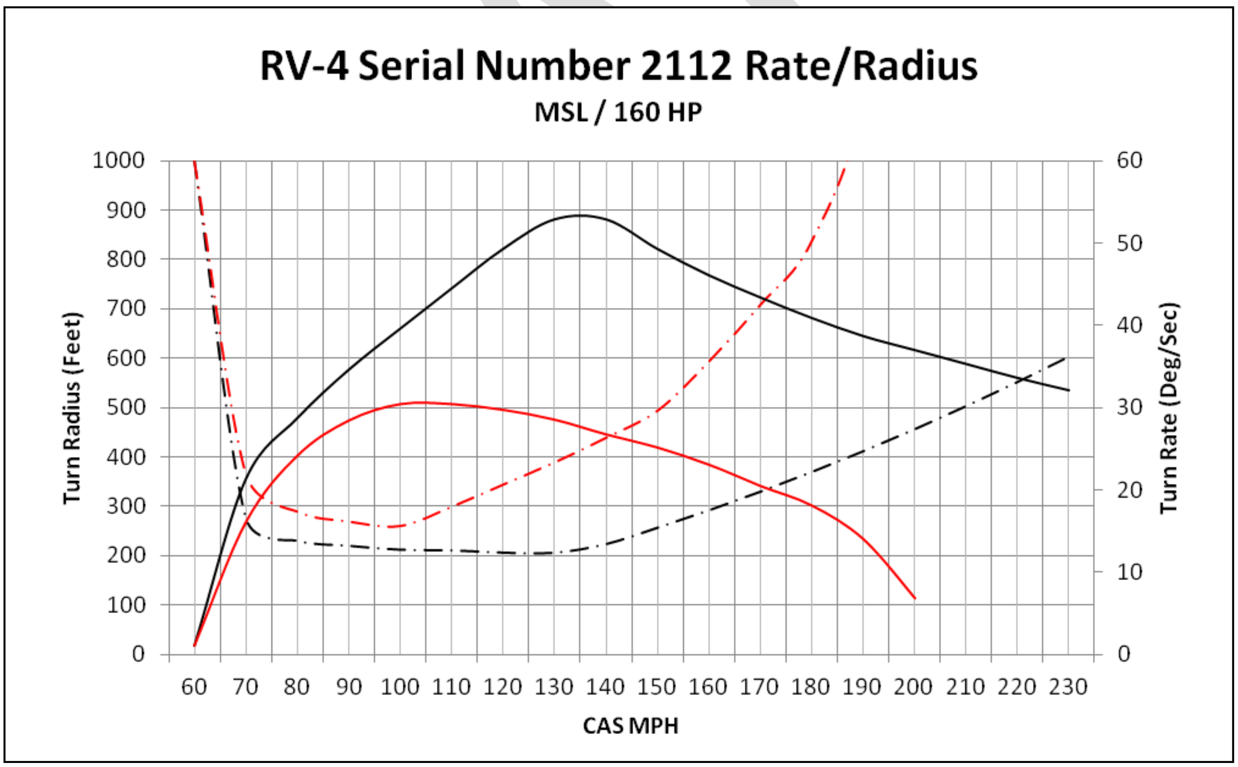


Figure 3-16. Example Turn Rate/Radius Diagram for an RV-4.

The sustained plot represents a 0 P_S (zero specific excess power or a neutral energy) condition. In other words, the airplane has sufficient thrust to maintain this turn condition. Sustained corner velocity is the speed at which a maximum, sustained rate of turn can be achieved without an accompanying loss of speed or altitude. P_S (specific excess power) values represent the ability of the airplane to change its energy state. A positive P_S refers to the ability to accelerate and/or climb, while a negative value means the airplane is slowing down and/or losing altitude. Best overall turn performance for the example 160 HP RV-4 is obtained between 90-135 MPH CAS, with best sustained radius performance on the low side of this band and an average sustained rate of turn of approximately 30 degrees/second across the band. Best range glide speed is roughly coincident with the bottom of the optimum turn band. Of note, best sustained turn performance occurs at speeds at and BELOW corner velocity (V_A).

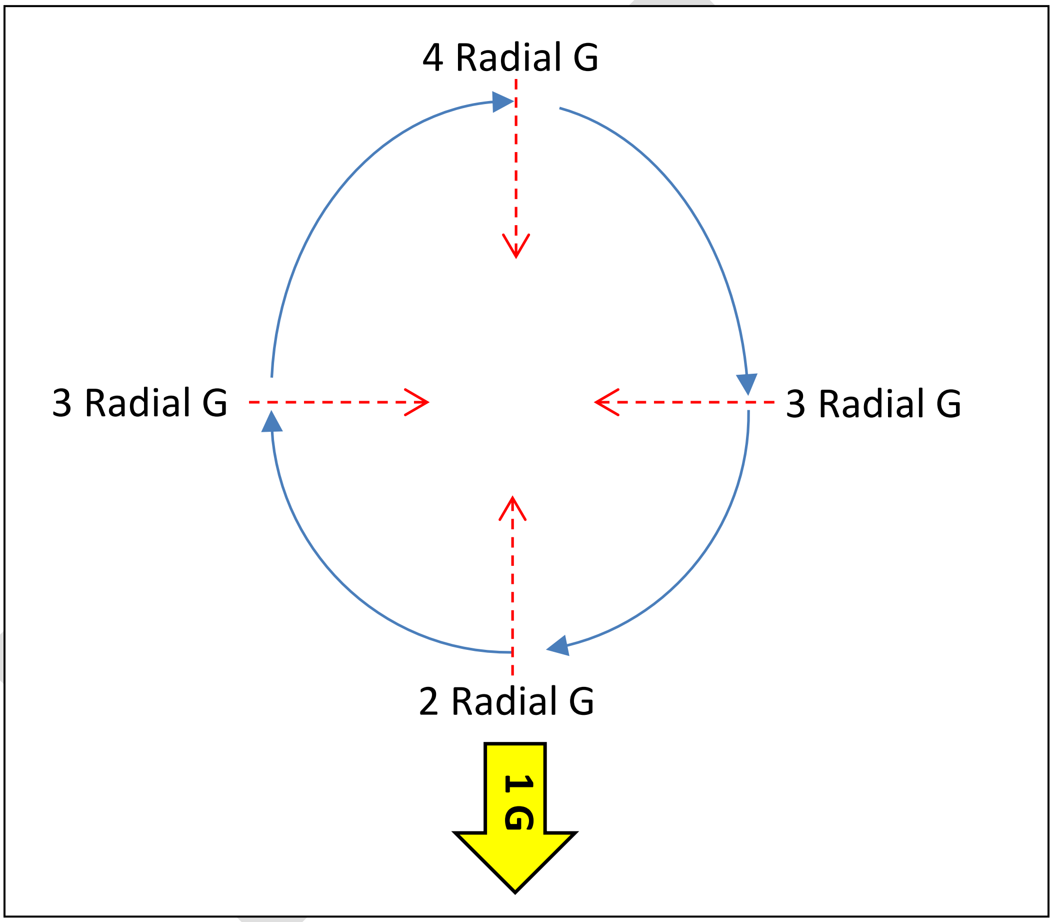


Figure 3-17. Constant 3 G Vertical Turn

Vertical Turn Performance. The purest form of a vertical turn is a constant cockpit G loop (or portion thereof). This is depicted in Figure 3-17. Since turn performance is a function of radial G and TAS, and radial G will vary throughout, this affects actual turn performance and causes a vertical turn to be shaped like an egg. In the example depicted in Figure 3-17, the pilot applies 3 G's at the start of the maneuver and maintains 3 G's on the g-meter throughout the maneuver. At the bottom of the loop, 1 G is required to maintain altitude, so only 2 radial G's are available to turn the airplane. As the airplane approaches 90^o of pitch, all cockpit G is available for turning the airplane (3 radial G's). When the airplane is inverted at the top of the loop, the 3 cockpit G's are added to actual force of gravity and 4 radial G's are available to turn. On the "back side" of the loop as the airplane once again achieves 90^o nose low, radial G once again equals cockpit G, but as pitch decreases below 90^o nose low, radial G begins to decrease and turn performance decreases. As the loop is completed, 2 radial G's remain.

Turn Performance Summary

Only two factors affect turn performance: radial G and TAS. As weight and/or altitude increase, overall turn performance will decrease. Actual turn performance will vary from airplane to airplane, with the greatest single factor affecting performance being thrust available (a function of engine/propeller combination), all other factors equal. If flight test data is not available for a specific aircraft, actual turn performance cannot be plotted; however, RV-types offer overall excellent overall turn performance, especially between 80 MPH / 75 KTS and V_A.

ENERGY MANAGEMENT

Overall, maneuvering flight can be thought of in terms of energy management. In its simplest form, energy is simply a combination of altitude, airspeed and excess power (thrust) available. Under engine-out conditions, it's just the combination of altitude and airspeed. Observing some basic rules of thumb and flying through planned "hoops" (known energy points) can greatly assist with developing a feel for proper energy management. Examples of known energy points are entry parameters for advanced handling maneuvers, high key, properly computed V_A, low key or final roll-out points in a flame-out/power-off pattern. If a pilot simply does what it takes to fly through a known energy point on parameters, there *will* be sufficient energy to execute the desired maneuver, whether that's a loop, wing-over, etc. or power-off landing. As experience is gained, the upgrading pilot will become more adept at real-time assessment of energy.

MAXIMUM STRUCTURAL CRUISING SPEED

Maximum structural cruising speed (V_{N0}) is coincident with the top of the green arc on the airspeed indicator. It is the maximum speed for normal operation. Most RV-types are capable of exceeding maximum structural cruising speed in level flight. This speed should only be exceeded in smooth air.

Be alert for weather conditions which will cause increasing turbulence when making descents from cruising altitude, especially during daylight operations. It is common for turbulence to increase near the surface. One consideration is any fair weather cumulus formations, air is generally bumpy beneath the cloud bases (due to updrafts causing cloud formation); so if these clouds are observed below, be prepared to slow down to observe speed limits and maintain comfort. It should be noted that in some cases, never exceed speed expressed as CAS can be LESS than V_{NO} (See NEVER EXCEED SPEED).

NEVER EXCEED SPEED

Never exceed speed (V_{NE}) is also referred to as "red line" speed since it is marked on the airspeed indicator with a red line. It is coincident with the top of the yellow arc on a properly marked airspeed indicator. Airspeed indicators, whether conventional or advanced displays, show dynamic pressure by measuring the difference between pitot and static pressure. Stall speed, maximum structural cruising speed and maneuvering speed are a function of dynamic pressure and thus, indicated airspeed. Never exceed speed (V_{NE}) is a function of true airspeed and is thus only marginally represented by the red line depicted on the airspeed indicator. As altitude and true airspeed increase, indicated airspeed will decrease or, put another way, for a given indicated airspeed, true airspeed will increase with altitude. ***Due to the low drag and high speed ratio of RV-types, even a moderate descent angle from altitude at normal cruise power is capable of generating true airspeeds in excess of design V_{NE}.*** Some RV-types are capable of exceeding V_{NE} in level flight, depending on engine and propeller fitted.

The pilot must be aware of true airspeed and be prepared to adjust "red line" speed based on altitude. One technique is to never exceed maximum structural cruising speed (although this rule of thumb breaks down at altitudes above about 12,000 feet at temperatures warmer than standard). Another is to calculate TAS based on ambient conditions and observe that limit. If the aircraft is not equipped with a TAS indicator, TAS can be roughly approximated by adding 3 KTS/MPH to CAS for each 1000' of altitude. Some advanced instrumentation systems equipped with an air data computer may display TAS in the cockpit. In aircraft equipped with properly calibrated and tested advanced instrumentation, observe V_{NE} by reference to the TAS display.

Flutter. The difference in TAS between which flutter occurs and actual speed is referred to as flutter margin. As actual TAS increases, flutter margin decreases, eventually reaching a critical speed that will result in aerodynamic flutter that could potentially be catastrophic. Depending on ambient conditions and gust load, aerodynamic flutter can cause nearly instantaneous failure of the primary structure of the airplane without warning. Van's aircraft has performed ground vibration tests to demonstrate good flutter margins throughout the design envelope of RV-types. Flutter may manifest itself as a high frequency airframe vibration with the stick vibrating/shaking a commensurate amount. If this phenomenon is encountered, it is imperative to slow down immediately. Power should be reduced and a gentle maneuver performed to establish a wing's level condition to ensure the velocity vector is transitioned to or above the horizon to slow the airplane as rapidly as possible. Descent may then be resumed at a lower true airspeed.

Warning

- ***V_{NE} is a function of TAS. Depending on ambient conditions, (high speed and high density altitude) operations within the yellow (or even green) arc could result in true airspeeds greater than V_{NE}. Regardless of indicated airspeed, recovery should be initiated at the first sign of flutter. V_{NE} is easily exceeded in a dive or descent, and some RV types are capable of exceeding it in level flight. At higher altitude, aerodynamic flutter may be encountered at indicated airspeeds that would no produce those effects at lower altitude.***
- There is a margin between V_{NE} and dive limit speed just is there is a margin between design load limit (e.g., 6 G's) and ultimate load limit (e.g., 9 G's). Although performance in the margin cannot be guaranteed, abrupt control input in this speed range could cause catastrophic failure. The actual margin between safe speed and flutter speeds is a function of TAS, which varies with altitude. As altitude increases, overall margin decreases, reaching less than 2% at 8000 feet.
- Elevator tab flutter may manifest itself as a distinct "buzz" transmitted through the control system to the stick, however catastrophic failure as a result of exceeding aerodynamic limits can occur without warning.
- If flutter is encountered or suspected, immediately reduce power and slow down. Avoid abrupt control input and land as soon as practical. Post-flight inspection for flutter induced damage may be warranted.

ACCELLERATION CHARACTERISTICS

> **Warning**
>
> If the velocity vector (flight path) is below the horizon, the aircraft will accelerate. ***If the nose and lift vector are below the horizon*** as well (e.g., inverted, nose low condition), ***the airplane will accelerate rapidly.*** A dangerous over-speed of the engine/propeller and/or airframe is likely if prompt action isn't taken to recover. Fixed pitch propeller or non-counterweighted controllable pitch propeller (i.e., "non-aerobatic" types) installations may permit an engine over-speed to occur if high manifold pressure is maintained in a dive.

Gravity causes an airplane's speed to increase (perhaps beyond safe limits) when its attitude is nose down. It also causes an airplane's speed to decrease (perhaps below stall speed) when its attitude is nose up. In level flight, an RV-type requires approximately 225 lbs of propeller thrust to produce a speed of 200 MPH/175 KTS. If the airplane is pointed straight down in a 90^o dive, then weight + thrust equal the total force acting on the airplane. In this example, an RV-type at 1350 pounds producing 225 lbs of propeller thrust would be accelerated by a total force of 1575 lbs. With the velocity vector (flight path) "buried" in this manner, it won't take very long to reach a destructively high speed. Even a 30^o dive produces a 750 lb "thrust" component, bringing total thrust to 925 lbs in this example. This *quadrupling* of energy would produce a top speed of 370-380 MPH/320-330 KTS if sustained. This far exceeds the red line (V_{NE}) limit. ***At speeds above red line, aerodynamic flutter and of forms of aero elasticity can destroy the airplane.***

Due to the low drag design (especially RV-types fitted with fixed pitch propellers optimized for cruise performance), ***the airplane will accelerate rapidly with the velocity vector (flight path) below the horizon, regardless of power setting.*** The pilot must be aware of airspeed and propeller/engine RPM when maneuvering. Engine over-speed may occur during maneuvering RV-types equipped with a fixed pitch or non-counterweighted controllable pitch propeller. Under most conditions, a reduction of power will be required any time the nose is down if the airplane is fitted with a fixed pitch propeller. Additionally, proper application of G (i.e., induced drag) will be required to prevent excessive airspeed build up. If an over-the-top maneuver is being attempted, the pilot should note airspeed at the beginning of the pull to ensure sufficient energy exists to complete the inverted portion of the maneuver at the top. Generally, 150 MPH/130 KTS CAS is sufficient for over-the-top performance assuming sufficient G is applied in the pull-up. Conversely, when maneuvering in a manner that the lift vector is below the horizon (e.g., split-S) an airspeed check is necessary prior to beginning the pull through portion of the maneuver to ensure that a dangerous acceleration won't occur. After the lift vector has been positioned, a smooth, rapid pull should be utilized to established desired G/nose rate. In general, if the indicated airspeed is greater than 110 MPH/95 KTS CAS in a 180^{o} bank (inverted) and the nose passing down through the horizon, a vertical pull-through should not be attempted, but rather the airplane should be rolled up right and recovered to level flight.

ENGINE AND PROPELLER EFFECTS

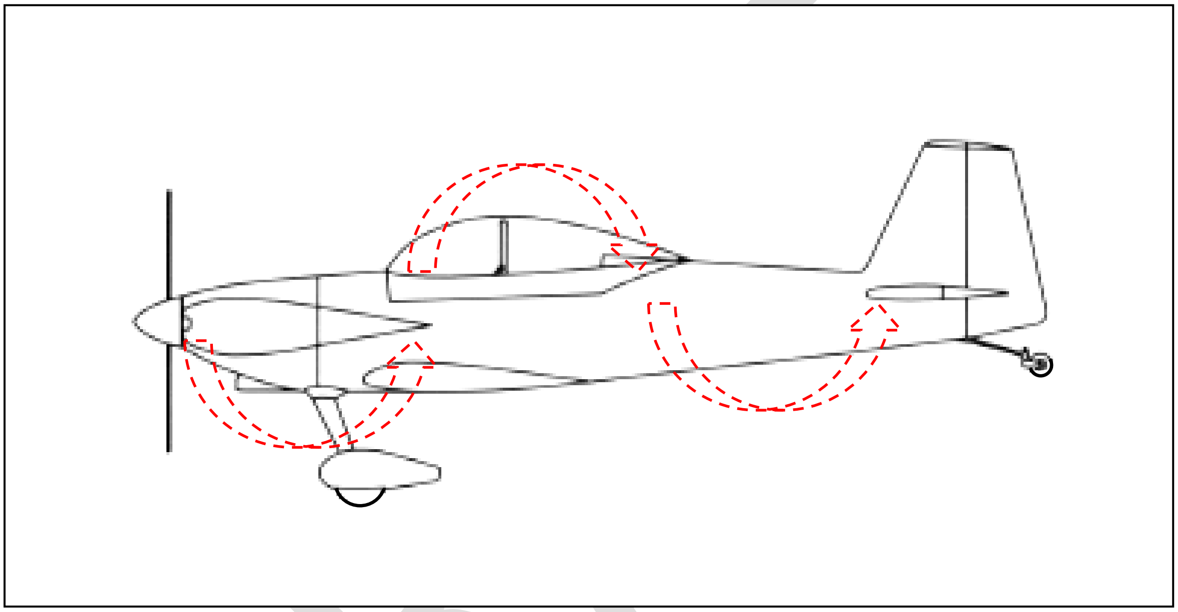


Figure 3-18: Propeller Effect—Spiraling Slipstream

The engine and propeller effect handling characteristics. There will be variation from airplane to airplane due to different engine/propeller combinations fitted. The amount and proportion of these effects vary with power setting and airspeed. There are three propeller effects: slipstream effect, p-factor, and gyroscopic precession. The engine effect is torque. These effects are depicted in Figures 3-18 through 3-21. With the exception of gyroscopic precession, the overall tendency of these effects is to cause yaw and roll to the left when viewed from the cockpit. In RV-types, these effects are most noticeable at high power, low airspeed. Slipstream effect (impact of the spiral slipstream generated by the propeller and wrapping around the airplane as it moves aft) impacts the aft, left fuselage and tail, imparting a left yaw when viewed from the cockpit. It also induces a slightly higher AOA on the left wing root than the right root (Figure 3-18). P-factor moves the aerodynamic center of the propeller to the right of the crankshaft axis, causing the aircraft to yaw left (viewed from the cockpit) as AOA or power is increased (Figure 3-19). Engine torque causes the airplane to want to roll to the left when viewed from the cockpit, opposite the direction of engine/propeller rotation (Figure 3-21). Gyroscopic precession causes a force applied to the turning propeller to act in a plane 90° from that in which it was applied: if the nose is yawed left, it will tend to pitch up; if yawed right, it will tend to pitch down; if pitched down, it will yaw left; and if pitched up, it will yaw right.

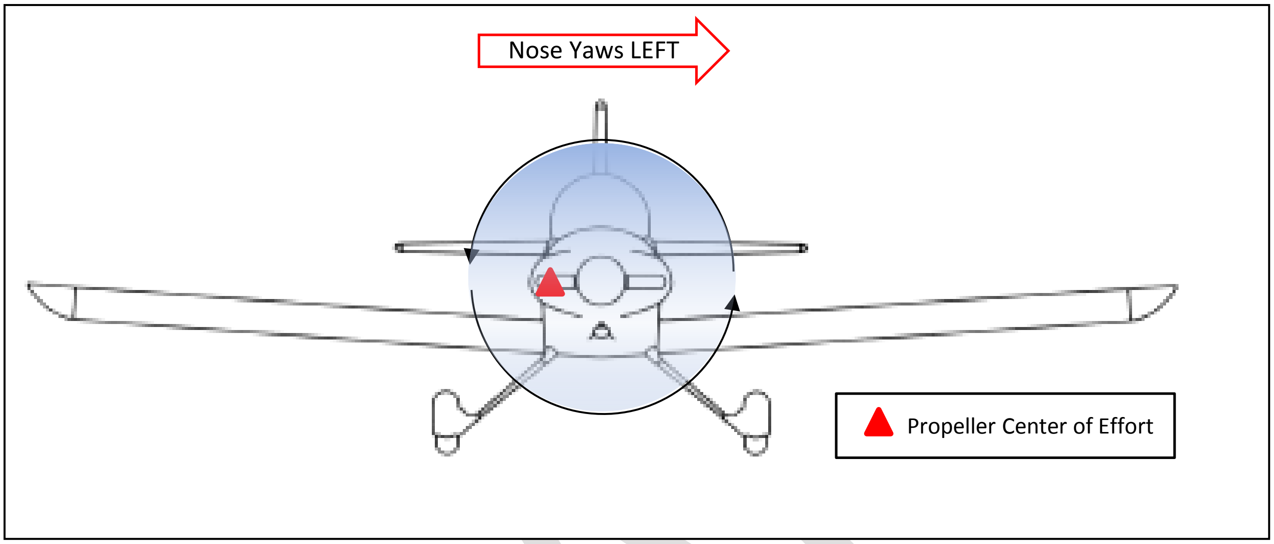


Figure 3-19: Propeller Effect—P-Factor

Airplanes equipped with larger, heavier propellers will exhibit more precession effects than those equipped with smaller, light weight propellers (Figure 3-20). One other engine and propeller effect is that an application of power makes the tail surfaces more effective at slow speed. Under non-stalled conditions, engine and propeller effects are controlled aerodynamically by proper application of flight controls: typically, this will be rudder application, although aileron can assist. The pilot must use the inclinometer (ball) or visual yaw cues to ascertain if rudder is being applied appropriately in sufficient amount. **Reducing power minimizes engine and propeller effects, regardless of AOA.**

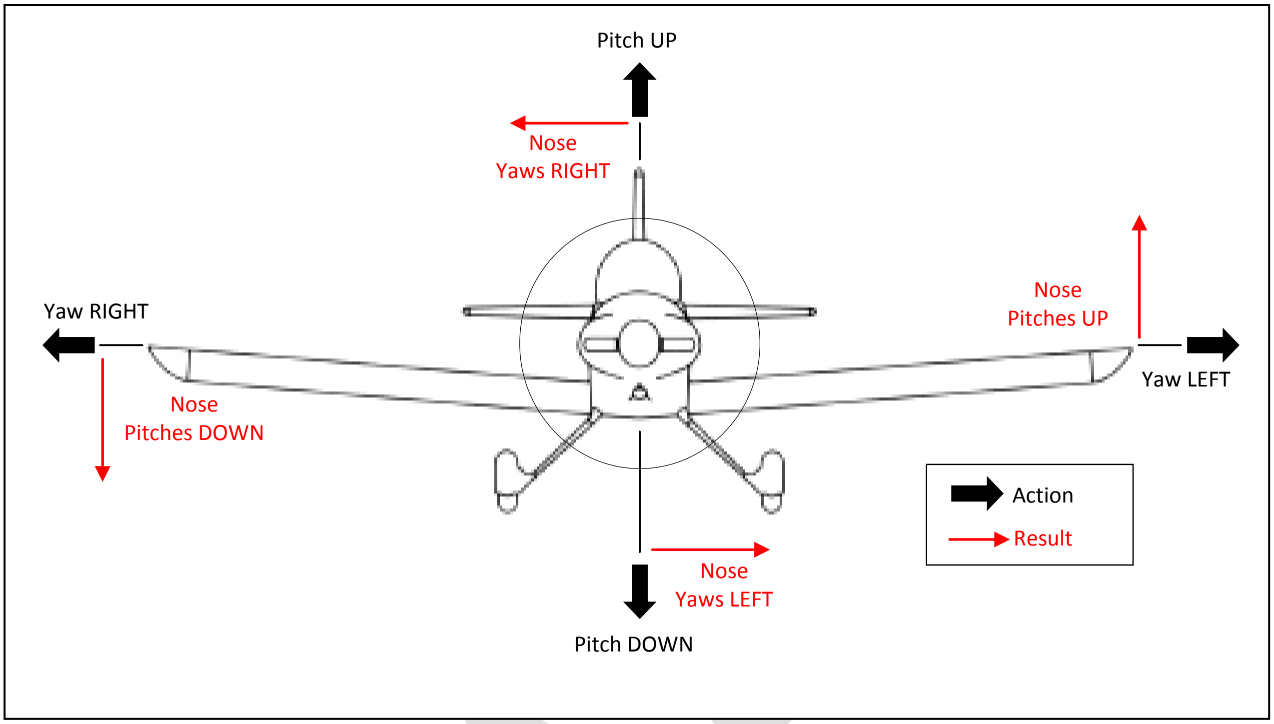


Figure 3-20: Propeller Effect—Gyroscopic Precession

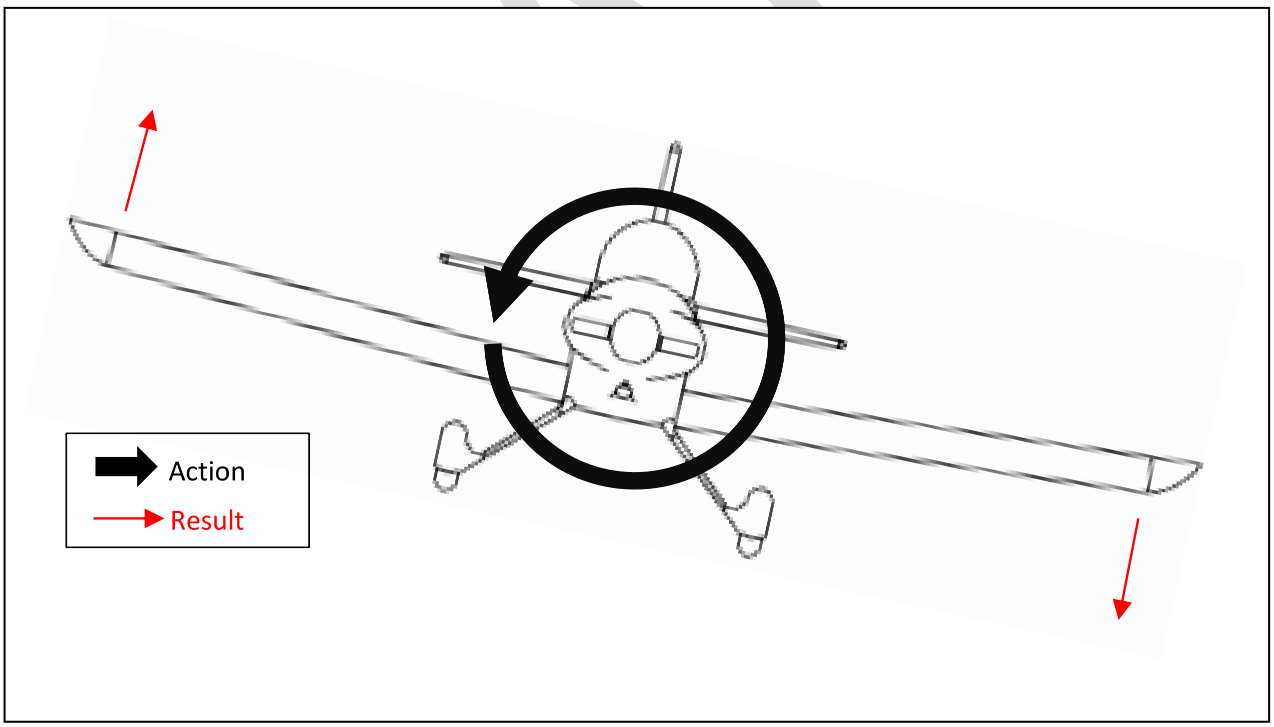


Figure 3-21: Engine/Propeller Effect—Torque

STABILITY CHECK

Prior to maneuvering flight, a basic flight control/stability check should be conducted. If the airplane is loaded within appropriate design limits, proper aircraft response to a stability check will ensure adequate stability and proper response to flight controls is available to safely perform confidence and advanced handling maneuvers. To perform the stability check, ensure lose items are stowed and harnesses are properly adjusted (tight). Establish a stabilized condition and power setting in smooth air (cruise climb or straight and level flight).

Pitch Check. Note trimmed stick position, then smoothly apply back stick to reduce indicated airspeed 10 KTS/MPH. Release longitudinal pressure on the stick and note pitch response. The airplane should nose down and airspeed will increase above the initial trim condition. Then the nose will rise again. Pitch oscillations will damp in 3-4 cycles. One cycle is sufficient to confirm proper response. As a technique, returning the stick to the noted trim position after the initial application of back pressure and noting pitch response will accomplish the same thing and result in less overshoots. Be alert for divergent behavior (i.e., airspeed continues to decrease/nose continues to rise after initial input).

Roll Check. Trim for wing's level flight. Check fuel balance (less than 6 gallons desired). Roll the airplane into 30-45^{o} of bank and relax lateral stick pressure. The airplane should maintain the bank angle or slowly trend toward wing's level (neutral or positive lateral stability). Divergent behavior is not normal, but lateral stability will decrease if there is a significant imbalance in fuel (i.e., a heavy wing).

Yaw Check. Trim for wing's level flight. Smoothly apply rudder to yaw the airplane in one direction and quickly release rudder pressure, keeping feet off the pedals. The airplane should immediately return to aligned flight. It is possible that an overshoot will occur (i.e., the airplane "fish tails"). Typically, 4-6 overshoots of decreasing intensity will occur before the input will damp out. Any roll left or right during this check is normal. Divergent behavior is not normal.

If divergent behavior is encountered during any portion of the stability check (other than roll due to a heavy wing), maneuvering flight and stalls should not be performed.

Note

FAR 91.307 states that unless each occupant of the aircraft is wearing an approved parachute, no pilot of a civil aircraft carrying any person *other than a crew member* may execute any intentional maneuver that exceeds 60^o of bank or ± 30^o pitch. The parameters only apply to the requirement for wearing a parachute and do not constitute a definition of aerobatic flight (AC 61-67C makes an exception for the conduct of spin training). FAR 91.303 defines aerobatic flight as intentional maneuver involving an abrupt change in an aircraft's attitude, an abnormal attitude, or abnormal acceleration, not necessary for normal flight.

UNUSUAL ATTITUDES/UPSET RECOVERY

Because of the low drag design and large speed range of RV-types, it is essential to interpret and correct unusual attitudes as rapidly as possible. Control movements and AOA control must be smooth, especially in nose high, low airspeed conditions to prevent an out-of-control situation; and G-application must be smooth and positive in nose low conditions to prevent dangerously high speeds, engine over-speed and/or over-G. Advanced instrumentation systems MAY provide reliable attitude information through 360 degrees of pitch and roll.

Unload for Control Concept. One key aircraft handling skill set is the ability to fly the airplane in a manner to avoid a loss of control, regardless of attitude. Simply put, any time a loss of control (stall, etc.) is impending, neutralizing aileron and rudder then smoothly unloading the airplane to a 0 to ½ positive G condition will most likely restore controlled flight, provided sufficient altitude exists. When unloaded to zero G, the airplane will not stall. The aircraft is no longer out-of-control when unloaded to 0 to ½ positive G and airspeed is increasing. This recovery technique may result in an unusual attitude during the recovery phase; but will reliably avoid auto-rotation if properly applied.

Regardless of attitude, if an impending loss of control is evident (buffet, rapidly decreasing airspeed, etc.), neutralize rudder and aileron and then reduce AOA (ease the stick forward). First neutralize aileron; then ease forward. Visually cross-check stick position, if required. ***Regardless of technique employed, control inputs must be SMOOTH and DELIBERATE.*** Never slam the stick forward. Power reduction depends on circumstances. For a simple airspeed decay in level flight or, perhaps, the base turn to final, unloading (relaxing the stick pressure/reducing AOA) will rapidly restore controlled flight. If, on the other hand, maneuvering at high power is being conducted (e.g., aerobatics), then reducing power to idle while simultaneously neutralizing controls may assist in maintaining control ("idlize and neutralize," see EMERGENCY PROCEDURES, OUT-OF-CONTROL).

In maneuvering situations with high pitch angles or during inverted flight, unloading to 0 G or less may result in a loss of power if the airplane is not equipped with inverted systems and/or has a carbureted engine. This is normal and should be anticipated. For aircraft without inverted systems/fuel injection, a recovery at +¼ to +½ G is just about as effective as a zero G condition and may allow the engine to continue running (or at least facilitate a windmill restart) and minimize oil loss. For airplanes without inverted systems, engine hesitation actually serves as a de facto G-meter that can assist with maintaining "eyes out" during recovery. If the airplane is equipped with a G-meter, it may be referenced during recovery; however the pilot should attempt to control G through feel. In addition to possible cues from a non-inverted engine, a "heels light" feeling on the rudder pedals, or a feeling of becoming light in the seat is ideal. If lose items in the cockpit start to float a true zero G condition has been established. Under these conditions, the airplane is ballistic and will fly a ballistic arc. Due to the relatively low airspeed and high turn rates of RV-types, the amount of time spent ballistic is generally minimal, and the pilot must be alert for recovery cues (aircraft unloaded [0 to +½ G], airspeed increasing) and transition to unusual attitude recovery. As a rule of thumb, degrees nose up will equal degrees nose down during a ballistic recovery. For example, if the unload is performed with the nose up 60 degrees and airspeed rapidly decaying, recovery will occur about 60 degrees nose low.

The airplane is once again under control when unloaded to 0 to ½ positive G and airspeed is increasing through 100 MPH/90 KTS.

Nose High, Airspeed Decreasing/Low Airspeed Recovery. If the nose is high and airspeed is decaying, select full throttle if engine and propeller effects are not a factor, neutralize ailerons and apply only enough rudder to maintain coordinated flight while establishing a low G condition. If the engine hesitates (non-inverted systems) or the pilot's feet or other items begin to float in the cockpit, smoothly apply a small amount of back pressure to stabilize in a zero to +½ G condition. Maintain 0 to +½ G condition until a safe flying airspeed (approximately 100 MPH/90 KTS) is reached. Then adjust bank, pitch and power to attain the desired flight attitude. While maintaining low G, bank may be adjusted with aileron to facilitate recovery. The most rapid recovery will be assured if a 90^{o} bank is maintained until approaching flying airspeed. If full throttle is applied during the initial stage of the recovery and the engine continues to operate normally throughout the recovery, RPM and acceleration will need to be monitored when the velocity vector has dropped below the horizon as it may be necessary to reduce power as the airplane begins to accelerate nose low. If power was reduced during the initial event or during subsequent acceleration, be sure to readjust as the velocity vector is once again on or above the horizon after recovery.

Note

- If in doubt, it is safer to establish a zero-G condition (allowing the engine to quit if necessary) and wait for the nose to drop and airspeed to increase. An air start may be accomplished after control is regained. In airplanes equipped with fixed pitch, light weight propellers, a prop-stopped condition may occur due to the low inertia of the propeller. Under these conditions, bumping the starter will be more expeditious than diving to windmill a stopped propeller.
- For typical fuel systems, some fuel odor may be noted in the cockpit under these conditions. This is due to fuel venting and is normal.

Nose Low, Airspeed Increasing or High Airspeed. Select idle power. With the velocity vector below the horizon and the nose low, RV-types will accelerate very rapidly, and are capable of reaching dangerous airspeed quickly. For airplanes equipped with fixed pitch propellers, if power is not adjusted to idle, an engine over-speed is very likely. Idle power will also help control airspeed build-up regardless of propeller type fitted, however proper, smooth application of G (drag created by lift) will be critical to maintain airspeed within limits. To recover, roll wings level and apply back pressure to pull the nose up to establish level flight. Do not increase G until the bank is less than 90 degrees. For minimum altitude loss, maintain airspeed at or below maneuvering speed and apply G as necessary to hold that speed (not to exceed maximum allowable G). Be aware of any buffet during the pull-out as the airplane has considerable elevator authority and is capable of generating sufficient pitch rates at low G to induce a secondary stall. If buffet is encountered, the pilot should stabilize the G until airspeed increases (buffet decreases) and/or a safe attitude is established. Airspeed cross-check is critical throughout recovery. Above maneuvering speed (V_A) the airplane is capable of generating G well in excess of allowable limits. If speed is above maneuvering speed and increasing, do not delay G input once 90 degrees of bank or less is reached. At speeds greater than maximum structural cruising speed (V_{NO}/top of the green arc of a properly marked airspeed indicator), even greater care must be taken when applying G. As with any type of maneuvering flight, smooth control input is critical. Abrupt control inputs applied at high speed could cause high instantaneous G and catastrophic airframe failure.

Emergency Dive Recovery. Altitude lost in a dive recovery is a function of radial G applied by the pilot and TAS throughout the recovery. Maximum turning performance is obtained at corner velocity/maneuvering speed (V_A). A fixed-pitch propeller is of little aid in increasing plate drag, so use of power in the dive depends on airspeed/buffet/G and speed relative to corner; but as a general rule, power should be at idle for airplanes equipped with a fixed pitch propeller. Drag produced by constant speed types may assist in controlling airspeed build up. A maximum performance, minimum-radius, limit-load pull up is accomplished by a smooth, quick pull to CL_{MAX} (indicated by buffet [AOA]), until reaching corner speed (V_A) , then remain at limit load (maximum G-allowable) until recovery. ***One of the most common errors during recovery is slow application of back stick during the initial phase of the recovery and an unnecessarily rapid increase in airspeed.*** Operation at CL_{MAX} (below corner/V_A) or maximum G allowable (above corner/V_A) will help control airspeed build up by creating maximum induced drag (drag due to the creation of lift). Buffet cues vary with airspeed and load, and if any nose slice (yaw) is encountered or the nose stops tracking, AOA should be eased since those are positive indications that CL_{MAX}/AOA_{CRIT} has been exceeded (i.e., an accelerated stall is occurring). Longitudinal stick position (i.e., amount of pull required) will vary throughout the recovery: as the nose begins to transition up to the horizon, back pressure will have to be eased to maintain maximum AOA or allowable G load. If it becomes apparent that red line speed (V_{NE}) will be exceeded during recovery, continue the smooth pull with the throttle in idle—do not panic and increase pull abruptly as this will only aggravate the problem. The recovery pull should continue until the velocity vector is above the horizon following pull out. The aircraft can continue in a shallow climb to assist with deceleration after recovery.

INTENTIONAL SPINS

Warning

- ***Unless flight tested, precise spin characteristics for a specific airplane are unknown.***
- ***There are significant aircraft to aircraft differences depending on CG, prop, control rigging, construction alignment, fairing configuration, etc.***
- Even when loaded within designer's limits for aerobatic flight, minor differences in the aerodynamic profile of a specific airplane can have an effect on spin and spin recovery characteristics.

When loaded within designer's limits, RV-types will not generally auto-rotate (spin) unless forced to do so by deliberate pro-spin application of controls. Factory prototype aerobatic RV-types have been spin tested at designer's acrobatic load limits and have demonstrated conventional spin characteristics. All RV-type factory prototypes demonstrated satisfactory recovery utilizing conventional recovery techniques when loaded within design aerobatic limits. Side-by-side types exhibit different autorotation characteristics than tandem types. Individual RV-types must be flight tested to determine suitability for use in spin training. ***Experimental Amateur Built aircraft do not conform to any type certificate nor do they exhibit performance (including spin recovery) commensurate with any category of certified aircraft, furthermore, <u>each aircraft is unique</u>. Operating Limitations specify approved maneuvers for individual RV-type aircraft.***

> **Note**
>
> Operating Limitations should be checked for a list of approved maneuvers or prohibitions prior to conducting spins. Specific wording found in Operating Limitations may vary. Operating Limitations may contain a list of tested/approved maneuvers, or they may reference an aircraft log book entry or they may contain prohibitions.

RV-types are hesitant to spin and initiation of significant sideslip near the stall is required to initiate auto-rotation with a full, erect spin developing should pro-spin controls be held. Spins in both directions exhibit reasonably similar characteristics with rotation rate steadily increasing and attitude flattening slightly with an increase number of turns. Engine and propeller effects make entry easier for left-hand turns. Side-by-side types tend to exhibit flatter spin characteristics than tandem types. Power-on spins exhibit a flatter attitude than power-off spins. Pilot disorientation is possible as the number of turns increase, and is probable if 7 turns or more are flown (unless sufficient experience has been gained). Some RV's may tend to enter a spiral dive instead of a spin at forward CG if spin entry is attempted at idle power. Increasing power slightly above idle may increase elevator effectiveness and assist with spin entry. Unless thoroughly familiar with spin characteristics and recovery for a particular airplane, spins should be limited to the incipient phase.

Warning

A few RV-types ***may*** tend to enter a spiral dive instead of a spin at forward CG. If an upright spin is attempted, but CAS increases above 100 MPH/KTS, the aircraft is probably in a spiral dive: recover immediately. Otherwise, there is a risk of exceeding VNE during dive recovery. See OUT-OF-CONTROL, SPIRAL DIVE.

Intentional spins should be entered at an altitude of 6000-8000' AGL or higher to allow plenty of altitude margin for recovery. A minimum planned recovery altitude of 3000' AGL is recommended. The pilot should be familiar with stall and post-stall behavior (including buffet cues, nose slice and/or wing drop), AOA and unusual attitude recoveries prior to accomplishing intentional spins. Initial spins performed for training should be limited to the incipient phase. After experience is gained in incipient spin recovery, developed spins may be flown, if desired. It is recommended that developed spins be initially limited to three total turns (including incipient phase), and then the number of turns may be increased as experience is gained. Spin recovery characteristics (and control techniques) will vary from the incipient phase vs. a developed spin.

Notes

- Nose slice (yaw) is generally apparent prior to auto rotation. If AOA is reduced and/or opposite rudder is applied at first indication of yaw, auto-rotation will not occur.
- RV-types are capable of inverted spins. Intentional inverted spins are not recommended if inverted fuel or oil systems are not fitted.

The auxiliary fuel pump should be ON. Intentional spins should be initiated from a power off stall with full rudder in the desired direction of spin and full elevator (aft stick) following the initial stall break. The aircraft more readily enters spins to the left due to engine and propeller effects. A slightly more rapid increase in AOA (i.e., quicker application of back stick) just prior to the stall can assist with entry to the right. A slight unload after the first 180 degrees of rotation will help stabilize the spin rate and attitude, but is not required. Typically, if control pressures are released (neutralized) immediately following incipient spin entry, recovery from auto-rotation will be automatic and almost immediate (generally no more than 1 turn) however, the airplane will likely be in a nose-low, low airspeed (airspeed increasing) unusual attitude when auto-rotation stops; and it will be necessary to recover from this attitude. If pro-spin controls are maintained and rotation is held for more than one full revolution, recovery can be accomplished quickly through application of anti-spin controls. If pro-spin controls are held until one and a half to two full revolutions have been completed, the spin will be fully developed. The pilot will note a distinct increase in rotation rate as the developed spin phase is entered.

The initial entry will look a bit like a barrel roll or wing-over as the airplane reacts to yaw (rudder) applied at the stall. During the first half turn, the airplane may tuck approximately 10-15^{o} beyond vertical. By the end of the first turn, the nose will come back up a bit as airflow reasserts itself and pushes the horizontal stabilizer down.

Spin recovery is prompt in all cases. Recovery may be affected during the incipient phase by neutralizing (or simply releasing) the flight controls; however the best method is to apply anti-spin rudder while centering the stick longitudinally and moving it forward. If recovery is initiated prior to a fully developed spin (approximately 1 ½ to 2 turns) occurring, anti-spin controls will result in recovery within a half turn or less. Neutral controls will generally result in recovery from an incipient spin within ½ to 1 ½ turns.

As the spin transitions from the incipient phase to full auto-rotation, there is a noticeable increase in yaw rate. In a developed spin, the rotation rate is approximately 180-270^{o} per second. Rotation speed is slower with full-aft stick. If the stick is eased forward during a developed upright spin, and full pro-spin rudder is maintained, the rate of rotation will increase due to inertial coupling. The airplane will lose approximately 300 feet per turn. For upright spins, indicated airspeed is unreliable and, if equipped, the g-meter will read approximately 1.0 throughout the maneuver. The actual descent rate in a developed spin is approximately 7000-9000 FPM. ***Recovery from a developed upright spin with anti-spin rudder requires approximately 1.5 turns and up to 1500' of altitude, including dive recovery.*** Power on spins will result in a slightly higher nose attitude and slower rotation rates than power off. A ten-turn spin, plus recovery requires approximately 3500-4000' of altitude. Inverted spins result in higher recovery speeds and require more altitude than upright spins. Regardless of orientation, aircraft unloaded (0 to +½ G) with airspeed increasing above 100 MPH/90 KTS CAS is a positive indication of recovery.

Warning

- If out-of-control below 3000’ AGL, consideration should be given to bailing out immediately. At typical RV-type spin descent rates, ground impact will occur 13-17 seconds after passing through 2000’ AGL.
- Spins greater than seven turns can result in pilot disorientation.

Intentional Spin Recovery Technique. The out-of-control procedure will recover the airplane from upright or inverted spin; however an intentional spin should not be considered an out-of-control situation, thus an alternate recovery procedure is offered. Actual spin characteristics and recovery performance will be a function of RV-type, CG location, control position/rigging and the sequence/extent of application during the recovery. Neutral controls may be sufficient to stop auto-rotation, but will not be as effective as applying rudder opposite yaw. For upright spins, if the stick is relaxed (or shoved forward) PRIOR to applying opposite rudder, rotation rate and dive angle will increase prior to recovery. If opposite rudder is applied until rotation stops and then forward stick is applied, a pronounced negative G and steep dive angle will result. If opposite rudder is applied simultaneously with relaxing the stick, rotation stops most rapidly and a moderate dive angle results. Approximately 500-1000’ of altitude will be lost during recovery (after auto-rotation stops) using a smooth 2 G pull-out. Anti-spin controls should be applied no later than 1500’ above planned recovery altitude/maneuvering floor to ensure adequate margin for recovery, keeping in mind that the altimeter may lag at the high descent rates experienced in a spin. If lift vector placement is critical post-spin (e.g., recovering to a specific heading), opposite rudder should be applied 90-120 degrees prior to desired heading.

Recommended Intentional Upright Spin Recovery

1. Power – IDLE

Reducing power to idle will minimize engine and propeller effects. Because the propeller continues to turn, even at idle, some effect will still be present causing a right hand spin to result in a more nose-down angle during upright auto-rotation than a left hand spin. Idle power will also mitigate risk of engine over-speed risk during post-spin recovery.

2. Controls – RUDDER OPPOSITE YAW (Spin Direction) THEN STICK FORWARD

The order of control application is important to control the magnitude of post-recovery dive angle and G. Opposite rudder should be applied as the stick and ailerons are adjusted to a neutral position. The pilot should apply rudder opposite spin direction and then release back control pressure on the stick while easing it forward. If forward stick is applied BEFORE opposite rudder, it will increase the rate of rotation and result in a more pronounced unload and dive angle post-rotation. Full opposite rudder and nearly simultaneous full-forward stick may transition the spin from upright to inverted. The stick should not be slammed forward.

3. Dive – RECOVER

The most efficient dive recovery technique is smooth, rapid application of back stick to achieve maximum nose rate (just shy of the aerodynamic limit) as the airplane accelerates to maneuvering speed/corner velocity. Smooth, rapid application of AOA has the effect of increasing induced drag, which aids in controlling acceleration. If any buffet is encountered and/or as radial G increases, back stick pressure will have to be relaxed slightly. Late application of back stick will result in a larger vertical turn radius, lower turn rate and greater increase in airspeed during the recovery.

Note

For intentional spins, select fullest fuel tank. This may assist with mitigating the potential for un-porting a fuel pick-up. The likelihood of un-porting increases as fuel quantity in the tank decreases. Non-inverted (standard) pick-ups are more prone to un-porting during spins than inverted pick-ups (flop tubes). The steeper the pitch angle during the spin (i.e., power off), the higher the probability of momentary fuel starvation during a spin. Engine stoppage may occur after 3 or 4 turns in a developed spin in this case. If equipped with a fixed pitch propeller, it may stop turning if the engine fails during a spin.

CONFIDENCE MANEUVERS

Confidence maneuvers are handling exercises designed to increase the pilot's confidence in the basic handling characteristics of aerobatic RV-types and provide a foundation for advanced handling training. The Lazy-8 (Wing-over) is particularly helpful for practicing maneuvering about multiple axis and energy management. The angle-of-attack recovery, low AOA roll and inverted recovery are handling exercises designed to teach proper unload techniques. The ability to establish a proper low-G condition regardless of attitude is the key to stall/auto-rotation avoidance and/or recovery. RV-types are departure (spin) resistant; however cross-controlled stall and basic spin familiarization will provide the upgrading pilot with the handling skills necessary to ensure prompt recovery in the event of unintentional auto-rotation.

Note

- ***Not all maneuvers are appropriate for all tracks of instruction, aircraft or load configurations. Maximum pitch and bank angles may be tailored to suit appropriate limits or pilot comfort level.***

- In accordance with AC61-67C Paragraph 301(b), parachutes are ***not*** required for spin training. For the purpose of application of this AC, cross-controlled stalls are considered spin training.

- Maneuvers in this section may differ in technique and description from maneuvers of the same name in FAA publications, including practical test standards.

Lazy 8. The Lazy 8 is a maneuver that requires the pilot to fly the airplane about multiple axes throughout the usable speed band (V_S or slower to V_{NO}) with smooth, coordinated application of flight controls. It also requires a robust cross-check. These characteristics make the maneuver an optimum warm-up for advanced handling.

One "leaf" of a Lazy 8 may also be referred to as a wing-over. A properly flown lazy 8 or wing-over is an energy neutral maneuver when initiated at cruise power setting—i.e., the energy (altitude/airspeed) at the end of the maneuver should be identical to the energy state (altitude/airspeed) at the beginning of the maneuver. Each leaf of the maneuver results in 180° of heading change, so having useful ground references will aid in accomplishment. If properly flown, the airplane should be constantly undergoing pitch and roll changes throughout the maneuver. To begin the maneuver, establish a 60-75% trimmed cruise condition at an appropriate altitude. Higher gross weight or density altitude conditions will require higher power setting. Handling characteristics for left and right leaves will vary (primarily in the application of rudder) due to engine and propeller effects.

To begin a turn to the left, smoothly pull the nose up 10-15 degrees applying approximately 2 G's and begin a slow roll. Continue to raise the nose and increase the bank. The objective is to reach 45° of bank at 30-45° of pitch (approximately heels on the horizon) after 45° of heading change. Initially left rudder will be required to coordinate the turn, but as the pitch increases and airspeed decreases, RIGHT rudder may be required to maintain coordinated flight. Airspeed will drop as maximum pitch is reached. From the 45-90° heading change points, the nose should gradually drop back to the horizon so that the 90° point, the nose is slicing through the horizon (0° pitch) at a 90° bank angle. Engine power effects will aid in pulling the nose down and left, but it may still be necessary to relax back pressure slightly to prevent turning past the 90 degree point before the nose is on the horizon. Airspeed will continue to build as the nose passes down through the horizon. At the 135^o turn point (45 degrees prior to desired roll-out heading), the dive angle should approximate the pitch angle obtained during the initial climbing turn and bank angle should be 45 degrees. Continue decreasing the bank and raise the nose applying approximately 2-3 G's (commensurate with dive angle and airspeed build-up) until you are wings level with the nose on the horizon at the 180 degree point. Air speed and altitude should be equal to parameters at the start of the maneuver; however primary emphasis should be re-establishing entry airspeed, even if this means starting the next leaf at a higher altitude than the previous. The key is to properly blend back pressure (i.e., G application), primarily through the last 45 degrees of turn. The most common error is insufficient back pressure during recovery allowing speed to build past entry parameters—it is more important to hit entry speed parameter than altitude. When performing the maneuver to the right, more coordinated bottom rudder will be required to help the nose transition down as engine and propeller effects have to be overcome. As proficiency is gained, the 90 degree point can be flown at high pitch angles (up to 80^o) and speeds below stall by transitioning to unloaded flight (0 – +½ G) as the pitch approaches the apex and using rudder to guide the nose through the top of the arc.

The Lazy 8/wing-over is an asymmetric maneuver, and asymmetric maneuvering speed (V_A) and G-limits apply. A ground reference helps with orientation throughout the maneuver, preferably a straight line of some sort (e.g., road, high tension lines, canal, etc.).

The Lazy 8 is energy neutral. 800-1000 feet of vertical maneuvering room is required to perform the maneuver. ***Depending on gross weight, ambient conditions and power setting, some altitude may be gained at the bottom of a "leaf" (i.e., energy gain) due to recovery airspeed taking priority over recovery altitude.***

Chandelle. A Chandelle is simply a high performance climbing 180^o turn. A variation of a Chandelle is the "pitch back."

To fly the Chandelle, establish a cruise power condition (65%) and entry speed of 150-180 MPH / 130-150 KTS. Maintaining precise altitude is not required, so unload as desired to assist with acceleration. After obtaining entry parameters, smoothly roll to establish 30-50^o of bank. After the bank is established, smoothly apply back pressure (2-3 G's). As the nose comes up and airspeed begins to decay in the climbing turn, advance power and mixture as required to WOT. For a Chandelle, the highest pitch point (approximately 30-40^o nose up) should be achieved at the 90^o turn point. Bank angle should remain constant through the first 90^o of turn: cross-check visual and instrument references, as required to keep angle constant during this portion of the maneuver. If turning left, engine power effects will tend to increase bank if not countered. Passing the 90^o point, begin decreasing the bank angle. Ease back pressure as required to maintain desired pitch. Since airspeed is decreasing throughout the maneuver, engine power effects will become more prominent. Monitor yaw (ball) and apply rudder as required to coordinate the roll out. While performing chandelles to the left, right rudder will eventually be required as the roll-out matures and engine power effects increase. When performing chandelles to the right, engine power effects will assist with roll-out.

The Chandelle is an asymmetric maneuver, and asymmetric maneuvering speed (V_A) and G-limits apply. A ground reference helps with orientation throughout the maneuver, preferably a straight line of some sort (e.g., road, high tension lines, canal, etc.).

The “pitch back” is a symmetric variation of the Chandelle. The set-up for the maneuver is identical, but an unloaded roll is used to “set” the lift vector (bank angle). 3-4 G’s are smoothly applied to begin the pull and throttle is advanced to wide open as the velocity vector/nose tracks above the horizon (i.e., at the point airspeed begins to decrease). A constant lift vector placement maintained throughout the maneuver to the 180^o point. This means that as the airplanes arcs up through the turn bank continues to increase. For example, if the pitch back is entered at 45^o of bank, the bank angle prior to beginning roll-out will be 135^o. Like the Chandelle, pitch will apex as the airplane is passing the 90^o turn point. To roll-out, the airplane is unloaded and the lift vector re-adjusted. An acceleration maneuver may be helpful at the conclusion following the roll-out.

The pitch back is a symmetric maneuver, and symmetric maneuvering speed (V_A) and G-limits apply. Familiarity with low AOA rolls and inverted recoveries will provide a good foundation for performance of the pitch back. A ground reference helps with orientation throughout the maneuver, preferably a straight line of some sort (e.g., road, high tension lines, canal, etc.).

The Chandelle and Pitch Back are energy gaining maneuvers. Depending on entry speed, 500-1500 feet of vertical maneuvering room are required to accomplish these maneuvers. Due to energy characteristics of the RV-types, the Chandelle will produce more altitude gain during the turn than a pitch back.

Low AOA Maneuvering. The set of low AOA confidence maneuvers includes the AOA (Ballistic) Recovery, Low AOA Inverted Recovery and Low AOA Aileron Roll. Airplanes cannot stall in a zero G condition. They may be maneuvered at speeds below normal stall speed at low G provided sufficient airflow exists to provide control authority. This maneuver set is designed to provide the proper seat-of-the-pants skill set required to establish a low-G condition (unload), allowing the pilot to maintain aircraft control at all times, and avoid unintentional stall or an out-of-control situation. The maneuvers are designed to maintain a small positive G margin, allowing accomplishment in any RV-type, regardless of fuel/oil system installed. For non-aerobatic types and configurations, the AOA (Ballistic) Recovery is appropriate.

An important skill is to develop the seat-of-the-pants feel for the low G condition. Cues will vary from pilot to pilot, but assuming the crew is securely strapped in, three good cues are available: heels "light," engine sound (if carbureted) and loose objects. As low-G is approached, a noticeable lightening of the legs occurs, in a normal seated position this is generally perceived as the heels of the feet becoming light on the rudder pedals. If the airplane is not equipped with inverted fuel and oil, as the airplane approaches zero G, the carburetor float will prevent fuel flow to the intake manifold. As this fuel flow diminishes, the pilot will detect a distinct change in pitch in the sound of the engine. Another cue is any loose items in the cockpit. If they are starting to rise (i.e., float), then a true zero to slightly negative G condition exists. If a bag, etc. is stowed under the pilot's elbow, he/she may feel that bump as the unload is executed. The key is to approach the low-G condition smoothly and deliberately so that these cues may be recognized. The stick should never be jammed forward.

Caution

- For airplanes NOT equipped with inverted fuel and oil systems:
    - If excess forward pressure is applied during an inverted unload, engine stoppage and oil loss may occur. If the propeller windmills, restart will occur automatically during recovery. If the propeller stops (more likely with a light-weight fixed-pitch installation), a manual restart (bumping the starter) will be required during recovery.
    - If inadvertent oil loss is encountered, the flight should be terminated and oil re-serviced since it is impossible to determine the extent of oil loss.
    - Unloaded maneuvering, even when properly flown can cause some oil venting. Instructors must limit the extent of maneuvering and be wary of handling errors which can cause venting when operating airplanes not equipped with inverted systems.
- Lap belts must be secure.

Low AOA maneuvers are energy neutral, but sufficient vertical maneuvering room should be available to ensure recovery at or above the desired maneuvering floor and allow for an upward trajectory along a ballistic arc as the maneuvers are initiated. Depending on entry speed, 500-1500 feet of vertical turning room above the maneuvering floor should be available for the conduct of these maneuvers.

AOA (Ballistic) Recovery. ***In a zero G condition, stall speed is reduced to zero.*** Under zero G, the airplane will maintain a ballistic trajectory, or portion thereof (think of a ball thrown on high arc). If sufficient altitude exists, lateral controls and rudder should be neutralized and an unloaded condition obtained through application of pitch input. Due to fuel and lubrication system limitations in airplanes not equipped with inverted systems, a true zero-G condition will result in (momentary) fuel starvation and oil pressure fluctuations. Generally a ¼ to ½ G condition is sufficient for recovery while maintaining normal engine operation. If engine hesitation or stoppage occurs, a re-start normally does not require pilot action if a positive G condition is established and the propeller is wind milling. If, however an aggressive unload is performed and sustained zero or negative G condition is established, engine and propeller stoppage may occur (especially in aircraft equipped with light-weight wooden or composite propellers due to the low inertia of the propeller). If propeller stoppage occurs, bumping the starter will result in a faster re-start than a dive to windmill the propeller. The purpose of the ballistic recovery exercise is to determine the stick neutral point which will establish the near-zero AOA, ¼ to ½ G condition.

To fly an AOA (Ballistic) Recovery, select an appropriate entry altitude, clear and ensure loose items are stowed. Angle of attack recoveries should initially be practiced from a nose-high attitude. A basic recovery may be practiced by pulling the nose approximately 45-60^{o} nose high (heels on the horizon). As airspeed decays toward stall speed (or onset of buffet, whichever occurs first), power should be reduced to idle and aileron and rudder should be neutralized. Smooth forward stick should be applied to establish approximately ¼ to ½ positive G. The nose should be allowed to drop and no attempt to roll (and/or pull) until the aircraft has unloaded and airspeed has begun to increase. Keep in mind that in a low-G condition, the airplane is essentially ballistic, i.e., the airplane will transition along a ballistic arc toward a nose-low condition as it accelerates. Normal acceleration rates should provide sufficient energy for recovery prior to reaching a nose low condition not later than the initial nose up condition, i.e., if the initial maneuver is begun at 40 degrees nose up, sufficient energy to roll and pull to recovery should be available no later than reaching a 40 degree nose down condition. Use caution not to transition to an excessively nose-low attitude without proper application of G and lift vector placement to control acceleration. As proficiency in a basic, wing's level attitude is gained, the maneuver should be flown with 30-60^{o} of bank.

A modified version of the AOA recovery maneuver may be flown by establishing random climb, bank and power conditions to a stall followed by a power off AOA recovery.

The AOA recovery is a low G, low airspeed maneuver. Depending on entry parameters, it can result in an unusual attitude recovery post-maneuver. Depending on fuel system configuration, some fuel venting may occur during the conduct of the maneuver and fuel odor may be noted in the cockpit.

Inverted Low AOA Recovery. An inverted low AOA recovery is essentially the same maneuver as the ballistic AOA recovery, but flown in an inverted attitude. The key to success is to perform the maneuver briskly to ensure maneuvering is commensurate with airspeed bleed (i.e., accomplishing the maneuver too slowly may result in insufficient airspeed available to achieve an inverted attitude prior to unloading). To fly an inverted low-AOA recovery, clear the area and establish a speed slightly below V_{N0}. Pull the nose up 45-60^o (at least "heels on the horizon"), reduce power to idle, unload and roll to inverted approaching 100 MPH / 95 KTS and no later than 80 MPH / 75 KTS. As airspeed (quickly) approaches stall, smoothly unload to a 0 to 1/2 G condition. A cockpit G meter can assist with proper control application, as can monitoring the engine (if the airplane is not equipped with inverted systems). If a loss of RPM is detected, increase back pressure slightly to maintain engine operation. The airplane will rapidly transition the ballistic arc. As the nose drops below the horizon, and unloaded roll to an upright, wing's level attitude should be performed. Monitor airspeed and apply recovery back pressure to avoid excessive airspeed build-up in recovery. Do not add power until the velocity vector (nose) has transited back above the horizon during recovery.

The inverted low AOA recovery is a low G, low airspeed maneuver. Flown properly, it will result in a nose-down, wings level dive; however a handling error could cause an unusual attitude recovery to be required. Depending on fuel system configuration, some fuel venting may occur during the conduct of the maneuver and fuel odor may be noted in the cockpit. If not equipped with inverted oil, the number of times the maneuver is performed should be limited since the amount of oil loss in the event of improper application of flight controls cannot be determined in flight.

Low AOA Aileron Roll. A low AOA aileron roll is performed by clearing the area, ensuring loos items are stowed and establishing speed at or slightly below V_{N0}. Pull the nose up 45-60^o (at least "heels on the horizon"), reduce power and smoothly unload to a ¼ to ½ G condition. Apply aileron in the desired direction of roll approaching 100 KTS/MPH. The low AOA aileron roll will combine elements of the basic AOA and inverted recoveries. Similar to a basic aileron roll, rudder coordination is desirable, but not required for safe accomplishment of the maneuver. As proficiency is gained, the rate of roll may be decreased and increased emphasis should be placed on proper rudder coordination to maintain a centered ball throughout the maneuver. Note this emphasis on coordination is somewhat at a variance with the technique of utilizing rudder to assist with proper heading/attitude control during a typical slow roll. The purpose of proper coordination to avoid unintentional yaw under low AOA, airspeed decreasing conditions—i.e., conditions that could cause autorotation in the event an unintentional stall occurs.

The low AOA aileron roll is a low G, low airspeed maneuver. Flown properly, it will result in a nose-down, wings level dive; however a handling error could cause an unusual attitude recovery to be required. Depending on fuel system configuration, some fuel venting may occur during the conduct of the maneuver and fuel odor may be noted in the cockpit.

Deep Stall. The deep stall is a confidence maneuver designed to familiarize the pilot with post-stall buffet, sink rate and yaw control. Not a true sustained deep stall, but rather a series of intermittent stalls, this maneuver is also referred to as a "falling leaf" stall. It provides a good example of positive longitudinal stability and familiarity with break-down of directional stability post-stall.

A deep stall is performed by initiating a stall (power off or power on, as desired) and maintaining full aft stick and neutral ailerons post-stall; utilizing rudder to control yaw and prevent unintended auto-rotation from occurring. Actual weight and CG location should be computed and the aircraft should be loaded within design limits prior to the conduct of the maneuver. Initially, the maneuver should be flown power off to mitigate engine power effects. Once familiarity with power-off post-stall handling characteristics gained, a partial power or power-on deep stall may be flown. During the maneuver, the aircraft will develop a significant buffet and sink rate so ensure adequate altitude is available prior to the start of the exercise.

To perform the deep stall, select an appropriate entry altitude, clear and ensure loose items are stowed. Slowly decelerate to the stall and maintain full aft stick. Be alert for nose slice/yaw post-stall. If the nose slides left or right, apply opposite rudder momentarily to prevent further yaw in that direction. In many cases, a wing will drop quickly if nose slice isn't perceived. It is necessary to develop the proper feel for rudder application and the technique is very similar to the application of rudder during landing conventional gear airplanes to prevent a swerve—i.e., make the input smoothly, deliberately and proportionately, then take the input out. Make rudder inputs as required to stop nose slice or pick up a wing that has dropped. It's possible to get out of sequence and exacerbate yaw by improper timing or amplitude of rudder input. Like any "over-control" situation, at that point it's best to return the rudder to a neutral position and either start over or break the stall and set the maneuver up again. RV-types tend to be more prone to developing post-stall yaw as center of gravity moves aft. Nose bob (i.e., uncontrolled nose drop) should be expected when post-stall maneuvering due to the inherent longitudinal stability of the airplane when loaded within design limits. The extent of bobbing will be proportional to the CG location. As GC moves aft, stability is reduced, bobbing will become less pronounced and nose slice (yaw) will become more pronounced. As experience is gained controlling yaw, the length of time spent maneuvering post-stall may be increased.

Post-stall rudder authority is good in all RV-types, but it is not practical to maintain a specified heading; rather, a general wing's level attitude (accepting heading excursions) while preventing auto-rotation through proper yaw control.

The deep stall is a low G, low airspeed maneuver. Recovery is akin to any stall recovery. Primary emphasis should be placed on reducing AOA and re-gaining flying speed. Power may be added as required/desired. The deep stall should generally be entered at an altitude commensurate with a spin to allow sufficient time to remain in the post-stall condition at high sink rate and still provide adequate vertical turning room to recover above the maneuvering floor (e.g., begin the maneuver 2000-3000 feet above the maneuvering floor).

Caution

During a sustained deep stall with flaps up, intermittent horizontal tail buffet may occur. This buffet may fatigue the horizontal stabilizer, elevators and/or fuselage attachment structures.

Incipient Spin. The incipient spin maneuver demonstrates the basic auto-rotation characteristics of RV-types, and allows the upgrading pilot to become familiar with recovery techniques and handling qualities associated with post-stall auto-rotation (spins). The incipient phase of the spin is defined as the time from which the airplane stalls until auto-rotation (steady-state spin) develops. Flying the incipient phase of the spin is sufficient to provide familiarity with basic upright spin characteristics and recovery sufficient for the purpose of transition training. The airplane must be loaded within designer's aerobatic limits to ensure adequate recovery margin is available.

For RV-types, the incipient phase generally lasts for 1-2 turns (4 to 6 seconds). Rotation rates are slower during the incipient spin than during fully developed auto-rotation; and, depending on CG location, simply neutralizing controls is generally sufficient for recovery (although anti-spin controls should be utilized for familiarization and practice).

To perform the incipient spin maneuver, select an appropriate entry altitude, clear and ensure loose items are stowed. Enter the spin by setting up for a power-off stall. Pro-spin rudder should be applied as the airplane stalls. Smoothly apply and maintain full rudder in the desired direction of spin. The spin entry can be facilitated if rudder is applied just prior stall and the last portion of back stick is applied a bit more quickly (especially when entering a right spin). Depending on deceleration rate, the nose may pitch past vertical as the outside wing rises and the spin starts. This is normal. Maintain pro-spin controls until recovery (full aft stick, full rudder in the desired direction of turn). Approaching the 270^{o} rotation point, apply anti-spin rudder and smoothly ease the stick off the aft stop. Auto-rotation will stop and the aircraft will be in a nose-low attitude on approximately the entry heading. Recover from the dive.

A ***minimum*** of 1500 feet of vertical turning room above the maneuvering floor should be available for a one-turn spin and recovery (See INTENTIONAL SPINS).

Cross-controlled Stall. The cross-controlled stall maneuver demonstrates the effect of improper control usage, especially during pattern operations, and how those control inputs can cause a departure from controlled flight. It builds confidence in the slip characteristics of RV-types and the utility of slipping to assist with controlling approach angle and familiarizes the upgrading pilot with the snap departure characteristics when rudder is inappropriately applied to skid the airplane during the base turn. There are two variations of the maneuver, a "slip" and a "skid", the latter of which will cause a rapid snap underneath which would make recovery doubtful if encountered at or below traffic pattern altitude. The use of flaps is not recommended to avoid exceeding V_{FE} and/or structural limits with flaps extended.

Slip. To fly a slipping cross-controlled stall, select an appropriate altitude and idle power to begin deceleration. Propeller (constant speed) and mixture should be adjusted as appropriate for stall recovery. As normal V_{REF} is approached (80 MPH / 70 KTS if not specified), a simulated base turn should be started. A slip to the inside of the turn should be initiated (i.e., left slip for a left turn). Outside/top rudder should be applied opposite the direction of turn, and inside/down aileron should be applied to maintain desired bank angle. Once the slip is established, AOA should be increased at a moderate rate to the stall.

As AOA increases, the airplane may begin a high AOA rudder roll in the direction of top rudder. If encountered, this is a slow roll or series of intermittent "ratcheting" rolls in the direction of yaw. In this case, as AOA passes critical, the roll may transition to a snap/flick roll in the direction in which rudder is applied. The amount of high AOA rudder roll is proportional to the rate at which AOA is increased/back stick is applied—i.e., if AOA is increased rapidly, the airplane will simply transition to a stall and/or snap roll. If applied more slowly, the rudder will become more effective for roll/lift vector control as AOA increases prior to the stall occurring.

Recovery should be initiated at the first sign of uncommanded roll or other stall indications. To recover, neutralize controls and reduce AOA.

Caution

If back stick is applied at an appropriate rate, the airplane will enter a sustained (deep) slipping stall, with little or no tendency to rudder or snap roll. Depending on CG location, the nose may "bob" until AOA is reduced. If a full cross-control condition is maintained post-stall with flaps up at speeds below $L/D_{MAX}/V_{REF}$, intermittent horizontal tail buffet may occur. This buffet may fatigue the horizontal tail, elevators and/or fuselage attachment structures.

Skid. To fly a "skidding" cross-controlled stall, select an appropriate altitude and idle power to begin deceleration. Propeller (constant speed) and mixture should be adjusted as appropriate for stall recovery. As normal V_{REF} is approached (80 MPH / 70 KTS if not specified), a flaps-up simulated base turn should be initiated. Rudder should smoothly be applied in the desired direction of turn. Opposite/outside aileron should be applied to maintain or decrease bank angle, allowing the nose to "skid" in the direction of the simulated base turn. AOA should be increased to critical. As critical AOA is exceeded, the airplane will rapidly snap roll underneath with little or no warning in the direction of rudder.

To recover, neutralize controls, reduce AOA and recovery from any unusual attitude. The quickest recovery occurs if the snap roll is continued to a wing's level attitude since any application of recovery controls prior to that point will cause a bank of 90^o or greater nose-down.

During a skidding cross-controlled stall, departure (snap roll) occurs immediately after critical angle of attack is exceeded with no or minimal tail buffeting.

Cross-controlled stalls are asymmetric energy depleting maneuvers and will require approximately 1000 feet of vertical maneuvering room above the maneuvering floor, i.e., expect a minimum of 1000 feet of altitude loss when setting up for the maneuver. Asymmetric G limits and maneuvering speed (V_A) apply.

A ***minimum*** of 1500 feet of vertical turning room above the maneuvering floor should be available for cross controlled stalls.

ANTI-G STRAINING

The ability to tolerate G's is a learned skill. One of the keys to dealing with G-load is to anticipate G-onset and properly applying an anti-G straining maneuver (AGSM). Performing an AGSM, involves tensing skeletal muscles and properly controlling breathing prior to and during the application of G-load.

Continuous tensing muscles in the legs, arms, abdomen and chest reduces blood flow in the G-dependent areas of the body and assists in keeping in the chest and head areas--think of “squeezing” the blood into your chest and head to keep it from draining out.

The respiratory component of the AGSM is repeated at 2.5 - 3.0 second intervals. The purpose of the respiratory component is to counter the downward G force by increasing chest pressure by expanding the lungs. This increased pressure forces blood to flow from the heart to the brain. The respiratory tract is an open breathing system which starts at the nose and mouth and ends deep in the lungs. The respiratory tract can be completely closed off at several different points. The most effective point is to close the system off at the glottis.

Closing the glottis (which is located behind the "Adam's Apple") yields the highest increase of chest pressure. It can be found and closed off by saying the word "Hick." This should be said following a deep inspiration and forcefully closing the glottis as you say "Hick." Bear down for 2.5 to 3.0 seconds, and then rapidly exhale by finishing the word "Hick." This is immediately followed by the next deep inhalation repeating the cycle. The exhalation and inhalation phase should last no more than 0.5 to 1.0 second.

G-tolerance will vary amongst individuals as a result of physical condition. Additionally, individual G-tolerance will vary from day-to-day. Any degradation in general health (including fatigue) will cause a decrease in G-tolerance. Time between exposures will also cause a decrease in G-tolerance (i.e., lack of practice/currency). A properly flown G warm-up maneuver can greatly assist with preparing pilots for aerobatic flight. If the body isn’t properly tensed prior to G-onset, it isn’t possible to “catch up.” G effects can occur at G loadings as low as 2 G’s. As blood drains from the brain, the first sign of impairment is degradation of vision (the eyes are extremely oxygen sensitive). If any narrowing of the visual field or grey-out occurs, G load should be reduced, and the muscles should be strained before re-applying G. A GLOC (G-induced loss of conciseness) can occur quickly and without warning. Pilots that suffer from GLOC will have no idea that the event occurred since GLOC events cause amnesia. Any time a pilot senses an issue with G tolerance, a “knock-it-off” is appropriate.

The instructor will teach the proper anti-G straining maneuver and it should be practiced on the ground prior to flight for familiarization. It should be practiced during flight during the G warm-up maneuver prior to maneuvering flight. As with individual hypoxia symptoms, pilots must become familiar with individual GLOC symptoms as well. If G tolerance is degraded, maximum performance maneuvering should not be attempted.

Notes

- Do not hold the respiratory strain too long (more than five seconds) since this will prevent the proper return of blood to the heart and may result in loss of consciousness.
- Anticipate a rapid-onset, high G exposure whenever possible. The skeletal muscles should be tensed *prior* to the onset of G's and coupled with the "hick" breathing cycle as the G's increase. Initiating the AGSM too early can inhibit the body's natural cardiovascular reflex responses. Starting the AGSM too late is a difficult situation to make up without reducing the G- stress. ***It is not practical to "catch up" if you strain late.***

ADVANCED HANDLING

> **Warning**
>
> A proper weight and balance analysis of any two-seat aerobatic RV type prior to conducting advanced handling dual instruction to ensure the aircraft is capable of carrying sufficient payload while remaining within designer's aerobatic limits. If the airplane operated has a high empty weight, the weight of fuel, crew and parachutes may make aerobatic flight impractical. Van's Aircraft states that: "An overweight RV IS a single-place aerobatic airplane, it's as simple as that."

The maneuvers contained in this section may also be considered "positive G recreational aerobatics" and may be flown in any aerobatic RV-type, regardless of the type of propeller fitted. They are designed to familiarize the transition pilot with RV-type handling characteristics and energy management. Inverted fuel and oil systems and/or fuel injection are not required to fly these maneuvers. These maneuvers combined with an understanding of RV-type aerodynamics/handling performance will provide a solid foundation upon which more advanced skills can be built, if desired. They will also provide seat-of-the-pants handling skills that will allow for effective "eye's out" maneuvering, greatly mitigating the chance of a handling error causing a mishap. ***The goal of advanced handling training is*** not to prepare the upgrading pilot for aerobatic competition; but rather ***to provide handling skills necessary for avoiding undesired autorotation, unusual attitude (upset) recovery and stall avoidance.*** The wide speed band, low wing loading, power loading and cleanliness of RV-types allows for more than one "right way" to perform the maneuvers in this section. The techniques and parameters described are simply a safe, common starting point presented for the purpose of standardization of basic instruction and familiarity. Techniques may vary from other types of aircraft. Advanced techniques for improving the quality or precision of purely "aerobatic" maneuvers are beyond the scope of this manual.

The airplane should be loaded in a manner that places the CG within acceptable designer's aerobatic limits. G-allowable and maneuvering speeds should be computed, briefed and understood prior to beginning maneuvering. In most cases, 4 G's is more than sufficient for completing safe, advanced handling maneuvers. This G load provides sufficient performance capability and doesn't exceed estimated asymmetric maneuvering limits, i.e., it is forgiving of handling error. The crew should be securely strapped in prior to attempting advanced handling. Any lose items in the cockpit or baggage areas must be properly secured. Harnesses (lap belts in particular) must be ***extremely*** snug prior to maneuvering. A four-point harness with a very tight lap belt is sufficient for positive G advanced handling maneuvering. The techniques in this manual take into account the lack of inverted fuel and oil systems on some RV-types and may vary from those used in other aerobatic aircraft. Advanced handling should be performed at a safe altitude. Consideration should be given to recovery from an unintentional spin. Minimum bail-out altitude should be computed and egress techniques reviewed. In general, 3000’ AGL should be considered the minimum altitude (floor) for advanced handling training. ***This means that all maneuvers are completed AT or ABOVE 3000’ AGL.*** The upgrading pilot must remain aware of relative position to the maneuvering floor and overall area orientation throughout maneuvering. Visual clearing in the direction of flight and *anticipated direction* is critical.

> **Note**
>
> Based on typical RV-type spin characteristics, intentional spins of four to six turns duration or less should be initiated at an altitude of approximately 6000’ AGL or above to allow sufficient altitude for recovery above 3000’ AGL. For the purpose of advanced handling instruction, it is recommended that intentional spins be limited to one turn during the incipient phase until sufficient experience is gained.

<u>Warm-up</u>

Prior to conducting advanced handling training, a proper warm-up should be conducted. This warm-up should consist of a basic stability check, G warm-up/anti-G strain practice and confidence maneuvers.

60^{o} Banked Steep Turn Warm-up. The purpose of the steep turn is to familiarize the pilot with the turn performance of the airplane and develop an eye’s out feel for 2 G’s. It will also provide familiarity with visual cues for determining bank angle. 180 to 360^{o} of turn in each direction should be flown. To perform the steep turn, establish a trimmed cruise condition using 65% power or greater. Bank angle may be initially established by reference to instruments, but after a stable turn is developed, the pilot should transition to primarily visual cues, cross-referencing instruments as required. It will be necessary to coordinate the roll-in, turn and roll-out with proper rudder inputs. Increased back pressure and pitch ($1\text{-}2^{o}$) will be required to establish the 2 G condition required for level flight in this attitude. Power may be increased slightly to maintain airspeed (if desired) and bank angle adjusted to ensure a level altitude is maintained throughout the maneuver. It is not recommended that trim be adjusted during the turn.

Two techniques may be used for flying steep turns. Using the first, the pilot should strive to maintain a constant indicated airspeed throughout the maneuver. This will normally require the use of wide-open throttle/full power (throttle may be adjusted during or after establishing parameters) for a 60^{o} bank turn. It is possible to fly steep turns to indicated airspeeds as low as 85 MPH / 75 KTS (or the onset of buffet, whichever occurs first) and they should be performed at different speeds and power settings as proficiency is gained. Another technique may be referred to as "set power." In this case, the power should be set at 65-75% prior to maneuvering and a 15-35 MPH/Knot CAS airspeed bleed should be anticipated during completion of 360 degrees of turn. Depending on technique flown, the steep turn is either energy neutral (power to maintain airspeed) or energy depleting (fixed power setting). If the later technique is utilized, it will be necessary to accelerate at the conclusion of the maneuver.

Note

A 60^{o} bank / 2 G condition will increase indicated stall speed by approximately 33%. If an accelerated stall is accidentally encountered, angle of attack should be reduced and opposite rudder applied (if necessary) to counter any yaw. If the stall is encountered in an uncoordinated condition, the airplane may snap initially until controls are neutralized. This may result in an unusual attitude.

G Warm-up. The purpose of the G Warm-up turn to familiarize the pilot with cues for establishing a 3 to 4 G condition and practice the anti-G straining maneuver. To perform a G warm-up, establish a safe altitude and 150-160 MPH / 130-140 KTS CAS at 65% power. Plan to lose 500-1000 feet during maneuvering. Roll to 80-120 degrees of bank, and ***smoothly*** apply 3 G's for the first 90 degrees of turn, modulating power as required. A G on-set rate of approximately 1G per second should be utilized (i.e., take 3-4 seconds to establish a 3-4G condition). Roll-out, momentarily adjust power (as required) and unload to 1 G or less to obtain 150-170 MPH / 130-150 KTS CAS, reverse turn direction and ***smoothly*** apply 3-4 G's for another 90 degrees of turn. It's necessary to allow the velocity vector to drop below the horizon to maintain energy throughout the turn (i.e., over-bank is required). Positive control is required to modulate airspeed and G to prevent a high-speed, nose-low condition from developing. Conversely, if the velocity vector is not allowed to transition below the horizon and airspeed is bled in the turn, a 4G accelerated stall may be encountered at approximately two times the normal 1 G stall speed. The nose will stop tracking across the horizon if an accelerated stall occurs and buffet or wing drop may be encountered.

> **Caution**
>
> The G warm-up maneuver is conducted at speeds above corner (V_A) with the airplane decelerating through corner (V_A) as the maneuver progresses. Use caution not to “snatch” the stick when applying G’s. Smooth input of 1G/second is recommended.

<u>Acceleration Maneuver.</u> In certain cases, it is desirable to accelerate as rapidly as possible (e.g., when setting up for an over-the-top maneuver like a loop, Immelmann, etc.). If sufficient altitude exists, the quickest way to accelerate is to unload initially to a +¼ to + ½ G condition (less than 1 G, “heels light”). If the engine hesitates, excessive forward stick has been applied. Once the nose is down and the velocity vector is below the horizon, indicated airspeed will build rapidly and it will be necessary to readjust back pressure to prevent a high-speed condition from occurring. Aileron may be applied to control the lift vector (bank angle) during low-G conditions; however primary attention should be devoted to regaining airspeed. As soon as airspeed is increasing above 80-100 MPH / 70-85 KTS CAS, coordinated lateral input may be applied to adjust the lift vector (bank angle). An acceleration maneuver can be applied at any time that additional airspeed is desired and sufficient altitude exists. It may be used expedite maneuvering vs. level acceleration.

<u>Basic Rolls</u>. Establish a safe altitude and clear the area. Ensure lose objects in the cockpit are properly stowed and restraints are tight. Establish 150-170 MPH/130-150 KTS CAS. Apply back-stick to raise the nose 20-30 degrees above the horizon. Neutralize the elevator control to stabilize the pitch angle and apply firm aileron input in the desired direction of roll. Use half-stick or greater deflection. Hold uniform aileron pressure through at least 300 degrees of roll. Reverse ailerons just prior to wings level to arrest the roll rate in a wings level condition. Apply back stick, as required to re-establish straight and level flight. It is not necessary to apply rudder during this maneuver. The nose will drop from the initial 20-30 nose-high condition throughout the maneuver. With 1/2 to 3/4 stick deflection, the nose should finish as many degrees BELOW the horizon as it was degrees ABOVE the horizon when the maneuver started. The aircraft rolls more readily to the left do to engine power effects of the engine, thus more right aileron will be required to achieve the same roll rate. This maneuver may also be practiced by reference to the primary flight instruments. As proficiency is gained, roll rates can be decreased, however a commensurate increase in pitch is required prior to beginning the roll.

Common errors when performing this maneuver include not establishing a sufficiently high pitch angle before rolling (this will cause a nose-low, high airspeed condition at the conclusion of the roll); failure to neutralize elevator pressure before rolling (this will result in a barrel roll and generally cause an excessive loss of altitude or cause a nose-low unusual attitude); and not applying sufficient aileron pressure (this will cause a slow roll rate and allow the nose to drop excessively during the roll). The airplane does not exhibit inertial coupling tendencies if full deflection aileron rolls are performed with neutral elevator. If the nose drops below the horizon before the mid-point of the roll, or a nose-low unusual attitude is encountered, reduce power, roll in the shortest direction to wing's level and smoothly apply G (as required) to reestablish straight and level flight.

The basic roll is a symmetric, energy neutral maneuver. When setting up for the basic roll, allow 500 feet of vertical turning room for the conduct of the maneuver.

Modified Aileron Roll. A true aileron roll, one in which the aircraft is held on a straight, level line is difficult to do without a full inverted fuel and oil system. The gravity fuel system in the airplane will quit feeding the engine at approximately the 90 degree bank point, and the ensuing lack of power will reduce the effectiveness of the elevator and rudder as well as causing a rapid loss of energy. If the engine is wind milling, oil will be pumped overboard via the breather. A modified roll may be flown by applying top rudder (rudder opposite the direction of roll) as the airplane approaches the 90 degree point, slight forward stick (+ ¼ to + ½ G) at the 180 degree point and top rudder again (rudder in the direction of roll) at the 270 degree point. The modified aileron roll should be practiced incrementally:

Top Rudder Application. To begin, establish a safe altitude and clear the area. Ensure lose objects in the cockpit are properly stowed and restraints are tight. Establish 170 MPH/150 KTS CAS. Apply back-stick to raise the nose 20-25 degrees above the horizon. Neutralize the elevator control to stabilize the pitch angle and apply firm aileron input in the desired direction of roll. Use half-stick or greater deflection. At the 90 degree point, apply top rudder and note the nose hangs on the horizon longer than when performing the basic roll. Reduce rudder pressure so that the rudder is neutral at the 180 degree point and then again apply top rudder approaching the 270 degree point.

Forward Stick Application. Establish a safe altitude and clear the area. Ensure loose objects in the cockpit are properly stowed and restraints are tight. Establish 170 MPH/150 Knot CAS. Apply back-stick to raise the nose 20-25 degrees above the horizon. Neutralize the elevator control to stabilize the pitch angle and apply firm aileron input in the desired direction of roll. Approaching 180 degrees of roll smoothly ease the stick forward to establish a heel's light (0-1/2 G) condition. The nose will hesitate slightly, and the rate of nose drop will decrease.

After some proficiency is gained in applying "nose up" controls about one axis at a time, the basic maneuvers should be combined. With top rudder and nose up elevator applied at optimum times, less altitude is lost in the roll, and rolls can be entered at lower pitch angles.

The modified aileron roll is an asymmetric, energy neutral maneuver. When setting up for the modified aileron roll, allow 200-300 feet of vertical turning room for the conduct of the maneuver.

Hesitation Rolls. The airplane is capable of accomplishing basic hesitation rolls. If the RV-type operated for training is not equipped with inverted fuel and oil systems, it is not possible to perform a pure, straight line hesitation roll. Because of the time required to hesitate, completion will require a greater elapsed time than would an aileron roll. Thus, hesitation rolls require a higher entry speed and pitch attitude (when appropriate) to ensure sufficient energy is available throughout the maneuver to preclude a nose-low, high airspeed condition.

First, single hesitations at the 180 degree (inverted) point should be flown. Establish a safe altitude and clear the area. Ensure loose objects in the cockpit are properly stowed and restraints are tight. Establish 170-180 MPH /150-160 KTS CAS. Apply back-stick to raise the nose 30^{o} above the horizon. Neutralize the elevator control to stabilize the pitch angle and apply firm aileron input in the desired direction of roll. Approaching 180 degrees of roll (inverted), smoothly ease the stick forward to establish a heel's light (0 to 1/2 G) condition. The nose will hesitate slightly, and the rate of nose drop will decrease. Pause long enough to cross check level with the horizon, and then re-initiate the roll to an upright position. Continue to practice this until a good feel is developed and the maneuver can be performed without interrupting engine operation (for aircraft not equipped with inverted systems). Reduce initial pitch up as proficiency is gained. Next, hesitate at only the 90 degree position. Apply and hold top rudder (opposite the direction of the roll) and opposite aileron to establish the 90 degree hesitation. As the wings stop in the vertical position, neutralize aileron and increase top rudder. Pause only long enough to ensure the wings are vertical and the nose is held up somewhat. Then apply aileron and rudder into the roll and complete the remaining 270 degrees of roll back to upright. Once each point has been practiced, combine the maneuvers. Ensure sufficient airspeed and pitch prior to beginning a complete 4 point roll.

The basic (positive G) hesitation roll is an asymmetric, energy neutral maneuver. When setting up for the hesitation roll, allow 500 feet of vertical turning room for the conduct of the maneuver.

Loop. Establish a safe altitude and clear the area. Ensure lose objects in the cockpit are properly stowed and restraints are tight. Establish 170-180 MPH /150-160 KTS CAS and wide open throttle (use caution to observe engine RPM red line). Smoothly apply 3-4 G's. Maintain 3-4 G's until the 90 degree nose high point. Cross-check airspeed (120-125 MPH / 105-110 KTS at this point will ensure sufficient energy is available to continue a straight pull and arrive at the top of the loop with at least 70-90 MPH / 60-80 KTS CAS). Passing the 90 degree nose-up point, begin easing back pressure to arrive at the top of the loop, inverted at 1 cockpit G. Apply back stick as necessary to ensure the nose continues to rate down to the horizon. Inverted at the apex of the loop, airspeed should be between 70-90 MPH / 60-80 KTS CAS (airspeeds as low as 50 MPH / 45 KTS are acceptable, however as airspeed decreases, available G is reduced, the controls become light, the airplane tends to fall and the pilot becomes light in the seat, and engine hesitation may occur). Passing inverted, reduce power to idle (fixed pitch airplanes) and increase back pressure to prevent excessive speed build up during the recovery phase.

Common problems include improper longitudinal stick control when inverted at the top of the loop. Excessive back pressure can result in an accelerated stall, unintentional snap roll and/or possible spin entry. If any buffet is encountered during the pull, the stick should be eased forward to cause the stall buffet to stop while continuing the loop. Conversely, insufficient back pressure approaching or on the top of the loop (insufficient nose rate) will cause a loss of energy and the airplane will begin to fall inverted. Depending on airspeed, there may not be sufficient elevator authority to pull the nose down and an inverted unloaded (zero to ½ G) recovery may be required. Maintain a low-G condition until the nose drops and airspeed is increasing before attempting to roll. When flying the back side of the loop, airspeed/AOA and G management are more important than altitude control or flying a perfectly symmetrical maneuver. On the back side of the loop, airspeed can increase at a dangerous rate, particularly if the throttle is unintentionally left open. Until experience is gained, the recommended technique is to max perform over the top to rate the nose, establish CL_{MAX} and then transition to G-available (target 4 G) as speed increases past V_A/corner velocity. Symmetry adjustments (if desired) can be made during the last 90 degrees of dive recovery on the back side of the loop, provided airspeed is under control. As with any dive recovery/nose low condition, it is more important to manage airspeed than altitude at the completion of a loop.

The loop is an energy neutral maneuver if start parameters are re-achieved at the conclusion—depending on power settings during the second half of the loop and G application throughout the maneuver, the loop can be flown in the shape of the letter “e” providing some energy (altitude) gain if desired (keeping in mind that airspeed/AOA control is more important than “nailing” a specific altitude parameter). The loop is a symmetric maneuver. When setting up for a loop, allow 1000 feet of vertical turning room for the conduct of the maneuver.

Aborted Loop. Skills used in performing confidence maneuvers may be combined with advanced handling training to establish the “easiest way back to level” to abort maneuvering flight. An “aborted loop” is a handling exercise designed to familiarize the upgrading pilot/instructor with techniques for recovery. The energy maneuverability and handling characteristics of RV-types may be easily adopted to provide an escape plan.

Figure 3-22 depicts three different options for aborting a loop and quickly re-establishing level flight.

Example A utilizes techniques identical to the INVERTED RECOVERY confidence maneuver, a series of 2 180 degree rolls. Adjusting the lift vector (rolling) allows for maintaining positive G and normal engine operation throughout the abort maneuver. It also provides a familiar means of maintaining adequate energy until recovery to level flight. A simple push at point A would result in engine failure in aircraft not equipped with inverted systems (or possibly extended time at 0 G in aircraft equipped with inverted systems). This would likely stop the prop, result in rapid airspeed decay and may lead to an unintentional tail slide.

Example B is a simple unloaded 180 degree roll. This abort technique can be used if the pilot judges that there is insufficient altitude for pull-through. This technique uses handling skills practiced in the LOW AOA AILERON ROLL confidence maneuver.

Example C is a de facto emergency dive recovery. Options at this point are limited, and the lift vector (bank angle) is already optimized for recovery as it is perpendicular to the horizon—i.e., it is not necessary to roll, only manipulate power and pull (G onset). At speeds above corner velocity (V_A), power should be reduced. Techniques described in the EMERGENCY DIVE RECOVERY section would be appropriate for this example.

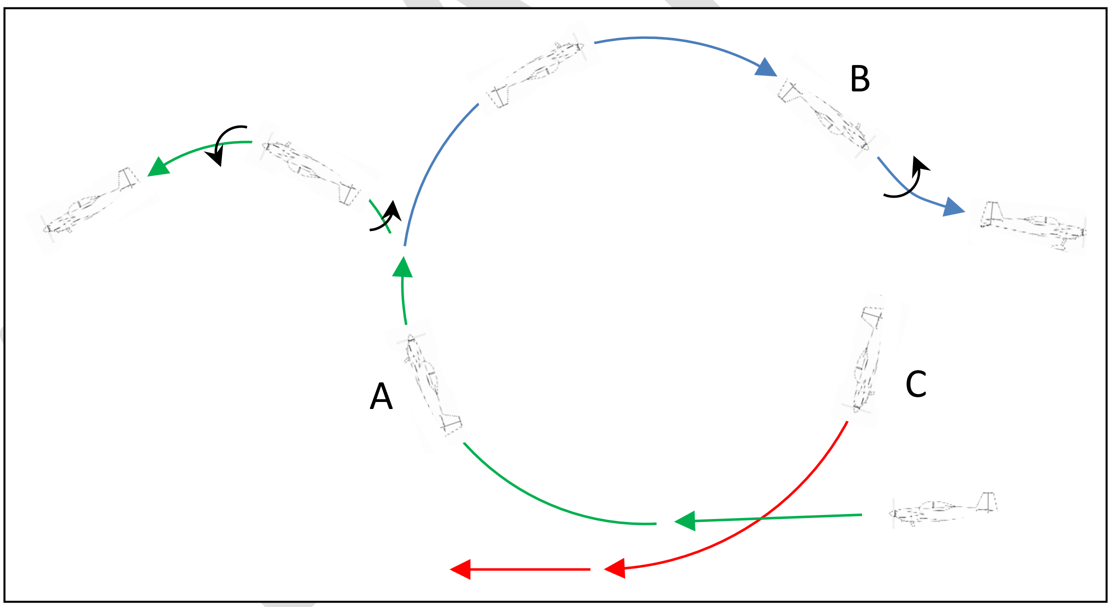


Figure 3-22: Aborted Loop Exercises

Pitch Back. A pitch back is simply an easier way to fly a high-performance climbing turn than a Chandelle. To perform a pitch back, establish cruise power, unload to accelerate to 150-180 MPH / 130-155 KTS CAS, roll to 45^{o} of bank, set the lift vector and pull using 2-3 G's; once the pull is begun, advance power to wide open throttle as speed decreases to corner velocity (V_A). As the apex is approached, roll-out to wing's level.

The pitch back is a symmetric, energy neutral maneuver (airspeed is traded for altitude). When setting up for a pitch back, allow 500-1000 of vertical turning room for the conduct of the maneuver.

Slice Back. A slice back is a maximum performance descending turn performed in the oblique. The lift vector and velocity vector are below the horizon throughout the maneuver. The slice back can be performed from a variety of initial conditions, however a speed band of V_A-40 MPH (or 35 KTS) to V_A is recommended. As with any maneuver in an RV-type that will commit the velocity vector below the horizon, the pilot must first assess the entry energy state. Initially, perform this maneuver by establishing level or wings-level climbing flight at/to 100 MPH / 85 KTS CAS, reducing power to 1500 RPM or less (fixed pitch) or 15-17" MP (constant speed), rolling to 120-135^{o} of bank and smoothly applying 3-4 G's. Modulate power and G to maintain airspeed at V_A or less throughout the maneuver.

The pilot should clear in the direction of the turn, ensure sufficient altitude is available for vertical maneuvering (plan on using 500-1000' for the maneuver) and select a ground reference to assist with orientation.

Due to the acceleration characteristics of the airframe/propeller combination, the maneuver should not be entered at speeds greater than nominal corner velocity (V_A). If the maneuver is entered at higher airspeed, insufficient G is applied or power is not modulated, a nose-low, high-airspeed condition can result. If airspeed cannot be properly controlled, recover from the nose-low, accelerating condition before airspeed becomes excessive. Conversely, excessive G application could cause and accelerated stall condition. Longitudinal stick force (G) should be eased if any buffet is encountered during the maneuver.

The slice back is a symmetric energy depleting maneuver. When setting up for the slice back, allow 500-1000 of vertical turning room for the conduct of the maneuver.

Barrel Roll. The nose should describe a circle around the reference point, and the rate of roll should be constant throughout the barrel roll. Engine engine power effects are somewhat pronounced, and more aggressive input is required to roll the airplane to the right than to the left.

To accomplish a barrel roll, clear the area and attain 150-180 MPH/130-160 KTS CAS with 65-75% power set. Select a reference point ahead of the aircraft and begin a slow, coordinated turn 20-30 degrees away from the point. Begin a steady 2-3G pull from a wings-level condition and begin to roll to arrive above the point at 90 degrees of bank. Relax some back pressure and increase aileron pressure slightly. Some forward stick/unload will be required during the inverted portion of the roll (target a "heel's light" approximately ¼ - ½ G condition, as required to ensure proper engine operation with non-inverted systems). Time the rate of roll so that you reach the inverted, wing's level position as the nose passes through the horizon. Back pressure should be reapplied and top rudder used as necessary to keep from dishing out of the bottom of the roll. Airspeed should be monitored when the lift vector transitions below the horizon and power adjusted to mitigate airspeed build-up while G is reapplied. The maneuver will be complete when the wings are level and the aircraft is in level flight with the nose 20-30 degrees from the initial reference point.

Difficulties with "dishing" out of the maneuver in the bottom half usually are due to insufficient rate of roll and to insufficient elevator force shortly after crossing down through the horizon: if an insufficient rate of roll when inverted results in airspeed build-up, an unusual attitude recovery should be performed vs. allowing a dangerous build-up of airspeed and possible asymmetric over-G.

Use rudder as necessary throughout to keep the maneuver coordinated. Positive G should be slight throughout the maneuver (i.e., definite seat pressure should exist at all times, with 1G desired throughout). The barrel roll is an energy neutral asymmetric maneuver requiring approximately 500-600 of total vertical turning room (above and below the reference altitude for entry).

Split-S. A split-S is simply the second half of a loop. The altitude lost in the maneuver is proportional to airspeed at the beginning of maneuver and the manner in which G is applied during the pull-through. Typically, 700-1000 feet will be lost, so entry altitude should be adjusted to remain above the desired aerobatic maneuvering floor.

To accomplish a split-S, climb to a suitable altitude, clear the area and establish 70-90 MPH/60-80 KTS CAS in a 10-30^o nose-up attitude. A zoom climb is an efficient way to develop vertical turning room. Unload, roll inverted with ailerons (make sure the wings are parallel with the horizon), and begin a smooth, maximum performance vertical pull. Adjust power as required to maintain corner speed (V_A). If equipped with a fixed pitch propeller, pull the power to IDLE as the pull through is initiated. When inverted, the lift vector and velocity vector are both below the horizon, and G must be applied to control acceleration throughout the maneuver. If buffet is encountered in the pull, stick pressure should be relaxed slightly to avoid an accelerated stall. Failure to apply sufficient aft stick will result in a rapid increase in airspeed. Radial G will decrease throughout the pull-out, and will require adjustment of pitch force (increase) as the maneuver is completed. A smooth pull to approximately 2 G's with back pressure increasing as airspeed increases to pull to CL_{MAX} (onset of buffet) initially and transition to G-available as corner speed (V_A) is passed. It is not normally necessary to increase power until the velocity vector has transitioned to or above the horizon after the completion of the maneuver. The split-S is an energy depleting symmetric maneuver and should be performed from sufficient altitude to allow for recover at or above the desired aerobatic maneuvering floor. A minimum of 1000' of vertical turning room should be planned when flying a split-S.

Warning

- Due to the acceleration characteristics of the airframe, starting a split-S at airspeeds greater than 100-110 MPH/85-95 KTS CAS can result in unintentionally attaining dangerously high airspeeds. Any delay in establishing back pressure at the beginning of the maneuver will result in a rapid increase in airspeed. Engine over-speed may occur if power is not reduced if the airplane is fitted with a fixed pitch propeller.
- Rapid application of back stick while inverted at low speed, can cause an unintentional snap roll (due to power effects) if the critical AOA is exceeded. Depending on CG location and the rate of pull, there may be little or no aerodynamic warning.

Immelmann. The Immelmann turn is a combination maneuver, consisting of the first half of a loop flowed by a half-roll to level flight. Entry speed is commensurate with a loop. Select MIL power and establish 160-180 MPH CAS. A smooth 4-G pull should be applied, just as when starting a loop. The Immelmann is identical to a loop until reaching a point inverted with the nose approximately 20 degrees above the horizon. At this point, relax back stick pressure to neutral (i.e., unload) and begin a coordinated roll in the desired direction. Due to the low speed at this point in the maneuver, a fairly rapid roll rate is desired to establish a wing's level condition as the nose falls to the horizon.

The aileron executes the half-roll portion of the maneuver. As with any slow roll, regard the rudder not as a coordinating control, but as an independent control to keep the aircraft headed straight while the ailerons are rolling it to level. Power modulation should not be required, however power may be adjusted to compensate for engine power effects. The airplane will roll more readily to the left under low-airspeed, high power conditions. If the RV-type operated for training is not equipped with inverted fuel and oil systems, AOA/G management throughout the roll is important. An unloaded roll is required, but slight (0 to ½) positive G should be maintained throughout if the airplane is not equipped with inverted systems. It is better to allow the nose to drop through or below the horizon during the final portion of the maneuver than to attempt to apply excessive forward stick to ensure roll completion before the nose tracks to the horizon. The Immelmann is an energy-gaining maneuver requiring approximately 1000 feet of vertical turning room.

The Immelmann is an energy neutral (airspeed is traded for altitude) symmetric maneuver requiring 1000 feet of planned vertical turning room.

Cuban 8. The Cuban 8 is another combination maneuver, combining a loop with a diving aileron roll. Each half of the eight can be visualized as an Immelman turn, completed 30-45 degrees below the horizon (on the "back half of the loop"). Entry speed and power should be the same as used in the loop, and a minimum of 1000' of vertical turning room above the entry altitude should be available. The Cuban 8 is an energy neutral maneuver.

Start the maneuver like a loop, reduce power after apexing inverted and relax back stick pressure to neutral when the nose is 30 degrees below the horizon, inverted after going over-the-top. Perform a half-roll to establish the aircraft on an accelerating 30-45 degree down line. Begin the pull-up to the next half of the maneuver upon reaching initial entry airspeed (180 MPH / 160 KTS CAS) and repeat the maneuver. Do not delay to initial entry altitude if airspeed is increasing past desired pull point during the down-line portion of the maneuver. The rate of roll is optional, but must be commensurate with the rate at which airspeed is increasing in the dive. A wing's level condition must be established before pulling up into the second half of the maneuver. If excessive speed is encountered, a nose-low unusual attitude recovery should be performed.

The Cuban 8 is an energy neutral symmetric maneuver requiring 1000-1500 of planned vertical turning room.

Cloverleaf. The cloverleaf is another combination maneuver, combining elements of the loop with the Lazy 8. It is composed of four very steep climbing turns, with a change of direction of 270 degrees in each turn. After clearing the area and ensuring adequate vertical turning room is available (plan 1500'), set 65% power and 150-160 MPH / 130-140 KTS CAS. Execute a smooth 2-3 G pull up to 60-70^{o} pitch. Begin a roll in either direction, timed so that the horizon is reached inverted after rolling 90 degrees from the initial entry heading. It's best to look to the left or right during the initial pull up to find a 90 degree reference point to assist with orientation when maneuvering over the top. During the 90^{o} change of direction, continue the climb with back stick pressure so that the climb attitude becomes almost vertical before the bank angle reaches 90^{o} and the nose starts down to the horizon.

The wings should be level (inverted) as the horizon is reached, and the rate of roll may have to be modified during the maneuver so that this will happen at exactly 90 degrees from the entry heading. In this maneuver, the same skills are required in timing of back stick and aileron pressures as are exercised in the barrel roll and the Lazy 8.

At the horizon inverted, add back stick pressure sufficient to keep the aircraft just comfortably outside the high-speed stall region as you pull the nose through a vertical dive into a normal climb attitude for the next "leaf" of the maneuver. Like a split-S or the back side of a loop, increasing speed with demand increasing back stick pressure and a reduction of power (if the aircraft is fitted with a fixed-pitch propeller). If the pull-out is not kept tight immediately after crossing down through the horizon, the aircraft will pick up excessive speed. Enter the next leaf of the clover without pause after the dive recovery, rolling in the same direction of the previous leaf until all four leaves are flown. Depending on power manipulation and G application, the Cloverleaf can be an energy gaining maneuver, with each leaf terminating at an altitude higher than the previous leaf.

The cloverleaf is an asymmetric maneuver. Allow 1000-1500 of vertical turning room for the conduct of the cloverleaf maneuver.

Hammerhead/Stall Turn. A hammerhead (stall) turn is entered from a vertical climb. 1/4 loop (pull or push) to vertical then as momentum/airspeed decreases, rudder is applied and the aircraft rotates around its yaw (vertical) axis, the nose falls through the horizon and points towards the ground, a momentary pause is made to establish a vertical dive, and 1/4 loop (dive recovery) is flown to level flight. Hammerheads are also referred to as a *stall turn* which is a misnomer because the aircraft never actually stalls. The hammerhead is performed when the airplane decelerates to a low airspeed condition (a perfect pivot would occur at precisely zero airspeed). The pivot portion of the hammerhead is performed with full rudder in the desired direction of turn. Power effects during portion of the maneuver will require proper control application to counter. The torque portion of power effects will require the application of aileron to counter during the maneuver, and the slipstream component will make a right-hand pivot problematic (the results of pivoting opposite slipstream effect are so poor that, in general, there is no point in attempting it). When pivoting left, power effects during the application of yaw will also require forward stick to maintain vertical.

To fly a basic, left-hand pivot hammerhead, establish a vertical climb (a climb angle of 80-85^{o} is sufficient for initial practice and will ensure that the airplane will pitch forward in the event an inadvertent stall is encountered) at full power using the same techniques used to perform the first portion of a loop. Power should be left on throughout the maneuver. It will be necessary to look at the left wing tip to estimate climb angle during the pull-up. Some left rudder will be necessary as the pull-up is initiated, but as the airplane slows, it will be necessary to apply right rudder to compensate for power effects and control yaw. Apply forward stick as necessary after the quarter-loop to maintain the desired vertical climb. Airspeed will decrease rapidly. As airspeed decreases, engine power effect will require some right aileron to compensate. About the time the left aileron is down about an inch and airspeed is decreasing through approximately 30-40 MPH / 25-30 KTS, smoothly apply left rudder (kicking the rudder may cause a rudder stall). As the airplane begins to turn/yaw around the vertical axis, smoothly increase rudder pressure. Forward stick and then right aileron will be required during the pivot to counter power effects. During the yaw turn "over-the-top" or "pirouette" portion of the maneuver, the proper sequence of control application is first rudder, followed by aileron then slight forward stick.

As the airplane transitions to a vertical dive, the forward stick should be neutralized and the aileron input removed. The airplane will accelerate rapidly during the dive. As airspeed is increasing through 100 MPH / 90 KTS, smooth application of aft stick is required to complete the recovery using 4 G's or less. Power may be reduced during the recovery to assist with controlling speed and preventing an inadvertent high-speed excursion. As with any dive recovery/nose low condition, it is more important to manage airspeed and AOA than altitude at the completion of a maneuver.

The basic hammerhead is an energy neutral asymmetric maneuver requiring approximately 1000-1500' of vertical turning room.

Snap Roll/Flick Roll. ***Intentional Snap Rolls are NOT RECOMMENDED.***

The RV-types require high G forces to produce a brisk snap roll, and asymmetric G limits will be exceeded if the maneuver is entered at speeds that exceed asymmetric maneuvering speed. Asymmetric G limits are not specified for RV-type aircraft (See HANDLING CHARACTERISTICS, MANEUVERING FLIGHT). The low stall and maneuvering speed of RV-types limit the speed range in which snap rolls can be performed. Furthermore, the stall characteristics of the RV-type's rectangular wing planform are not compatible with the asymmetric stall requirements of intentional snap rolls.

To perform a basic, positive G (inside) snap roll, establish level 1 G flight at calculated V_A for asymmetric maneuvering minus 5 KTS/MPH. Smoothly and aggressively apply positive G to stall. Simultaneously apply smooth aggressive rudder in the desired direction of roll. The airplane will roll more briskly to the left than right due to power effects. Approaching 270 degrees of roll, neutralize aft stick and apply opposite rudder to achieve wings level. Adjust AOA and power to maintain flying speed.

The snap/flick roll is an asymmetric energy depleting maneuver. Allow a ***minimum*** of 500 feet of vertical turning room for the conduct of a snap/flick roll, however keep in mind that a botched snap/flick roll may result in a developed spin. As with the cross-controlled stall, allowing 1500 feet of vertical turning room until proficiency is gained is recommended.

Warning

- Snap rolls may be thought of as a "horizontal spin." The flight control inputs required to generate a snap roll are asymmetric, i.e., maneuvering is conducted about two or more axis simultaneously. Asymmetric maneuvering limits are not specified for RV-types. For aircraft certified in the aerobatic category under FAR 23, asymmetric G limits are reduced by 33%. RV-types are not certified.
- V_A (maneuvering speed/corner velocity) must be calculated for gross weight and G allowable. "Normal" V_A is too fast to perform "snap" maneuvering and could result in structural damage. If asymmetric G limit is presumed to be 33% of maximum allowable G (e.g., 6.0), then the asymmetric limit is 4.0. The square root of the G limit (2.0 in this example) is multiplied by the stall speed at operating (gross) weight to determine asymmetric V_A (See HANDLING CHARACTERISTICS, MANEUVERING FLIGHT)

<u>Tail Slide</u>. ***Intentional tail slides are NOT RECOMMENDED.***

Early recognition and proper application of the unusual attitude procedure will allow recovery from a nose-high, low-airspeed condition. Confidence maneuvers and unusual attitude recovery practice are designed to provide the basic handling building block skills required for maneuvering under low airspeed conditions. ***A properly timed low/0 to ½ positive G recovery will prevent a tail slide from occurring.*** As with any nose-high, low-airspeed condition, power should be left on (or advanced to full). If the airplane is not equipped with inverted fuel delivery capability, engine stoppage may occur during recovery. This is of secondary concern until adequate flying speed is regained. If a nose-high, low-airspeed condition causes an inadvertent spin, the out-of-control procedure should be applied.

It is difficult, but not impossible to achieve a flight condition that will cause reverse airflow (i.e., the airplane falling backwards through the air). Reverse airflow has the potential to cause structural damage to primary and secondary flight controls and should be avoided to the maximum extent practical. If reverse flow (a true tail slide) is inadvertently encountered, two options exist: (1) firmly holding flight controls (including rudders) in a neutral position; or (2) positioning the flight controls against a control stop and holding them there until the airplane "flops" out of the tail slide condition.

If positioning the flight controls "against a control stop," left rudder is preferred and the stick should be pulled straight aft. Controls should be neutralized as soon as the nose transitions back down. Diver recovery should be affected when the aircraft is unloaded (0 – ½ G) and airspeed is increasing past 100 MPH / 90 KTS.

Due to the method in which RV-type primary and secondary flight controls are designed and actuated, the flight controls should not be released or allowed to float during a potential tail slide. If reverse flow is unintentionally encountered, releasing the flight controls has the potential to cause structural damage to primary and/or secondary flight controls.

Handling Error Summary

A handling error is always possible during maneuvering flight. The UNUSUAL ATTITUDE/UPSET RECOVERY techniques described in the HANDLING CHARACTERISTICS section may be utilized to "bail-out" from any aborted advanced handling maneuver, keeping in mind the basic technique of "idleize and neutralize" while properly unloading to a 0 to ½ G condition until airspeed increases past 100 MPH / 90 KTS and adjusting lift vector (low speed recovery) or properly adjusting lift vector with an unloaded roll and smooth application of G (high speed recovery) will allow the upgrading pilot to re-establish straight and level flight. Confidence maneuvers in this manual have been designed to provide the basic handling skills needed to successfully maneuver the aircraft during recovery. The ABORTED LOOP exercise described in this section is designed to combine handling skills developed flying confidence maneuvers and unusual attitude recoveries to find the "easiest way back to level." If maneuvering isn't aborted in a timely manner, a loss of control or high-speed excursion may occur. The loss of control will manifest itself as an unintentional spin or tail slide. If an unintentional spin is encountered, the OUT-OF-CONTROL procedure in the EMERGENCY PROCEDURES section should be applied. If sufficient altitude is available, recovery from any of these conditions is practical. As a general rule of thumb (assuming sufficient altitude is available), the RV-type pilot should always prioritize airspeed/AOA control over other flight parameters when maneuvering.

Appendix A: Personal Proficiency Training

Proficiency Training Concept. Airmen should consider developing an individual personal proficiency training program that allows them to accomplish individual flight tasks on a regular basis for the purpose of maintaining proficiency. The Federal Aviation Regulations specify minimum requirements for currency, but only address specific tasks (other than landing) for instrument currency. Table A-1 “Example Annual Continuation Training Program” provides a basic outline of a possible personal “annual training” program that can be adopted any way a pilot sees fit to assist with maintaining personal proficiency in individual flight tasks. Unless dictated by FAR, recommended frequencies (Desired Currency), annual targets and method of regaining currency may be modified at the pilot’s discretion. Newly transitioned RV pilots may wish to consult with a mentor when developing a suitable individual program. Less experienced pilots may consider shorter frequencies and higher annual targets until experience is gained.

Mentor Concept. A mentor can be an instructor, experienced pilot or proficient “buddy wingman” that is capable of providing mutual support appropriate for assisting with regaining currency for the task. Mutual support may consist of dual instruction, co-occupancy of the airplane, radio assistance, chase operations or simply a thorough brief and assistance with flight preparation. Post-flight debrief discussion is very helpful and encouraged. RV pilots should consider finding a suitable mentor or mentors to assist with transition and safe operation of RV types. If a pilot goes “non-current” in a specific flight task, they may consider use of a mentor to assist with regaining currency through practice. In some cases, a current, qualified CFI(I) may be required or appropriate.

Table A-1: Example Annual Proficiency Training Program

Event	Desired Currency	Annual Target	Reestablishing Currency
Day Landing	30 Days	24	>30 days but ≤90days: Complete a full-stop landing. >90 Days: IAW FARs (consider use of qualified mutual support).
Night Landing[1]	60 Days	6	>30 days but ≤90days: Complete a day full-stop landing within 30 days. >90 Days: IAW FARs (consider use of qualified mutual support).
Go-around/Balked Landing	60 Days	6	Complete a go-around/balked landing.
Towered Field Operation	180 days	4	>180 days but ≤360 days: complete controlled field operations, including arrival and departure. >360 days: complete controlled field operations including arrival and departure with mutual support.
Non-towered Filed	180 days	4	>180 days but ≤360 days: complete uncontrolled

Operations			field operations, including arrival and departure. >360 days: complete uncontrolled field operations including arrival and departure with mutual support.
Short Field Approach/Landing	90 days	4	>90 days but ≤180days: Complete a short-field approach and full-stop landing. >180 Days: complete a short field approach and full-stop landing with mutual support.
Soft Field Approach/Landing	90 days	4	>90 days but ≤180days: Complete a soft-field approach and full-stop landing. >180 Days: complete a soft field approach and full-stop landing with mutual support.
Power-on Stall	90 days	4	>90 days but ≤180days: Complete a power-on stall. >180 Days: complete a power-on stall with mutual support.
Power-off Stall	90 days	4	>90 days but ≤180days: Complete a power-off stall. >180 Days: complete a power-off stall with mutual support.
Slow Flight (V_S +5)	90 days	4	>90 days but ≤180days: Complete slow flight. >180 Days: complete slow flight with mutual support.
Unusual Attitudes	90 days	4	>90 days but ≤180days: Complete unusual attitudes. >180 Days: complete unusual attitudes with mutual support.
Confidence Maneuver	90 days	4	>90 days but ≤180days: Complete a confidence maneuver. >180 Days: complete a confidence maneuver with mutual support.
Aerobatics	90 days	4	>90 days but ≤180days: Complete an aerobatic maneuver. >180 Days: complete an aerobatic maneuver with mutual support.
SEPT	180 days	2	Discuss situational emergency procedures with a fellow pilot or mentor.
Max Gross Takeoff	180 days	2	>180 days but ≤360 days: complete a MGTOW departure. >360 days: complete a MGTOW departure with mutual support.
Heavy Weight Landing	180 days	2	>180 days but ≤360 days: complete a heavy weight full-stop landing. >360 days: complete a heavy weight full-stop landing with mutual support.
Class B/C Airspace Operation	180 days	2	>180 days but ≤360 days: complete Class B or C airspace operations including arrival or departure. >360 days: review Class B/C operations.
Visual Straight-in	90 days	4	>90 days but ≤180days: Complete a visual straight-in approach. >180 Days: complete a visual straight-in with mutual support.
Navigation Sortie > 100 NM	90 days	4	>90 days but ≤180days: Complete a Navigation sortie to a destination >100 NM from point of departure. >180 Days: complete a navigation sortie to a destination >100 NM from point of departure

			with mutual support.
Non-precision Instrument Approach[2]	45 days	6	>45 days but ≤360 days: complete a non-precision instrument approach. >360 days: complete an instrument competency check with a CFII.
Precision Instrument Approach[2]	45 days	6	>45 days but ≤360 days: complete a precision instrument approach. >360 days: complete an instrument competency check with a CFII.
Missed Approach[2]	180 days	2	>180 days but ≤360 days: Complete a missed approach. > 360 days complete a missed approach under the supervision of a CFII.
Course Intercept/Tracking[2]	180 days	2	>180 days but ≤360 days: complete course intercept/tracking. >360 days: complete an instrument competency check with a CFII.
Holding[2]	180 days	2	>180 days but ≤360 days: complete holding. >360 days: complete an instrument competency check with a CFII.
SFO/Emergency Landing	30 Days	12	>30 days but ≤180days: Complete a SFO pattern. >180 Days: complete a SFO pattern with mutual support.

Definitions

Event: Maneuver or flight element. Not all elements are applicable to all pilots.
Desired Currency: Baseline provided may be modified at individual pilot discretion unless established by FAR.
Annual Target: The number of times an event or maneuver should be flown in a 12-month (annual) period.
Qualified: Valid pilot certificate, valid medical certificate, biennial flight review or flight check within the preceding 24 months; instrument rating required for IFR operations.
Current: Minimum frequency required to perform an event or sortie safely.
Proficient: Demonstrated ability to accomplish event safely and effectively, requires currency.
Safe: Demonstrated ability to accomplish even safely, sufficient to reestablish currency.
Experienced: 100 hours in type
Inexperienced: Less than 100 hours in type
Mutual Support: The appropriate level of assistance to practice and regain currency in a maneuver based on circumstances and judgment. This assistance could be provided by an instructor, mentor, flight lead or proficient fellow pilot.
Instrument Competency Check: IAW 14 CFR Part 61. CFII required.
"SFO": "simulated flame out," i.e., simulated engine-out emergency pattern.

Notes

[1]Required for night operations. Day landing currency does not update night landing currency for the purpose of FAR compliance, but a day landing within 30 days is desired prior to establishing night currency.
[2]Required for IFR operation.

Appendix B: RV-4/6/7/8 Advanced Handling Briefing

Warning

- Information in this briefing guide is not intended as a substitute for suitable and appropriate flight training. It has been designed for instructors and/or pilots current and qualified in the appropriate RV-type that are familiar with and qualified to perform aerobatic flight.
- Van's Aircraft aerobatic design limits are included in this briefing guide and must be adhered to for the conduct of aerobatic operations. Not all RV-types are capable of being operated in a "dual instruction" configuration for the purpose of aerobatic instruction due to weight and balance limitations. Weight and balance data and Operating Limitations for the aircraft operated must be utilized to determine suitability.

The briefing guide in this section has been prepared to assist instructors preparing to practice or teach RV-type advanced handling techniques or for qualified pilots familiar with RV-type advanced handling techniques that are interested in a review prior to conducting personal proficiency training. Specific transition briefing guides are included in Part 2 of this publication for use with syllabus training flights.

This briefing is presented in a chronological, detailed "talking paper" format and is designed to be presented in 45 minutes by a qualified instructor. It is aligned with information presented in Parts 1-3 of this publication. A cross-section of confidence, advanced handling maneuvers and exercises is presented in this briefing. Not all maneuvers or exercises may be appropriate for all flights or conditions and the briefing should be modified accordingly. Not all maneuvers or exercises included in Parts 1-3 of this publication are included in this briefing guide. All maneuvers are designed for positive G.

<u>Instructor Briefing Considerations</u>

An effective briefing should be custom-tailored as circumstances require. One of the most important considerations is to keep the upgrading pilot engaged during the briefing. Effective use of questioning is a good way to do this--a briefing should never be "one way." There is a limit to any pilot's ability to sit through a briefing and absorb information—if that limit is exceeded, the briefing becomes counter-productive. As a general rule, briefing time should not exceed 45 minutes. If the upgrading pilot is actively engaged in the briefing and participating by asking or answering questions, the total briefing time may increase to approximately 60 minutes. Flying aerobatic RV-types throughout the envelope is serious business and fun at the same time—be sure to impart that when briefing, teaching or mentoring.

One of the most important considerations is to be clear and correct (the law of primacy of learning applies) when briefing. New skills and knowledge must be presented correctly the first time. A mix of graphic, video aids or model demonstrations can greatly enhance a verbal description of the task--pictures truly are worth a thousand words. One briefed technique for task accomplishment is generally sufficient—attempt to give the upgrading pilot something to "hang their hat on." An alternative technique can be offered if it becomes clear that the upgrading pilot does not understand what is being briefed or, more likely, may be offered real-time in the cockpit if the upgrading pilot is not having success accomplishing a task with the technique initially presented during the briefing.

Although not specifically contained in the briefing guide, a brief re-cap followed by an opportunity for the upgrading pilot to ask any additional questions should be provided at the end of every briefing.

This guide has been prepared in a chronological flow—it covers the flight from start to finish, in order. If the upgrading pilot is already proficient in basic RV-type operations, it may be more effective to re-arrange the briefing order. Start with "admin" (i.e., getting to the area and RTB), special subjects, and academic review (not to exceed 5-10 minutes), then cover the "meat" of the flight: area work. This alternative briefing flow utilizes the basic learning law of recency to maximize retention opportunity for the upgrading pilot regarding area work described.

Academic briefings presented in Part 2 or techniques and handling characteristic information presented in Part 3 of this document can provide additional source material, if desired.

<u>RV-4/6/7/8 Advanced Handling Briefing Guide</u>

Objectives

- Practice normal operations
- Practice RV-type advanced handling
- Practice 3000’ AGL Simulated “Flame-out” (SFO) Pattern

Airworthiness Determination

- **Fuel on board**
    - Visually confirmed

Weather/NOTAMs/TFRs

Special Subjects

- **RV-4 Design Limits Review**
    - Aerobatic max allowable gross: 1375 lbs
        - Aerobatic gross is set by structural limit (non-negotiable)
    - Aerobatic CG Limits: 68.7” to 75.9” (15% - 27.5% MAC)
        - CG moves AFT during flight due to fuel burn: more with aft load than solo
        - Weight and Balance Calculation for this flight: Gross weight _____ and CG location ____ inches aft of datum; ____% MAC
    - Airspeed
        - V_{NO}: 180 MPH / 156 KTS
        - V_{NE}: 210 MPH / 182 KTS
        - V_{FE}: 100 MPH / 87 KTS
        - V_A (“Corner”); flaps UP: V_{S1} x 2.5 (6 G symmetric limit)
            - “Published” speed (Van’s published performance data): 127 MPH / 111 KTS CAS at 1375 lbs
            - ***Actual IAS <u>must</u> be established by flight test***
            - V_A DECREASES at weights above max aerobatic gross due to reduced G limits at higher gross weight
            - “Roll, set lift vector, pull”
        - “Rolling G” reduces G limit by 33%: “Roll <u>and</u> pull”
            - “Asymmetric” $V_A = V_{S1}$ x 2 (4 G asymmetric limit)
        - No intentional snap maneuvering > 100 MPH / 85 KTS CAS
            - Cross-controlled stall only
            - Intentional snap/flick roll not recommended by Van’s Aircraft

- **RV-6/6A Design Limits Review**
  - Aerobatic max allowable gross: 1375 lbs
    - Aerobatic gross is set by structural limit (non-negotiable)
  - Aerobatic CG Limits: 68.7" to 75.3" (15% - 26.5% MAC)
    - CG moves AFT during flight due to fuel burn
    - Weight and Balance Calculation for this flight: Gross weight _____ and CG location ____ inches aft of datum; ____% MAC
  - Airspeed
    - V_{NO}: 180 MPH / 156 KTS
    - V_{NE}: 210 MPH / 182 KTS
    - V_{FE}: 100 MPH / 87 KTS
    - V_A ("Corner"); flaps UP: V_{S1} x 2.5 (6 G symmetric limit)
      - "Published" speed (Van's published performance data): 130 MPH / 113 KTS CAS at 1375 lbs
      - ***Actual IAS must be established by flight test***
      - V_A DECREASES at weights above max aerobatic gross due to reduced G limits at higher gross weight
      - "Roll, set lift vector, pull"
    - "Rolling G" reduces G limit by 33%: "Roll and pull"
      - "Asymmetric" V_A = V_{S1} x 2 (4 G asymmetric limit)
    - No intentional snap maneuvering > 100 MPH / 85 KTS CAS
      - Cross-controlled stall only
      - Intentional snap/flick roll not recommended by Van's Aircraft
- **RV-7/7A Design Limits Review**
  - Aerobatic max allowable gross: 1600 lbs
    - Aerobatic gross is set by structural limit (non-negotiable)
  - Aerobatic CG Limits: 78.7" to 84.5" (15% - 25% MAC)
    - CG moves AFT during flight due to fuel burn
    - Weight and Balance Calculation for this flight: Gross weight _____ and CG location ____ inches aft of datum; ____% MAC
  - Airspeed
    - V_{NO}: 193 MPH / 167 KTS
    - V_{NE}: 230 MPH / 199 KTS
    - V_{FE}: 100 MPH / 87 KTS
    - V_A ("Corner"); flaps UP: V_{S1} x 2.5 (6 G symmetric limit)
      - "Published" speed (Van's published performance data): 135 MPH / 117 KTS CAS at 1600 lbs
      - ***Actual IAS must be established by flight test***

            - V_A DECREASES at weights above max aerobatic gross due to reduced G limits at higher gross weight
            - "Roll, set lift vector, pull"
        - "Rolling G" reduces G limit by 33%: "Roll <u>and</u> pull"
            - "Asymmetric" $V_A = V_{S1}$ x 2 (4 G asymmetric limit)
        - No intentional snap maneuvering > 100 MPH / 85 KTS CAS
            - Cross-controlled stall only
            - Intentional snap/flick roll not recommended by Van's Aircraft

- **RV-8/8A Design Limits Review (Dash One Wing)**
    - Aerobatic max allowable gross: 1600 lbs
        - Aerobatic gross is set by structural limit (non-negotiable)
        - Non Dash One Wing (kits shipped prior to Jan 2001): 1550 lbs aerobatic gross weight limit
    - Aerobatic CG Limits: 78.7" to 85.3" (15% - 26.5% MAC)
        - CG moves AFT during flight due to fuel burn
        - Weight and Balance Calculation for this flight: Gross weight _____ and CG location ____ inches aft of datum; ____% MAC
    - Airspeed
        - V_{NO}: 193 MPH / 167 KTS
        - V_{NE}: 230 MPH / 199 KTS
        - V_{FE}: 100 MPH / 87 KTS
        - V_A ("Corner"); flaps UP: V_{S1} x 2.5 (6 G symmetric limit)
            - "Published" speed (Van's published performance data): 135 MPH / 117 KTS CAS at 1600 lbs
            - ***Actual IAS <u>must</u> be established by flight test***
            - V_A DECREASES at weights above max aerobatic gross due to reduced G limits at higher gross weight
            - "Roll, set lift vector, pull"
        - "Rolling G" reduces G limit by 33%: "Roll <u>and</u> pull"
            - "Asymmetric" $V_A = V_{S1}$ x 2 (4 G asymmetric limit)
        - No intentional snap maneuvering > 100 MPH / 85 KTS CAS
            - Cross-controlled stall only
            - Intentional snap/flick roll not recommended by Van's Aircraft
- "G-allowable" = G limits (4 or 6)
- "G-available" = aerodynamic G the airplane is capable of generating based on dynamic pressure (airspeed)
    - **ABOVE MANEUVERING SPEED ("CORNER VELOCITY"); G-AVAILABLE <u>EXCEEDS</u> G-ALLOWABLE**

- @90 MPH 2.7 G's available
- @110 MPH 4.0 G's available
- @130 MPH 5.6 G's available
- @V_A 6.0 G's available (approximately 135 MPH / 117 KTS)
- @V_{NO} (top of the green arc) 10.7 G's available
- @V_{NE} (red line, TAS) 14.6 G's available
  - Absolute design G limit 9.0 symmetrical (flaps retracted); catastrophic failure can occur at G loads in excess of 9.0 if sustained more than 3 seconds
    - Assumes no construction errors or fatigue damage
    - Fatigue damage in metal airplanes is cumulative over time; structure has a "memory"; history of over-G fatigue damage can cause catastrophic failure at g loads less than design limits

- Decreased pitch stability
  - High power / high pitch angle
- Terminology
  - "Energy" (E_M) ≈ altitude + airspeed + specific power (P_S)
  - "Velocity Vector" = where the airplane is going, but not necessarily pointing (flight patch indicator)
  - "Lift Vector" = direction in which lift is acting, roughly perpendicular to the wings or the direction the pilot's head is pointing when sitting upright
  - "Boresight" = where the airplane's nose is pointing
  - "ON SPEED" = $L/D_{MAX} \approx V_{REF}$ (1.3 to 1.4 V_S)
- "Unload for Control" Concept
  - Unless planned, unload for control (release or decrease back stick pressure as required) at first sign of loss of control ("departure"): buffet, wing rock/drop, nose slice or nose rise (stick lightening)
    - Bail out of maneuver before things get worse…
      - Terminate maneuvering and recover to level flight by flying to the nearest horizon
    - Airplane can't stall at zero G; V_S significantly reduced at "low G" (0 to ½ positive G)
  - "Idlize and neutralize"
    - Power to Idle
    - Neutralize rudder input
    - Center stick laterally
    - Smooth unload to 0 to ½ G condition
      - Seat of the pants cues: heels light, items might start to float

            - Carb'd engine? Reduction in RPM / engine noise = effective forward limit (unless control is in doubt, then establish zero G condition and allow engine to stop, if required)
        - Anticipate ballistic condition / recovery: speed increasing past 100 MPH / 90 KTS
            - Nose high ROT: degrees nose up at unload = degrees nose down during recovery
        - Confidence maneuvers are designed to practice low G (0 – ½), low airspeed handling
- <u>Out-of-Control ("Departure" from controlled flight)</u>
    - **Check altimeter: Recover / Bail-out?**
        - Decent rate in a developed spin is 7000-9000 FPM
        - Recovery from a developed upright spin (including dive recovery) requires 1 ½ turns and 1500 feet of altitude
            - Above maneuvering floor; time available
            - Below minimum out-of-control bail-out altitude; might as well work on it!
    - Power IDLE
    - Controls NEUTRAL
        - Be PATIENT: immediate aircraft response to neutral controls may not be apparent
    - Rudder OPPOSITE YAW (IF REQUIRED)
        - Sight down nose; needle (if equipped)
    - Elevators PAST NEUTRAL (IF REQUIRED)
        - Forward stick if upright, back stick if inverted
    - Unusual Attitude RECOVER
        - Aircraft is no longer out of control if unloaded (0 to ½ G condition) and airspeed is increasing past 100 MPH / 90 KTS
        - Dive recovery: smooth application of G and power to control airspeed
            - IDLE if speed > V_A
                - Fixed pitch prop? Low drag = be ready!
            - ANTICIPATE ACCELERATION; apply back stick as required during initial phase to prevent over-speed: DON'T HESITATE TO APPLY SUFFICIENT G (short of limit loads) TO ARREST/CONTROL RATE OF ACCELERATION
                - Be alert for buffet; nose stops tracking; nose slice; wing drop—these are positive stall indications
            - If unintentional over-speed (red line) occurs, do not panic; continue smooth pull with throttle IDLE

        - Avoid secondary stall
- Bailout
  - Parachute requirement: More than one on-board; Pitch > 30^{o} and/or Roll > 60^{o}
    - "Aerobatic" definition: "any intentional maneuver involving an abrupt change in and aircraft's attitude, an abnormal attitude, or abnormal acceleration, not necessary for normal flight"
    - RV-4 canopy is jettisoned by opening it in flight; once the pins are released, air load will pull the canopy off of the airframe
      - The hinge on the right side will tear away from the fuselage
    - Clamshell canopies on side-by-side types may be fitted with jettison handle
    - Sliding canopies may or may not be equipped for jettison
      - As a curved surface, all canopies generate lift; depending on track configuration, in-flight opening and/or jettison may be difficult
      - Air loads will be reduced at lower airspeed
  - Minimum Bailout Altitude
    - Practice area MSL surface elevation: ____________
    - Add 2500 feet (round answer up): ____________
      - 2500 feet AGL is TR limit assuming a "standard" 5-10 second egress sequence; determine individual egress time and increase altitude, as required
      - See Determining Minimum Out-of-Control Bailout Altitude
- Air Start
  - Handling error (sustained low G) can cause fuel starvation if aircraft not equipped with inverted systems
    - One reason SMOOTH, deliberate pitch control is required; never "slam" the stick—airplane takes time to respond to inputs
    - Be alert to noise cues: engine as G meter
  - Engine may stop: don't adjust engine controls
  - Lightweight, fixed-pitch prop? Prop will likely stop if low G (zero or less) and low airspeed condition is achieved (generally V_S or less)
  - Maintain aircraft control; apply standard unload for control concepts; if prop is windmilling, engine will re-start; if prop is stopped, wait until airspeed is increasing and hit the starter switch
      - A windmill restart can be conducted, but requires considerable airspeed (altitude) to start turning a stopped propeller
- Engine and Power Effects
  - Pay attention to the ball—do what it takes to keep the ball centered

        - "Step on the ball" Unless intentionally slipping or skidding, always fly in a coordinated manner
    - High airspeed: generally left rudder
    - Low airspeed: IT DEPENDS
        - High power—right rudder
        - Low power—in the direction of roll
    - Use to your advantage: Roll left when you're learning!

Training Rules

- Discernable horizon; standard cloud clearance limits; 3SM visibility minimum
    - 1000 above / 500 below / 2000 horizontal
    - Make allowance for maneuvering room required
- Loaded within Van's specified design limits
- Phase I tested maneuvers: annotated in log book or operating limitations
- Area Selection (FAR requirements):
    - Not over congested area/open air assembly of persons
    - Not within lateral boundaries of Class B, C, D or E Airspace designated for an airport
    - Not within 4 NM of the centerline of federal airway
    - 1500' AGL minimum altitude
- Stability Check complete / acceptable
- Maximum fuel imbalance: 6 gallons (36 lbs; approximately 42 minutes of fuel burn)
- Pre-maneuver flow complete prior to each maneuver or sequence of maneuvers
    - Loose items stowed / harness secure / fuel balanced / boost pump on
    - Area clear
- Planned spins: 1 ½ turn or less
- Floor: 3000' AGL
    - _______________MSL
        - Round answer up to something easy to read on the altimeter
- Minimum "admin" airspeed: 80 MPH / 70 CAS (everything except accept stalls / post-stall maneuvering / slow flight / confidence maneuvers and advanced handling / takeoff and landing)
- Smooth control application
- Maximum symmetric G: 6
- Maximum asymmetric (rolling) G: 4
- Target maneuvering G: 4
    - Sufficient airspeed available

- Minimum G: 0
    - Negative G excursion: knock-it-off if oil loss is suspected, land as soon as practical and check servicing
- Monitor appropriate ATC frequency

Normal Ground Ops

- Start IAW Checklist
- Lean aggressively after start and during ground ops
    - Warm-up ROT 200^{o} CHT (if equipped) prior to taxi
    - Brake check
- Taxi speed control: throttle primary / proper brake use / maximum speeds
    - 15 KTS GS pavement (5-10 turning) / "jogging speed" 5-7 kts unpaved
    - Flight controls: stick aft to 15 knot tailwind / "dive away" or "turn into"
    - S-turns generally not necessary at design eye height
    - Task management: stop as required / avoid "head's down" in motion
- Be aware of prop blast at all times
- Run-up: mixture use / EGT rise on one ignition system / be expeditious
    - Fouled plugs not likely with proper leaning (on ground and airborne)
    - Prop blast considerations over-ride pointing into the wind
    - Canopy secure and checked PRIOR to run-up
    - Bad check = rough engine or falling/erratic EGT (if equipped) on any cylinder
        - If equipped, watch monitor and tach
    - Engine sufficiently warm for takeoff? Lycoming answer: when power can be advanced without hesitation; alternatively oil 85^{o}F or warmer and/or warmest CHT 300^{o} (if equipped) or warmer.

Normal Take-off

- Before takeoff flow / checklist complete
    - Mixture (if lean) SET
        - Full rich below 3000' density altitude
    - Note hobbs / tach and hack stopwatch
    - Flaps 20 / trim set
        - Neutral for solo / more nose down if CG aft (passenger / baggage)
    - Final clear
    - Note wind: anticipate cross-wind steering requirement
- Smooth application of power: don't jam throttle
    - Technique

        - "2 Count"
        - Pause at approximately 50%: check gauges (oil pressure / airspeed off the peg at approximately 25)
        - "2 Count" to WOT
    - Full power: check MP (inches approximately = altimeter setting) + RPM
        - Fixed pitch: typically 2100-2200 RPM
        - Constant speed: typically red line RPM
- Anticipate need for right rudder: rotate and establish crab as necessary to track centerline
- Flaps up NLT V_{FE}: Don't allow aircraft to "settle" during flap retraction

Cruise Climb

- Wide speed band for climb performance: set 120-140 MPH / 105-125 KTS CAS
    - Monitor CHT: ≤ 400°F (desired) max; adjust speed as required for cooling
- WOT climb
    - Constant speed: RPM as required for noise-abatement (if desired)
- Note EGT (if equipped) when climb condition established
- Passing 3000' density altitude, slowly lean to EGT noted at start of climb (best power condition)

Level Off

- Trim
- Accelerate to desired / anticipated cruise speed (TAS or CAS)
- Set cruise power
    - "Rule of 48" (normally aspirated below approximately 10,000 feet)
        - MP (inches) + RPM/100 ≈ power setting
        - If total 48, then ≈ 75%
        - If total 45, then ≈ 65%
        - If total 42, then ≈ 55%
        - Interpolate as desired
    - Engine power chart, if available over-rides "Rule of 48"
- Mixture: already best power if leaning started in climb; else "big pull" to target best power EGT; fine adjustment to best economy (LOP), as desired
    - LOP
        - As desired if injected / balanced
        - 25° LOP target / rough engine if carbureted
    - Can't hurt engine by leaning at power settings less than 60-65%

- Use same technique for each intermediate level-off as required; adjust mixture as necessary but be sure to advance for increased power required for climb
- For handling sortie, level-off at maneuvering floor (3000' AGL recommended) + 2000 to 3000 feet as desired
  - Set appropriate hemispheric cruise altitude enroute to practice area: "odd men fly east"

Stability Check

- Stability check is performed to determine if aircraft will exhibit normal (non-divergent) stability during maneuvering flight; confirms weight and balance and helps calibrate pilot's butt; should initially be performed from straight and level flight until proficiency is gained; ***DO NOT CONDUCT MANEUVERING FLIGHT IF STABILITY CHECK IS NOT SATISFACTORY***
- Review/emphasize weight and balance condition for flight
  - Stick force gradient and static margin function of CG/AC relationship (% MAC)
- Fuel balanced < 6 gallons (36 lbs) differential (approximately 42 minutes on stop watch)
- <u>Pitch Check</u> (Positive stability required)
  - Trim; note stick position
  - Smooth pull to -10 to 15 MPH / KTS of trim speed
  - Ease stick forward to trim position
  - Note pitch response
  - Bad check: nose continues to pitch up or oscillate
- <u>Roll Check</u> (Neutral stability required; may exhibit positive stability)
  - Trim (if equipped)
  - Roll 45-60^{o} bank
  - Neutralize aileron input
  - Note roll response
  - Bad check: roll continues to steepen
- <u>Yaw Check</u> (Positive stability required)
  - Note ball; trim (if equipped)
  - Smoothly induce yaw input
  - Remove feet from pedals
  - Note yaw response (fish tail + Dutch roll is normal)
  - Bad check: yaw oscillations don't damp after 4-6 excursions

Basic Maneuvering Flight Considerations

- Adjust mixture and throttle as required—make sure that mixture is always advanced ahead of throttle
    - Full rich if in doubt
- Accomplish "pre-maneuver" flow; make sure you and the airplane are ready for all-attitude maneuvering
    - Loose items stowed / harness secure / fuel balanced / aux pump on / area clear
    - Accomplish this flow before each maneuver or set of maneuvers during practice
    - Foot stomper: Keep your scan going; instruments as required to assess energy and outside!
- Fuel venting is normal during maneuvering flight; especially with a full tank
    - May notice fuel odor in cockpit
    - Fuel system/vents built to plans:
        - Fuel tends to vent on belly during low G maneuvering (0 – ½ cockpit G)
        - Fuel tends to vent over wing root(s) during post-stall (spin) maneuvering
- Ensure harness (lap belt) is TIGHT and loose items are secure
    - Harness may tend to loosen during maneuvering due to clothing and seat cushion compression—re-check and tighten as necessary between maneuvers
- Maintain navigational SA (ground references / moving map display) and CLEAR throughout maneuver sequence; monitor appropriate ATC approach or departure frequency (if appropriate)
    - Be alert for ATC call if you are the "bogey"
- Look for smooth air: morning, above LCL (lifted condensation level, i.e., clouds), etc.
- Maneuvering at altitude? Tradeoff between finding smooth air and hitting airspeed limits: be aware of TAS
    - V_{NO} effective maneuvering limit; know V_A
    - Beware V_{NE} (redline): TAS, not CAS/IAS

Determining Maneuver Speed / Corner Velocity

- Definition: Speed below which you can *move a single flight control, one time, to full deflection for one axis of airplane rotation only* (pitch, roll or yaw), in smooth air, without risk of damage to the airplane.
    - Below maneuvering speed, airplane will stall before hitting structural limits
    - Flaps UP
    - Minimum turn radius, maximum turn rate occurs at this speed
    - **Generally SLOWER than most folks realize**
- Varies by gross weight / stall speed; need to know SYMMETRIC and ASYMMETRIC speeds
    - "Straight pull" vs "rolling G"

  - Asymmetric G limits not specified by Van's Aircraft; assuming 33% reduction in G-allowable
  - Formula: Stall Speed x √G-allowable = maneuvering speed
- Determine V_{S1}: power-off flaps-up stall speed; use standard 1 MPH / knot per second deceleration; note IAS at which airplane stalls
- Determine V_A
  - Stall x 2.5 = symmetric V_A
  - Stall x 2.0 = asymmetric V_A
- Write speeds down on line-up card
- Above maneuvering speed; a handling error can result in an over-G condition
- "Unload, roll, set, pull" concept

G Warm-up

- Energy losing; plan to lose 500-1000' for 180^o of turn; start at Floor +1000'
- Need to strain PRIOR to G-onset; can't "catch up"
  - Knock-it-off if: ANY reduction in visual acuity or ability to discern color
- Establish slow cruise condition: V_A ("corner velocity") + 20
  - Entry speed can be increased as proficiency is gained; higher speed requires less altitude but more prone to handling error
- 3-4 G "Break turn"
  - Remind yourself to begin anti-G strain
  - Unload
  - Roll (set 90-110^o bank)
  - Smooth pull to 3-4 G's
    - Increase power to WOT during G onset
    - Maintain for 180^o of turn then reverse for another 180^o
  - Adjust lift vector ("windshield wiper") as required to maintain corner (V_A) and desired G throughout
    - Note buffet cues, if any

Confidence Maneuvers

- Confidence maneuvers are designed to increase pilot confidence and teach low AOA handling and recovery techniques. They provide a foundation for advanced handling maneuvers and all-attitude upset recovery.
- <u>Steep Turns</u>
  - Energy Neutral → Losing, Floor +500' min entry

- Two techniques: cruise power (energy bleeding turn) or WOT (energy sustaining turn)
- *Cruise Power*
  - Ground reference points can assist with orientation, else consider use of cardinal heading to start
  - Power: set for cruise
  - Bank: 45-70^o
    - Visual cue: cowl/cowl fasteners relative to horizon; varies by sitting height; different for left vs. right turn
  - Back pressure as required
    - 1.4 G's at 45^o
    - 2.0 G's at 60^o
    - 3.0 G's at 70^o
  - Airspeed will bleed at stabilize after bank is established
  - Coordinate
  - Anticipate roll-out: NLT desired heading -10^o
  - Remove back pressure
- *WOT*
  - Same as cruise power except increase throttle to wide open when rolling into the turn
  - Speed should stabilize at or slightly below entry speed (some bleed if 70^o of bank used)

- Lazy 8 (Energy Neutral → Gaining, Floor min entry)
  - Not the Lazy 8 described in the FAA Flight Training Handbook or Practical Test Standards
    - Maneuver is designed to utilize the entire speed band from stall (or less) to V_{NO}, G loads from 0 to +2.5, and pitch and bank angles up to 90^o
    - **Optimum RV-type handling warm up maneuver; intensity can be increased as proficiency is gained**
    - Excess power is available: Power settings at/above 65% will cause altitude gain each leaf
  - Select a ground reference: straight line of some type optimum; cross-perpendicular to start maneuvering
    - Cardinal heading can help
  - Set cruise power condition: 60-65%
  - Smooth pull into vertical as you begin to roll
    - Coordinate!

        - Left roll/pull/turn easier than right due to engine power effects; anticipate
    - Pitch/Bank ≈ 45^{o} at 45^{o} turn point
        - $+45^{o}$ pitch ≈ heels on the horizon
    - Float pitch as required to get airspeed as low as desired
        - Unload
        - May notice fuel odor in cockpit if tanks are venting
    - Rudder as required to keep nose tracking
        - Check ball
    - Pitch as desired for airspeed / Bank 90^{o} as nose slices through horizon
        - Check airspeed
        - With <1G, speed can be lower than stall
            - Left turn easier than right turn: necessary to carry more airspeed over the top for a right turn
    - As nose drops through horizon; begin pull and roll
        - Look outside: figure out where you want to point when you "bottom out" and adjust roll rate to get there
    - At 45^{o} point, pitch should be -30 to -45^{o} and bank angle should be decreasing through 45^{o}
    - Exact pitch isn't important: what IS important is controlling airspeed and altitude during bottom leaf—airspeed (less than V_{NO}) always takes priority over altitude
        - Accept any climb at the bottom to keep airspeed under control
        - Altitude? Be aware of TAS
    - Complete as many "leaves" as desired
- <u>AOA (Ballistic) Recovery</u>
    - Energy Neutral → Loosing, Floor +1000' min entry
    - Cruise condition
    - Aileron and rudder neutral
    - Smooth pull: $45\text{-}60^{o}$ nose up (heels on the horizon +)
    - Airspeed approaching 100: smooth unload 0 to ½ G, power IDLE
        - "Heels light"
        - Carb? Keep engine running by maintaining sufficient positive G
    - Maintain low G (0 to ½) condition until airspeed increasing above 100 MPH / 90 KTS
        - Degrees up = degrees down
    - Recover
    - As proficiency gained, perform maneuver from $30\text{-}60^{o}$ bank

- <u>Inverted Recovery</u>
  - Energy Neutral → Loosing, Floor +1000' min entry
  - Similar to AOA Recovery, but flown inverted
  - Speed V_{NO} or slightly less
  - Smooth pull: WOT, 45-60^o nose up (heels on the horizon +)
  - Airspeed approaching 100: smooth unload to 0 to ½ G, power IDLE
    - "Heels Light"
    - Carb? Keep engine running
  - Roll to inverted (Established NLT 80 MPH / 70 KTS)
  - Maintain 0 – ½ G condition
    - Stick as required to maintain G; push may be required but don't go negative
  - Unloaded roll to upright as speed passes 100 MPH / 90 KTS
  - Recover
    - Degrees up = degrees down
- <u>Low AOA Aileron Roll</u>
  - Energy Neutral → Loosing, Floor +1000' min entry
  - Similar to Inverted Recovery, but steady unloaded roll
  - Speed V_{NO} or slightly less
  - Smooth pull: WOT, 45-60^o nose up (heels on the horizon +)
  - Airspeed approaching 100: smooth unload to 0 to ½ G, power IDLE, ROLL
    - Stick as required during roll to maintain 0 – ½ G
    - "Heels Light"
    - Carb? Keep engine running
  - Recover as airspeed passes 100 MPH / 90 KTS
    - Degrees up = degrees down
  - Initially, roll left; right roll as proficiency is gained

Stalls

- NACA 23013.5 Airfoil: Critical AOA 14-15^o
  - Standard design (no stall strips or VG's fitted): normal stall characteristics; limited buffet warning (only 1-2 MPH prior to stall at 1 G); stall progresses from root outboard—ailerons remain effective; but RUDDER is primary yaw control
  - Stall cues
    - Buffet (proportional to G load: higher G—slightly more buffet)
    - Nose rise (stick getting light)
    - Nose slice (uncommanded yaw you pick up by sighting down the nose)
    - Wing drop (can be significant and abrupt)

        - **Aerodynamic cues can be missed with aggressive G / AOA onset rate**
    - Engine power effects increase as airspeed decreases
        - Keep ball in cross-check / scan
        - If (right) aileron is used pre-stall to control engine power effects; (left) wing drop is likely post-stall (can be significant)
    - Recovery is prompt when AOA is reduced
        - "Unload for control;" primary stall recovery procedure is to REDUCE AOA; if sufficient altitude is available, adding power is not necessary to recover
- Type of gear fairings affect post-stall handling characteristics
    - Fairings provide vertical aerodynamic surface AHEAD of the aerodynamic center
    - Larger chord fairings (e.g., Harmon Rocket) are more destabilizing than Van's supplied fairings
    - Type/configuration of fairings can affect aerodynamic buffeting of the horizontal stabilizer
- <u>Power-off</u>
    - Energy Losing, Floor +500' min entry
    - Flaps Up
    - Flaps Down
        - Note flaps down speed, multiply by 1.4 to determine V_{REF} for landing if not equipped with AOA indicator
    - Use 1 MPH / Knot per second decel rate
    - If trimming stop NLT computed V_{REF} / ON SPEED (approach speed) for current configuration
    - Keep an eye on the ball; center it up with your feet
        - Some roll prior to stall is normal (engine power effects)
        - Eye's out only? If you counter left rolling tendency with right aileron; left wing will drop post stall
        - Ball centered? Airplane will stall straight ahead
    - Recovery: relax back pressure (reduce AOA)
        - Airplane will recover promptly
    - Add power, if desired
    - Can vary flap settings and bank angle at stall
        - Full flaps and 20-45^{o} bank simulated base turn for "approach stall"
- <u>Power-on</u>
    - Energy Neutral → Losing, Floor +500'min entry
    - Power: 50% to WOT

        - Nose up attitude will vary with power setting and entry technique; low power loading (HP/lb) results in significant nose-up at high power settings
            - Anticipate need for significant right rudder at low airspeed / high power settings
            - Build-up approach: increase power setting / pitch angle as proficiency is gained
            - If zoom into stall isn't desired; allow airplane to slow and increase pitch and power simultaneously
    - If trimming stop NLT computed V_{REF} / ON SPEED (approach speed) for current configuration
        - Pitch stability begins to break down at high pitch / high power settings
        - Stick gets lighter—less need for trim (anticipate)
    - Keep an eye on the ball; center it up with your feet
        - Do what it takes; but anticipate need for right rudder
            - Significant at high power settings
    - Recovery: relax back pressure (reduce AOA)
        - Airplane will recover promptly
- <u>Accelerated Stall</u>
    - **Airplane can stall at any airspeed and any attitude if 14^{o} α is exceeded**
        - α_{crit} is constant: not affected by gross weight
    - Energy Losing, Floor +500' min entry
    - Power: Cruise to WOT
    - Flaps up only
    - 2 G stall will occur ≈ 130% V_S
        - About 80 MPH / 70 KTS ; normal pattern speed
    - Establish 120-130 MPH / 105-115 KTS
    - Roll to 60^{o} + bank
    - Smoothly and aggressively apply G
        - 2 G per second onset to 3-4 G's (≈ 2-3 second pull)
        - 3.5G stall at approximately 105 MPH / 91 KTS
            - Nose stops tracking
    - Stall cues
        - Buffet
        - Nose rise (stick getting light)
        - Nose stops tracking across horizon
        - Wing drop (can be significant and abrupt)

        - Aerodynamic cues can be missed with aggressive G onset rate; wing drop likely first cue
    - Slow pull? Aircraft will bleed energy (airspeed); may develop high sink rate in lieu of stall
    - Recover
        - Reduce AOA
        - Adjust lift vector, as required
        - Reduce power if having difficulty maintaining yaw control
- <u>Deep Stall</u> ("Falling Leaf" Stall)
    - Energy Losing, Floor +2000' min entry
    - Power: IDLE (mitigate engine power effects)
    - Flaps up only
    - If trimming stop NLT computed V_{REF} / ON SPEED (approach speed) for current configuration
    - Stick-centered stall (ailerons neutral)—do what it takes with the rudder to keep the wing's level; don't try to maintain heading
    - Two-hand technique: assists with maintaining stick centered laterally
        - Tendency with one hand is back and right
        - "Zipper / Button" pull: aim at your buttons to keep it straight
    - Control rigging considerations
        - Van's specified elevator limits
            - Design limits +30° up / -25° down
            - Minimum limit +25° up / -20° down
            - Variation can effect individual aircraft handling characteristics
    - Rudder remains effective post-stall
        - Precise heading control not practical
        - Be alert for nose slice
        - Significant wing rock (drop) likely
        - Make corrections similar to directional control on the ground—get the required rudder IN then OUT (neutralize); sustained rudder input post-stall will force auto-rotation (spin)
            - Constant/needless rudder inputs can aggravate the post-stall situation ad make it difficult to determine actual aircraft performance—neutralize or pause to assess input effect
    - Nose will "bob" with CG in forward 2/3 of aerobatic envelope with full aft stick
        - Spin resistant in this part of the envelope
    - Post-stall directional stability begins to break down at the back of the envelope
        - Assume no margin at aft limits: be alert for uncommanded yaw

    - Significant buffet normal in sustained deep stall
    - Check VVI: high descent rate
    - Recover
        - Reduce AOA
        - Add power, if desired
- <u>Cross-controlled Stall</u>
    - Energy Losing, Floor +1500' min entry
    - Flaps up only
    - These maneuvers will result in a low energy (below asymmetric V_A) snap roll "departure"
    - Maneuvers designed to demonstrate what happens if coordinated flight isn't maintained and critical AOA is unintentionally exceed during the base turn
    - Slip
        - Can be simple stall or rolling departure, over-the-top (must be forced)
        - Plenty of aerodynamic warning of departure/auto-rotation: High AOA rudder roll prior to stall
        - Simulating slipping base turn to final
        - Power IDLE
        - At 80 MPH CAS (70 KTS), start base turn
        - Initiate a slip to the "inside" of the turn
            - Left turn, left slip: ("inside") left aileron + right ("outside") rudder
            - Right turn, right slip: right aileron + left rudder
        - Increase AOA to stall
            - Generally, airplane will simply stall in the slipping turn without rolling over-the-top (in the direction in which rudder is applied)
            - If forced, airplane may rudder roll (in the direction in which rudder is applied) due to roll-coupling effects as AOA increases past approximately 10^o
                - Rudder roll may be steady or a series of ratcheting partial rolls, depending on rate at which back stick was applied
                - This roll is aerodynamic warning of impending departure
                - As AOA passes $14\text{-}15^o$, rudder roll will transition to snap roll in direction in which rudder is applied
        - Recovery
            - **At first sign of stall or rudder roll**
                - Sustained post-stall maneuvering with slip input applied causes significant horizontal tail buffet
                    - Possible structural fatigue

            - Not recommended
        - **Depends on whether aircraft just stalled or departed (snap rolled):**
            - Just stalled (no/little rudder roll encountered prior to stall)
                - Reduce AOA
                - Slip input can be maintained throughout stall/recovery
            - Rudder roll occurred prior to stall:
                - Neutralize lateral stick and rudder
                - Reduce AOA
            - If snap/flick roll occurs post-stall (departure):
                - Neutralize lateral stick and rudder
                - Reduce AOA
                - Fastest recovery is to "snap" back to upright; otherwise unusual attitude recovery may be necessary
                - **If in a nose-low, unusual attitude close to the ground PULLING may not be appropriate control input: do what it takes not to hit the ground**
    - **Remember rudder roll picture: if rudder roll opposite aileron is encountered, *you need to reduce AOA when slipping***
- "Skid"
    - Rapid rolling departure (snap roll) in direction rudder deflected when airplane stalls
    - Little or no aerodynamic warning
    - Simulating over-shooting base to final turn
    - Power IDLE
    - At 80 MPH CAS (70 KTS), start base turn
    - Initiate a skid to the "inside" of the turn
        - Left turn, left rudder
        - Right turn, right rudder
        - Counter rudder induced bank with opposite aileron; allow nose to "skid" in desired direction of turn with wings remaining relatively level
    - Increase back pressure and allow airspeed to decrease
    - As AOA passes 14-15^{o}, airplane will rapidly snap "underneath" (in direction in which rudder is applied)
        - Little or no aerodynamic warning

      - Recovery
        - Neutralize lateral stick and rudder
        - Reduce AOA
        - Fastest recovery is to "snap" back to upright; otherwise unusual attitude recovery may be necessary
          - **If in a nose-low, unusual attitude close to the ground PULLING may not be appropriate control input: do what it takes not to hit the ground**
        - Note altitude lost and compare to typical base turn AGL altitudes
        - Remember lack of aerodynamic cues; if you do over-shoot final—let the overshoot happen, if you can't correct using coordinated flight, then go-around

- <u>"All Attitude" stall</u> (Nose High Visual Unusual Attitude Recovery)
  - Energy Neutral → Losing, Floor +500' min entry
  - Flaps up only
  - Pitch limit 70-80^{o} to avoid unintentional tail slide
  - "Unload for Control" techniques apply
    - Nose up = nose down; be patient
    - 0 to ½ G; maintain until aircraft is unloaded and airspeed is increasing past 100 MPH / 90 KTS
    - Unloaded roll to 90^{o} bank is OK to assist with recovery
      - Maintain bank angle until nose hits the horizon and airspeed is increasing; unloaded roll back to upright
  - Inverted? Observe minimum G limit; keep engine running—full stall may not be practical

Nose Low Visual Unusual Attitude (Dive) Recovery

- Low-drag characteristics = fast acceleration
  - Wide speed band approximately 4:1 (V_{NE} to V_S) due to low drag characteristics
  - RV-types accelerate quickly (especially with a fixed-pitch prop) any time the velocity vector is below the horizon
    - DANGEROUS speeds can be obtained unintentionally
      - Botched recovery can cause structural failure
    - Engine over speed possible with fixed-pitch prop
    - Power control and G-onset rate critical during maneuvering flight
      - Fixed pitch? Generally IDLE power with nose down; REQUIRED if airspeed > V_A

        - Common error: slow application of back stick during initial phase of recovery
        - Induced drag is your friend: highest below C_{Lmax}; best recovery turn performance obtained at V_A
        - ROT: IDLE power, G as required to stay between ON SPEED and V_A as long as practical; don't exceed V_{NO}
- Nose-Low Unusual Attitude Recovery (Visual references)
    - Power IDLE
    - Roll until wings are perpendicular to horizon
        - Do not increase G (pull) until lift vector is adjusted above the horizon; bank angle <90^o
        - Rolling pull? 4 G limit
        - Unloaded roll, set lift vector perpendicular to horizon, smooth pull? 6 G limit
    - Smoothly apply maximum allowable G; be alert for aerodynamic limit cues:
        - Buffet (first cue)
        - Stick force lightening
        - Nose stops tracking
        - Nose slice (uncommanded yaw)
        - Wing rock / drop
    - Relax pull if aerodynamic limit is encountered
    - Cross-check airspeed / AOA throughout recovery
        - If V_{NO} or V_{NE} (TAS) is unintentionally exceeded; don't panic—continue smooth pull and do not exceed G limits
    - Continue recovery until nose is on/above horizon and level flight is re-established

Spins

- Incipient Spins
    - Energy Losing, Floor +1500' min entry
    - RV-types are spin resistant (hesitant to spin) with CG in forward 2/3d's of aerobatic envelope; significant sideslip (yaw) near the stall is required to auto-rotate
        - "Full" spin requires 1.5+ turns to develop
    - Airplane will generally recover if controls are released during the first turn to turn and ½, however the purpose of this maneuver is to practice positive spin entry and exit IAW the out-of-control procedure
    - Pick ground references to assist with heading orientation during recovery

- Power IDLE; deceleration same as power-off stall
- Left incipient spin
  - Ailerons neutral throughout maneuver
  - At buffet onset, stick approaching full aft: Firm, smooth application of full left rudder
    - Maintain full aft stick and full left rudder until recovery is initiated
  - At stall, nose will rise slightly and left wing will drop significantly
  - As airplane rotates through 180^o nose will tuck slightly past vertical
  - At 270^o (3/4 turn point), apply right rudder and ease stick forward (neutral or beyond, as required)
    - Exact recovery heading is not important
  - As rotation stops, neutralize rudder and recover from dive
- Right incipient spin
  - Overall, same as left spin but a more rapid application of back stick at approximately V_S + 15 MPH / KTS during deceleration will assist with entry
    - Helps counter engine power effects

Advanced Handling

- Advanced handling maneuvers are basic aerobatic maneuvers that are designed to familiarize the upgrading pilot with all-attitude maneuvering and basic energy management in maneuvering flight; techniques are designed to maintain positive G throughout (G limit is zero; keep the engine running)
- <u>Acceleration Maneuver</u>
  - Used any time additional energy (airspeed) is desired
    - Can expedite sequence flow
    - Reminder: watch TAS if operating at altitude (210 MPH / 180 KTS TAS red line); typical acceleration limit is V_{NO} (180 MPH / 155 KTS CAS, top of green arc)
  - Unload (less than one G) with WOT (or desired power setting); allow the airplane to accelerate going downhill (ballistic arc)
    - Aerodynamically more efficient than a 1 G dive; requires less altitude trade-off
    - Target standard unload range of 0 to ½ positive G (keep the engine running)
      - Anything less than 1 G helps
- <u>Basic Roll</u>

- 500’ of vertical turning room required; energy neutral—finish at approximately entry altitude
- Many RV-types will exhibit “aileron bump” at high roll rates; this is normal
  - Distinct cue transmitted through control stick
  - Caused by momentary “aileron stall” (airflow separation)
- Airspeed: Cruise (150-170 MPH / 130-150 KTS)
- Power: Cruise
- Smooth pull to raise the nose 20-30^o above the horizon
- Neutralize elevator input BEFORE you roll
  - Slight relax to set desired pitch
- Smoothly apply firm aileron in desired direction of roll
  - Half stick or greater deflection
  - Hold uniform pressure through at least 300^o of roll
- Reverse aileron just prior to wings level
- Back stick as required to re-establish straight and level flight
  - Nose will drop throughout the roll, proportionate to roll speed
    - Faster roll rate = less nose drop
    - Half-stick deflection ROT: nose will end up about as many degrees nose low as it was nose high at the start of the roll
- Rudder
  - Not necessary during initial attempts
  - Bring ball into cross-check as proficiency is gained and start to coordinate roll
    - Do what it takes to “step on the ball”
    - Changes throughout the roll
- Slow roll rate as proficiency is gained
  - Increase pitch for slower roll

- <u>Loop</u>
  - 1000’ of vertical turning room required; energy neutral—finish at or above entry altitude
  - Ground reference line can help with rudder coordination and not rolling during pull-through
  - Airspeed slightly less than V_{NO}
    - 170-180 MPH / 150-160 KTS
  - WOT
  - Smooth pull: 3-4 G’s; maintain to 90^o of pitch
  - Cross-check airspeed at 90^o point
    - 120 MPH / 105 KTS

        - Minimum to get over the top with adequate energy (70-90 MPH / 60-80 KTS)
    - Begin to ease back stick passing 90° point
        - Continue to "rate" nose down to horizon; play G to control airspeed
            - Target 80 MPH / 70 KTS inverted, "canopy bow" on the horizon
    - Arrive inverted at 1 cockpit G
        - Be alert for buffet if airspeed low over the top (50 MPH / 40 KTS), ease back pressure (unload to less than 1 G, as required) and allow nose to float down to regain airspeed; aircraft ballistic—like inverted recovery
    - Apply back stick to rate the nose down and begin back side
        - Do not pull abruptly; unintentional inverted stall will likely cause a snap roll
        - Reference nose track across the ground
    - Fixed pitch prop? Reduce power to IDLE on back side for initial attempts
        - As proficiency is gained, power should be increased and G should be modulated to achieve desired nose rate and energy state (airspeed)
    - "Rate" nose to control airspeed build-up during recovery
        - Airspeed takes priority over altitude during recovery; don't exceed entry speed / V_{NO}
        - Be aware of TAS if flying at altitude
        - Precise entry/exit altitude? Depends on airspeed management
    - Stay coordinated: requires constant rudder inputs due to constantly changing airspeed
        - Generally increasing right rudder during first half and decreasing (or left) rudder during second half as airplane accelerates.
- <u>Split-S</u>
    - 1000' of vertical turning room required—energy neutral; will finish below entry altitude
    - Ground reference line can help with rudder coordination and not rolling during pull-through
    - Warning: too much energy (airspeed) at the start of a split-S attempt is DANGEROUS
        - Don't attempt a pure vertical pull-through with more than 100 MPH 90 KTS CAS at the start of the maneuver
    - Entry speed 80-100 MPH / 60-80 KTS
        - Maneuver entry can be expedited by zooming to decelerate to desired entry speed
    - Power: IDLE

  - Fixed pitch? Be ready for acceleration when lift vector is pointed at the ground
    - Don't let engine over-speed
  - Power can be modulated or increased as proficiency is gained: as a technique with a fixed pitch propeller, either leave power in IDLE throughout the maneuver or get some G on the airplane before adding power
    - Never add power above V_A
    - Corner happens fast with lift vector buried
- Pitch: level to slightly nose-up (20-30°)
  - Unload after establishing pitch angle
  - Same technique used for basic roll: ease as required to neutralize elevator before starting pull
  - More nose up better until proficiency is gained
- Roll to inverted as airspeed decreases to 80-100 MPH / 70-90 KTS
  - Slower is better until proficiency is gained
- SMOOTH pull to buffet cue
  - If entering at 80 MPH / 70 KTS, initial pull to ≈ 2 G's
  - Increase G as airspeed increases on the back side: USE BUFFET as cue
    - Keep increasing G to keep buffet the same
    - You'll end up pulling about 3-4 G's if airspeed is properly controlled
  - Smooth, brisk pull required to just shy of the buffet to prevent excessive airspeed build-up
    - Don't jerk the stick back at low airspeed during any "over-the-top" maneuver when you are on your back: will cause unintentional stall / snap roll with little or no aerodynamic warning
- Coordinate rudder as airspeed increases
  - Do what it takes with your feet to keep nose on reference line
- Keep airspeed in the cross-check during pull through
  - Rate the nose as required to keep it under control
  - Fastest turn at V_A
  - Don't exceed 6 G's in straight pull
  - Don't exceed V_{NO} during recovery
- Add power as nose comes back up to horizon

• <u>Barrel Roll</u>

- 1000’ of vertical turning room required; energy neutral—finish at approximately entry altitude
- Pick a reference point
- Set 65% to WOT
- Airspeed slightly less than V_{NO}
  - 150-180 MPH / 130-160 KTS
- “Check away” from reference point (smooth, coordinated turn) 20-30^{o}
- Begin smooth 2-3G pull from wing’s level and begin slow roll to arrive above the reference point at 90^{o} bank angle; pitch = to original offset (20-30^{o})
  - Get the nose up! Common error is not enough initial pull
    - Target: feet on the horizon
- Continue to roll to inverted, reducing G
  - Unload required: ease stick forward, keep rolling
  - 0 to ½ G (keep engine running) to allow airplane to float at about 80 MPH/70 KTS CAS “over-the-top” as it is rolling
  - Strive for inverted at apex of vertical pull
- Passing inverted, adjust roll rate as required to control airspeed build up
  - Fixed pitch prop? Reduce power (IDLE) if required
  - More roll rate required during the second (“bottom”) half due to effect of gravity
    - Check airspeed inverted, if fast over-the-top (e.g. 100 MPH/86 KTS) don’t “dish out.” Increase roll rate as required
      - Primary focus needs to transition to keeping airspeed under control if this happens
      - Dish out likely if nose starts down before reaching inverted
- Pass below reference point at 90^{o} bank angle with pitch = original offset (20-30^{o} nose down); airspeed permitting
- Continue pull to finish in level flight offset 20-30^{o} from reference point

- <u>Immelmann</u>
  - 1000’ of vertical turning room required—energy neutral; will finish above entry altitude at low airspeed
  - Airspeed slightly less than V_{NO}
    - 170-180 MPH / 150-160 KTS
  - WOT
  - Smooth pull: 3-4 G’s; maintain to 90^{o} of pitch
  - Cross-check airspeed at 90^{o} point
    - 120 MPH / 105 KTS

        - Minimum to get over the top with adequate energy (70-90 MPH / 60-80 KTS)
    - Begin to ease back stick passing 90^{o} point
    - As nose approaches 30^{o} above the horizon inverted, unload and roll in desired direction
        - Nose will continue to drop during unloaded roll
        - Coordinate roll with rudder as proficiency increases
            - Use of a ground reference can assist

- <u>Cloverleaf</u>
    - 1000-1500’ of vertical turning room required; energy neutral—may gain or lose altitude overall depending on power setting; note gain/loss at end of first “leaf” to determine trend
    - Starting on a cardinal heading or use of ground references is helpful
    - Pick a point over your left /right shoulder that you will “pull” to during the next leaf
        - 90^{o} off entry heading
    - Airspeed: 150-160 MPH / 130-140 KTS (Do not exceed V_{NO})
    - Power: Cruise to WOT
    - Smooth pull: 2-3 G’s
    - As nose approaches $60\text{-}70^{o}$ of pitch, roll to put lift vector on your reference point
        - Continue to roll and pull as the airplane begins to roll
        - Nearly vertical climb as roll approaches 90^{o} point
    - Pitch as required to fly the airplane over-the-top, inverted similar to the top half of a loop
        - Think “float”; unload as required to sustain energy over the top
        - Adjust roll rate as required to make the nose dropping inverted through the horizon coincident with 90^{o} reference
    - Back side of the leaf: same as a loop
        - Fixed pitch? Power IDLE
        - Adjust to entry setting (cruise to WOT) during last 45 to 30^{o} of pull-up
        - Airspeed takes priority over altitude during recovery
    - Pick next “over-the-shoulder” reference; repeat as many leaves as desired
- <u>Cuban 8</u>
    - 1000’ of vertical turning room required; energy neutral
    - Use of a ground reference line can assist with orientation and application of rudder
    - Airspeed slightly less than V_{NO}
        - 170-180 MPH / 150-160 KTS

- WOT
- Smooth pull: 3-4 G's; maintain to 90^{o} of pitch
- Cross-check airspeed at 90^{o} point
    - 120 MPH / 105 KTS
    - Minimum to get over the top with adequate energy (70-90 MPH / 60-80 KTS)
- Begin to ease back stick passing 90^{o} point
- Over-the-top same as a loop
    - Fixed pitch? IDLE down back side OK until proficiency gained
- As nose tracks down to $30\text{-}45^{o}$ below, unload and roll
- Maintain dive angle $30\text{-}45^{o}$ (pitch as required after roll to establish/maintain "down line")
    - Precise angle is not important
    - Dive angle can be increased as proficiency is gained; but lack of inverted systems may limit
    - Modulate power as proficiency is gained to control energy for second "loop" entry
- At 170-180 MPH / 150-160 KTS (not to exceed V_{NO}) begin smooth pull: 3-4G's
- Repeat

- <u>Loop Abort Exercise</u>
    - Combines skills learned in confidence maneuver and advanced handling practice
    - Abort in first 90^{o} (1/4 loop)
        - Insufficient airspeed to make it over the top (<120 MPH / 105 KTS) as nose approaches vertical
        - Unload, roll to inverted
        - Smooth pull to get nose started down
        - INVERTED RECOVERY as airspeed allows
            - If airspeed >80 and stable or increasing, can continue to roll
            - If airspeed <100 and decreasing, unload to 0 – ½ G condition
    - Abort "over-the-top"
        - Insufficient altitude to pull through and complete loop
        - UNLOADED ROLL to upright as nose tracks down (approximately $30\text{-}45^{o}$ nose low as you start down "back side" of loop)
        - Recover from the dive to wings level
    - Emergency Dive Recovery
        - Last 90^{o} (3/4 loop point)
        - Lift Vector already set
        - Maximum performance pull

        - Check airspeed
        - >V_A → IDLE power
        - Pull to maximum allowable G or onset of buffet

In-Flight Ignition System Check

- An inflight check of the ignition system should be performed periodically
    - Prior to "top of descent"
    - Conventional magnetos
        - Power: stabilized cruise condition 65% or less
        - Mixture lean (as LOP as practical depending on configuration)
        - Select L and R systems independently (15-20 seconds minimum)
            - If equipped with data recorder, time ≥ 5 recording cycles (i.e., minimum of 5 data points per system)
            - Pause on BOTH for same amount of time you ran on single system before you check the other system
            - Monitor CHT (if equipped)
            - Monitor for roughness / Check EGT rise (if equipped)
        - Bad check = roughness, falling/erratic EGT (if equipped), high CHT (if equipped)
    - Electronic ignition systems: IAW Manufacturer's instructions

RTB: Cruise Descent

- Plan: 3 degrees (altitude to lose x 3); VNAV (if equipped)
- Power: 15-17" MP
- Red Line is TAS; monitor (critical when descending above 8000 feet)
- Do not exceed V_{NO} (top of green arc) except in smooth air
- Descent Check
- Mixture Control during descent: forward (richen) as required to maintain smooth engine

3000' AGL Simulated Flame-out (SFO) Exercise

- E_M basics: steep bank and high descent rate or shallow bank and low descent rate; average over time can produce identical result
    - Estimate winds aloft (advanced instrumentation may display)
    - "Hoops" to fly through to make this work:
        - 3000' AGL above TDZ at L/D_{MAX} (approximately top of white arc--Van's standard airspeed indicator markings)

        - "High Key" above TDZ at 1500-1700' AGL at L/D_{MAX}/ best range glide speed (approximately top of white arc)
        - "Low Key" above perch at 800-1000' AGL at normal V_{REF} (ON SPEED: appropriate AOA or V_S x 1.3-1.4)
        - Final roll-out 3000' from desired TDZ at 300' AGL (6^o visual glideslope), no wind
            - Keep some extra energy if there is a strong surface wind down the runway
            - Assess during base turn from low key; if in doubt establish low drag; high lift configuration (Flaps 20) and head directly for TDZ
        - **Key: do what it takes to fly the airplane through desired hoops; think ground reference maneuver basics [turn around a point] to manage bank angle and fly over desired reference points**
        - Keep some "energy in the bank" (altitude and/or airspeed) and spend it in small increments; delay configuring the airplane until you are sure that adequate energy is available (first half of flap travel [up to Flaps 20] = lift; second half of flap travel [Flaps 20 to Flaps 40] = drag)
            - Slipping base turn and or final can be very helpful to "cash out" some altitude while keeping speed under control
            - Alternatively: subtle S-turns can help bleed some excess energy
    - **Know the amount of altitude lost in a 180^o gliding turn (idle power, propeller windmilling) for your airplane; flight test required!** Generally, fixed pitch propellers optimized for cruise performance with have have highest glide ratio—this requires some PLANNING when conducting a power-off landing
        - Fixed pitch equipped airplanes can have glide ratio in excess of 10:1
        - If equipped advanced instrumentation and/or GPS may display glide ratio real-time

Normal Pattern

- Calculate V_{REF} and V_{APP}
    - Stall speed, landing configuration (full flaps) x 1.3 - 1.4 (Van's Aircraft)
        - V_{REF} = ON SPEED ≈ V_S x 1.3-1.4
        - $V_{APP} = V_{REF}$ + 5 MPH/KTS
    - AOA? Fly ON SPEED , back up AOA with airspeed
- Emphasize perch management; anticipate winds (overshooting / undershooting)
    - Adjust perch for wind; pick ground reference
    - No wind 1000' AGL downwind
        - Fixed pitch prop: runway just under wing tip

        - Constant speed prop: runway at 1/2 to 2/3rds span (1/2 to 1/3 span inboard from wing tip)
- GUMP check + technique
    - Complete on downwind approaching the perch point
    - Carburetor: "Pump, pressure, throat"
    - Injected: "Pump, pressure, air"
    - Mixture management: don't be in a hurry to richen; only REQUIRED for go-around (technique: leave hand or continue to touch mixture control to ensure that it is richened if the throttle is advanced for go-around; or FULL RICH approaching pattern altitude)
- Configuration: Flaps 20 decelerating through V_{FE} (100 MPH CAS); final configuration prior to rolling off perch
    - Manual flap technique: allow airplane to slow to ON SPEED / V_{REF} (approximately 80 MPH / 70 KTS CAS for typical RV-type) prior to applying "second notch" (full) flaps (reduces air loads/force required to deploy)
    - Continue to trim as aircraft decelerates
        - Significant nose up trim required for solo operation at typical V_{REF} speeds
- Base Turn
    - Properly calibrated AOA? Should be primary reference; use airspeed (V_{REF}) as back-up
    - Note desired final roll-out point: 3000' from desired TDZ at 300' AGL; adjust bank as required (think turn around a point) to fly to that point
    - Glide characteristics depend on propeller type fitted
        - Significant difference between light-weight fixed pitch installation and constant speed propeller; constant speed types provide significant drag at high RPM and low MP
    - Fly the same base turn every time you fly a visual pattern!
        - Flying power-off (idle) 180^o will ensure "standard" visual pattern mimics "low key" flame-out—i.e., you're practicing a power-off, precision landing EVERY pattern
        - Use a standard configuration: Flaps 40 unless gusty / x-wind conditions
        - Roll off the perch in landing configuration: concentrate on flying during the turn; ground reference maneuver until rolling out on final
- Transition to stabilized final
    - 3000' from TDZ / 300' AGL (6^o visual glide path)
        - "Power off" technique
        - 3^o final is fine: 150' AGL at 3K' from TDZ; add power rolling out

            - Bottom line: know desired MSL roll-out altitude for transition from base turn to final (60:1 rule)
    - Aim point / AOA or airspeed on final approach
        - TDZ where velocity vector is pointing—spot not moving up or down in windscreen
    - Cross-wind controls
        - Initial crab to assess on final
        - Blend in cross-wind controls approaching the threshold, just prior to the flare
- Touchdown technique
    - Be ready for ground effect; may require pitch (forward) adjustment (especially with aft CG)
    - No right/wrong way to land tail wheel airplane (3-point, wheel or combination)
        - Three-point requires tail wheel touchdown prior to mains (gear geometry)
            - More pronounced with short gear RV-4 vs. other types
        - Wheel landing is conventional; bounce tendency due to Wittman-style gear
            - Bounce? Transition to three-point or go-around
        - "Tail low wheel landings" work very well in RV types
            - Fly airplane on to ground (one or two main mounts, depending on cross-wind); then fly the tail down
        - Stay focused: last third of landing roll (deceleration) is where you make your money!
            - Stick back when applying brakes
            - OK to retract flaps to transfer weight to mains IF it doesn't distract
    - Nose wheel equipped airplanes: objective is to keep the weight off the nose wheel as much as practical during landing and throughout landing roll-out
        - Touchdown on mains only (8-10^{o} pitch picture)
        - Maintain aft stick and hold off nose wheel as long as practical
        - Stick back when applying brakes
        - OK to retract flaps to transfer weight to mains IF it doesn't distract
        - Bounce? Add power, re-establish 8-10^{o} pitch attitude and re-attempt landing (runway available) or go-around
            - Don't allow nose gear to touchdown before mains, ever
- Closed Pattern
    - Low approach

        - Slow application of power
            - 2 seconds to 1900-2000 RPM initially (≈80%)
        - Allow airplane to stabilize
            - Stop descent
        - Half Flaps
            - Adjust trim
        - WOT
            - 2 seconds to wide-open-throttle
        - Accelerate
            - Flaps UP NLT V_{FE}
            - Trim
                - Be ready for substantial trim forces
        - Check airspeed increasing through approximately 120+ MPH / 105+ KTS
        - Smooth vertical pull (approximately 2 G's)
        - Nose / velocity vector transiting up?
            - Roll
                - Aileron or Rudder
        - Unload as required to maintain airspeed and climb to pattern altitude
            - Target V_{APP} to V_{FE}
        - Reduce power at level-off (IDLE-1200 RPM) and head for desired perch
    - Be a good neighbor! Adjust your pattern as required to accommodate other traffic; tight RV-type patterns may not always be possible when sharing the traffic pattern; as a ROT, give way to less maneuverable airplanes and give consideration to airplanes with less/poor visibility
- Generally, it's more important to listen and clear than to talk on the radio; never ***assume*** separation based on a radio call unless you can establish that adequate altitude separation exists.

Appendix C: RV-type Handling Rules of Thumb

Information in this section is explained in detail in Part 3: Techniques, Procedures and Handling Characteristics. Rules of Thumb are presented in "phase of flight" format for quick reference.

GROUND OPERATIONS

1. Lean aggressively during ground operation after start (conventional Lycoming power plant installation).

2. Be aware of prop blast at all times. Position the airplane so that prop blast is not a hazard to persons, other airplanes or property.

3. Some tail wheel equipped airplanes have limited forward visibility, requiring planning ahead and S-turns.

4. Nose wheel equipped airplanes should be taxied in a manner that keeps as much weight as practical off of the nose wheel. They use free castoring nose wheels and depend primarily on rudder movement for taxi steering. Slight differential braking should be used, when required.

5. Be alert for hazards while taxiing, especially on a soft/unprepared surface.   RV-types may be equipped with tight-fitting wheel pants and have limited clearance for landing gear components, including main gear fairings, tail wheel forks and nose wheel assemblies.

6. Do not ride the brakes during ground operation. Control taxi speed with power. If braking is required, apply the brakes to slow to desired speed (or assist with steering) and then release. S-turning can assist with controlling taxi speed. Taxi at low speed on unprepared/soft surfaces to mitigate fatigue of landing gear and associated components.

7. Apply proper flight control input for wind conditions when taxiing. Apply aileron away from a quartering tailwind and into a quartering headwind. Generally, maintain full aft stick during ground operations. This keeps weight off nose wheel for nose wheel equipped airplanes and maintains tail wheel steering authority on tail wheel equipped airplanes. When tail winds approach or exceed 15 KTS, elevator adjustment may be required.

8. Perform the pre-takeoff engine run-up with flaps UP and full aft stick for tailwheel equipped airplanes.

TAKEOFF

9. RV-types have relatively low power loading (weight divided by horsepower). The throttle shouldn't be jammed forward. Rapid power application at low airspeed can result in significant power effects in the form of yaw and roll making directional control difficult. Power effects must be anticipated and the throttle should be advanced only as fast as proper directional control can be maintained. Anticipate the need for right rudder.

10. Anticipate cross-wind control requirement and apply appropriate flight controls, when required. Avoid over-control (RV-types have light stick forces and quick control response).

11. Anticipate density altitude, tail wind and runway condition (as appropriate) effects on takeoff performance.

12. Flap settings up to 20^{o} (half-flaps RV-4/-6/-7/-8) or 15^{o} (RV-9) may be used for takeoff. Flap settings up to half-flaps improve lift, decrease takeoff ground roll and assist with raising the tail on tail wheel equipped airplanes (especially tandem types at high weight/aft CG conditions). Flap settings greater than half-flaps increase drag and should not be used for takeoff.

13. Lean the engine properly for high altitude takeoff (conventional Lycoming power plant installation).

CLIMB

14. Best rate of climb occurs at approximately L/D_{MAX}. IAS for best rate of climb decreases with altitude, but TAS remains relatively constant. Decreasing IAS 1%/1000 feet during climb will approximate a constant TAS. Climb at high power settings and low airspeed results in low over-the-nose visibility and requires significant right rudder input to compensate for power effects.

15. Stick force lightening (decreased pitch stability due to reduced static margin) occurs during climb at high power settings, and may be encountered at high power/low airspeed. Depending on CG location, some airplanes exhibit neutral or negative pitch stability during climb at high power settings. Some RV's will diverge from trimmed airspeed and may slow to the stall if the pilot does not actively control pitch/airspeed, i.e., do what it takes to maintain desired airspeed/AOA.

16. Climb performance is excellent over a wide speed band (approximately 80-140 MPH/70-125 KTS CAS). Cruise climb speed can be adjusted to maintain desired engine temperatures with little degradation in performance. If most efficient performance is desired, fly faster if confronted with a headwind and climb faster if assisted by a tailwind to desired cruise altitude.

17. Optimum Climb. Climb at a speed equal to 1.32 times V_Y appropriate for gross weight and altitude (as determined by flight test). Climb at this speed until VVI decreases to 500 FPM.

Maintain 500 FPM until indicated airspeed reaches V_Y and then transition to V_Y until reaching desired climb altitude.

18. If power loss occurs during climb after takeoff, significant nose down elevator input may be required to establish proper glide/AOA condition.

19. Lean during climb above 3000 feet density altitude. If equipped, note EGT during WOT operation following takeoff. Adjust mixture to maintain that EGT (or slightly cooler) when climbing above 3000 feet density altitude (conventional Lycoming power plant installation).

CRUISE

20. RV-types have a wide speed band for normal operation. The speed band is the ratio of V_{NE} to V_S. This ratio is approximately 4:1 for RV-types. Do not exceed V_{NO} CAS except in smooth air. Do not exceed V_{NE} TAS.

21. When leveling off, trim and allow the airplane to accelerate to desired cruise speed before adjusting power for cruise. Make fine trim adjustments at high speed, the RV-type trim tab is quite effective at typical cruise speed.

22. Lycoming recommends cruise power settings at or below 65% for maximum engine life. "Over-square" operation does no harm: manifold pressure may exceed RPM (normally aspirated Lycoming power plant) if CHT (when equipped) and oil temperatures are within limits and mixture is properly adjusted. Precise power cannot be determined for aircraft not equipped with a manifold pressure gauge/sensor.

23. If equipped with a manifold pressure gauge and tachometer, power setting can be approximated using the "rule of 48" where MAP (inches) + RPM/100 = 48 equates to approximately 75%. When the sum is 45, power is approximately 65% and when the sum is 42, power is approximately 55% (normally aspirated Lycoming power plant).

24. Optimum Cruise. No wind optimum cruise in RV-types occurs at whatever pressure altitude allows WOT to produce the desired cruise power setting. Application of partial carb heat (when equipped) and pulling the throttle back very slightly to cock the throttle valve for carbureted engines during optimum cruise can improve induction fuel/air mixture (conventional Lycoming power plant installation).

25. Lean for cruise operations, regardless of altitude. Adjust mixture to LOP or 75-100 degrees F rich of peak for the leanest cylinder. Avoid operation between peak and 50 degrees F rich of peak. Best economy cruise occurs when the mixture is adjusted as LOP as practical (conventional Lycoming power plant installation). See Table 3-1.

26. Maximum endurance (most time aloft for fuel burned) occurs at L/D_{MAX}. L/D_{MAX} must be determined by flight test. Maximum fuel efficiency occurs at a speed approximately 30% greater than L/D_{MAX} (Carson's number/most miles per gallon) and represents a reasonable compromise for "maximum endurance" cruise (e.g., holding). If increased range/endurance is desired; slow down and choose a higher cruise altitude (as the CAS will be will be lower for a given TAS).

27. Use a light, relaxed touch for basic aircraft control. RV-types have high gain flight control systems optimized for maneuvering flight. This causes increased workload in non-maneuvering flight (especially IMC). Avoid over-control, fly known pitch/power settings and trim.

28. Maintain lateral fuel balance within approximately 6 gallons when practical to assist with maintaining lateral trim/stability.

29. Slow down when turbulence is encountered. In moderate to heavy turbulence, maintain V_A. RV-types are prone to yaw excursions in turbulence. Ensure harnesses are secure—it is possible to hit the canopy in moderate to heavy turbulence, especially if the harness is not tight.

MANUVERING FLIGHT

30. Control inputs should be SMOOTH and DELIBERATE, never abrupt. Keep a light (relaxed) grip on the stick and maintain positive control of the rudder.

31. Be aware of airspeed (dynamic pressure or "Q") and G limits at all times during maneuvering flight. Sufficient flight control authority is available in all RV-types to allow structural damage or failure to occur if abrupt flight controls are applied inappropriately at speeds above maneuvering speed (V_A). See Table 3-7.

32. Maneuvering speed (IAS) for a specific airplane must be determined by flight test. Multiply stall speed (IAS) by the square root of G-allowable (G limit) to determine maneuvering speed. Maneuvering speed only applies to a single actuation of one flight control about one axis of motion.

33. RV-type maneuvering speed depends on G allowable (G limit) and gross weight. At gross weights in excess of maximum allowable aerobatic gross weight (or 1600 lbs for RV-9/9A), maneuvering speed DECREASES due to less G allowable. See Figure 3-9.

34. Asymmetric maneuvering reduces G allowable. For aircraft certified in the aerobatic category under FAR 23, this decrease is 33%. V_A decreases under asymmetric G ("rolling G") conditions. Van's Aircraft does not specify asymmetric G limits for RV-types. For aerobatic RV-

types, a + 4 G limit target for all positive G maneuvering should avoid unintentional over-G under standard design load conditions (i.e., designer's aerobatic limits observed).

35. Van's Aircraft does not specify G-limits with flaps extended. For aircraft certified under FAR 23, flaps must be designed to withstand a minimum 2 G load.

36. Loaded within designer's CG limits, RV-types exhibits positive static pitch stability, except at high pitch angles and, for some aircraft, during high power, maximum performance climb. Static margin is increased when the RV-type is loaded within designer's aerobatic limits (when appropriate).

37. Roll stability is generally neutral.

38. Yaw stability is always positive, but transients are likely—especially in turbulence.

39. CG moves aft as fuel is burned and pitch stability decreases throughout flight.

40. Stick force gradient (lbs of push or pull required per G) is a function of CG location. Forward CG creates a higher gradient (heavier stick); aft CG lowers the stick force gradient (lighter stick).

41. At or near aft CG limit, pitch stability tends toward neutral. This can be very pronounced in tandem aircraft in the flare/landing. As stability approaches neutral, the pilot must use whatever control force is necessary to establish/maintain desired pitch attitude.

42. RV-types accelerate quickly when the velocity vector is below the horizon (i.e., the nose is down). Dangerous speeds can be obtained unintentionally. If maneuvering, smooth application of flight controls, G-onset rate and power control are critical, especially for aircraft equipped with fixed-pitch propellers.

43. Half flaps (20^o) or less increase lift; more than half flaps (>20^o) increases drag.

44. Many RV-types exhibit "aileron bump" when a maximum performance roll is flown. This feedback through the flight control system is normal.

45. Best turn performance occurs between best range glide speed/V_Y and V_A (maneuvering speed/corner velocity).

46. Check airspeed before attempting any vertical pull-through (up or down). Recommended maximum speed for a pure Split S is 100 MPH / 85 KTS and minimum speed for an over-the-top is 150 MPH / 130 KTS until experience is gained. In both cases, smoothly and rapidly apply initial target G (3-4) using an onset rate of 1-2 G's/second.

47. V_{NE} (red line) is a function of TAS and flutter margin is reduced as altitude increases. No consistent, reliable flutter cues exist, and V_{NE} is easily exceeded in any RV-type. V_{NO} (maximum structural cruising speed/top of the green arc) should only be exceeded in smooth air. At high altitude (at or above approximately 10,000-12,000 feet), operation at V_{NO} may result in a TAS in excess of red line. If the airplane has advanced flight instrumentation and displays TAS, observe V_{NE} limits for displayed TAS. If the airplane has a conventional airspeed indicator, TAS may be roughly approximated by adding 3 KTS/MPH per 1000' of altitude to CAS.

48. Post-stall handling characteristics vary by aircraft and load. Generally, if the airplane is within aerobatic design limits, sufficient rudder authority remains to control yaw post-stall and prevent autorotation.

49. Under low G conditions, most RV-types exhibit little or no buffet warning prior to stall. Buffet cues increase with G load.

50. A wing drop will occur at stall, unless the ball is centered.

51. Engine and power effects are present at ALL power settings; they are minimized at LOW power settings.

52. Power-on stall pitch attitude can be quite nose high due to the low power loading of RV-types.

53. 2 G accelerated stall speed is roughly coincident with $L/D_{MAX}/V_{REF}$ and sufficient elevator authority exists to allow an accelerated stall to occur during pattern operations.

54. It is difficult to cause a departure from a slip condition, but a skid will cause immediate departure if critical AOA is exceeded. If a departure is encountered at or below pattern altitude, recovery is not likely.

55. An inadvertent stall/spin encountered at or below traffic pattern altitude is likely non-recoverable.

56. The airplane cannot stall or depart controlled flight if a zero G condition is established. A low G condition can be established in any attitude by neutralizing controls and applying sufficient forward stick to establish desired G, regardless of aircraft attitude. A carbureted engine will generally hesitate or stop at approximately 0 G (this creates a distinct change in engine noise, even at low power settings). A light weight, fixed pitch propeller may stop completely if the engine fails due to fuel starvation and a low G condition is maintained.

57. If the airplane is unloaded to 0 to +½ G and airspeed is increasing through 100 MPH / 90 KTS, it is no longer out-of-control.

58. During incipient spin, releasing the controls will, generally, result in recovery from autorotation, but positive control input is desirable. During developed autorotation (spin), releasing controls will not cause recovery. After any spin recovery, the pilot must be ready to recover from any subsequent unusual attitude using smooth, positive control inputs.

59. When recovering from a departure/loss-of-control/incipient spin/autorotation, initially "idleize and neutralize." If necessary, apply rudder opposite yaw, and then smoothly apply stick as required to unload. Be ready for unusual attitude recovery.

60. If the lift vector is below the horizon (e.g., Split S, back side of a loop, slice back, etc.), modulate G or reduce power (to idle, if necessary) as the nose tracks through the horizon and increase power at dive angles less than 90^o after establishing desired G. This is especially critical for fixed pitch equipped airplanes to control airspeed.

61. The fastest way to reposition the lift vector (roll) is to unload, then roll. After the lift vector has been reset, then pull to set G, if desired.

62. The rudder is only marginally effective for rolling and only at high AOA.

63. Post-stall departure (incipient spin and subsequent autorotation) will always occur in the direction of yaw. Post-stall, the nose will slice in the direction of yaw.

64. During maneuvering flight, if the pilot senses force on the stick becoming light (perceptible decrease in stick force gradient) while approaching critical AOA, this is an indication that directional control is breaking down.

65. Any time the pilot senses a potential loss of control, rudder and aileron should be neutralized and AOA reduced (unload for control).

66. When maneuvering vertically (e.g., loop) with steep dive angles, controlling airspeed is more critical than any altitude parameter. It may be necessary (i.e., safer) to finish "high" to prevent a dangerous build-up of airspeed if G was not properly applied during maneuvering to manage airspeed.

67. Due to the efficient aerodynamics and power loading of RV-types, many basic aerobatic maneuvers can be "energy gaining," i.e., you can finish at a higher altitude than you start, if desired for profile/energy management.

68. At high AOA, moving the flight controls in the shape of a cross (i.e., neutralize aileron first then neutralize elevator and visually cross-check control position, if required) and controlling yaw with rudder will assist with maintaining aircraft control and avoiding unintentional departure (wing drop or snap roll) post-stall.

69. Never jam the throttle. A deliberate 3-second count will assist with controlling power effects. Rapid application of throttle at low airspeed will cause significant power effects in the form of yaw and roll to the left.

70. "Step on the ball" to control yaw. Be alert for nose slice (sideways motion that is detected by sighting down the nose) that accompanies yaw.

71. All RV-types exhibit excellent glide performance. Fixed pitch equipped airplanes (especially those fitted with a cruise propeller) exhibit even better glide performance and this must be anticipated during pattern operations. Best glide (minimum drag) performance for airplanes equipped with constant speed propellers can be achieved by setting LOW RPM for glide.

72. If not determined during flight test, L/D_{MAX} can be approximated by flying V_X or best glide speed. If no data is available, L/D_{MAX} may be crudely approximated by flying 135% of V_S.

73. Best range glide occurs at approximately V_Y. Maximum endurance glide occurs at approximately $V_{X.}$

74. Between maximum endurance and maximum range glide speed, expect to lose 500-700 feet per 180^o of descending turn (fixed pitch or constant speed propeller at low RPM, bank 0-30^o).

75. If bank angle is increased in a gliding (descending) turn, pitch down needs to be increased (AOA reduced).

DESCENT

76. Use caution not to exceed V_{NE} (TAS) during descent. Only exceed V_{NO} in smooth air.

77. Lean properly for descent: richen only as required to maintain smooth operation (or desired EGT).

PATTERN OPERATIONS

78. If not equipped with an AOA indicator, V_{REF} for approach and landing is 1.3-1.4 V_S (where V_S equals stall speed in landing configuration). This varies from the standard FAA definition of V_{REF} and is slightly faster.

79. A properly stabilized final approach is the key to consistently good landings.

80. Conventional gear RV-types are capable of three-point, wheel or tail-low wheel landings. Aircraft equipped with Whitman-style gear tend to bounce when wheel landed improperly.

81. Nose wheel equipped airplanes: objective is to keep the weight off the nose wheel as much as practical during landing and throughout landing roll-out. Don't allow nose gear to touchdown before mains, ever. Primary directional control via flight controls (rudder) utilizing differential braking only as required.

82. With tandem types loaded to an aft CG, expect some stick force lightening during flare and round out when landing. This is a characteristic of the low-aspect ratio wing downwash increasing as AOA increases in the flare. The pilot should maintain landing pitch throughout, even if that means easing back pressure (or applying forward pressure)—i.e., do what it takes to maintain the landing picture.

83. Bounced Landing Recovery: Add power (as required), re-establish normal 8-10^{o} pitch landing attitude and re-attempt landing (runway available) or go-around. Keep it straight (longitudinal axis aligned with touchdown path/runway). For conventional gear types, one transition from botched wheel landing bounce to three-point permissible with sufficient runway remaining, if in doubt, go around.

84. Do not jam power when going around or flying a low approach. Power effects are quite strong and if full throttle is rapidly applied during an attempted landing flare at low speed, significant yaw and roll may be experienced. RV-types are capable of maintaining level flight (and, depending on conditions) climbing with full flaps.

85. Use full rich mixture for go around (unless operating at a high altitude airport).

86. A go-around and closed pattern to a full-stop landing requires approximately ½ - ¾ gallon of fuel.