



The Basic Aerobatic Manual

With Spin and Upset
Recovery Techniques



Third Edition

Based on the original text by
William K. Kershner
Edited by William C. Kershner

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AVIATION SUPPLIES & ACADEMICS, INC.
NEWCASTLE, WASHINGTON

After doing his first spin at the age of 16 in an Aeronca TAC, **William K. Kershner** flew and taught aerobatics for 60 years. Bill put his degree in technical journalism and aerodynamics, along with his ability to make complex ideas seem simple, to work in writing *The Student Pilot's Flight Manual*, *The Instrument Flight Manual*, *The Advanced Pilot's Flight Manual*, *The Flight Instructor's Manual* and *The Basic Aerobatic Manual*. He also wrote *Logging Flight Time*, a collection of aviation anecdotes and experiences collected over a lifetime in aviation. The Kershner Flight Manual Series has influenced hundreds of thousands of pilots, with over 1.3 million copies printed in at least 3 languages.

Bill received the General Aviation Flight Instructor of the Year and the Ninety-Nines Award of Merit, among many other honors. To date he is the only person to have been inducted into both the International Aerobatic Club Hall of Fame and the Flight Instructor's Hall of Fame. He was among the first to be inducted into the Tennessee Aviation Hall of Fame.

Kershner operated an aerobatic school for many years at the Sewanee-Franklin County airport in Tennessee using a Cessna 152 Aerobat. His airplane, N7557L, is on display at the National Air and Space Museum's Udvar-Hazy Center at Dulles International Airport. Bill Kershner died January 8th, 2007.

Editor **William C. Kershner** received his early flight training from his father, William K. Kershner. He holds Commercial, Flight Instructor, and Airline Transport Pilot certificates and has flown 22 types of airplanes, ranging in size from Cessna 150s to Boeing 777s, in his 16,000 flight hours. He retired from commercial aviation as a 737 check airman and lives near Sewanee, Tennessee, with his wife.

The Basic Aerobatic Manual: With Spin and Upset Recovery Techniques

Third Edition

William K. Kershner

Illustrated by the Author

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Preface to the First Edition

This manual was written to be used as a reference guide in conjunction with an introductory aerobatic course, with emphasis on flying the Cessna Aerobat. The airspeeds and techniques are those recommended for the Aerobat; however, the maneuvers described may be done (at the appropriate airspeeds) in other airplanes certificated for aerobatics.

The maneuvers are introduced in the expected order of difficulty. You should study the text and illustrations both before and after the flight in which the maneuver is introduced by your instructor.

While we're on the subject of your instructor, it should be noted that self-taught aerobatics is not the way to go. That method is certainly very inefficient—and can be dangerous.

This is a guide only. Performance of the various aerobatic maneuvers depends on the experience and skill of the individual, and the time necessary to learn the various maneuvers will vary among pilots. Your instructor will know when you're ready to move on to a new or more complex maneuver.

This book is an updated version of the Cessna 150 *Aerobat Training Manual* written in 1969. The recommended entry airspeeds were in miles per hour rather than knots (which are now almost universally used in flying). Power (RPM) settings were higher than those used in the Cessna 152 Aerobat (the “standard” power setting at cruise for chandelles, wingovers, lazy eights, and aileron rolls is 2,300 RPM for the C-152 and 2,500 RPM for the C-150 model). The 1976 and 1977 Cessna 150 Aerobats changed to knots but used the same power settings as the earlier 150. I have included speeds and power settings for all models of the airplanes; the first figures are for the C-152 Aerobat in knots, the figures following in parentheses for the C-150 in miles per hour. You'll note that the values don't always jibe with the conversion factor for knots and miles per hour. There are a couple of reasons for this: (1) I have slightly changed some entry speeds (knots) for various

maneuvers, based on several hundred hours of instructing in the Aerobat, and (2) the speeds in miles per hour are rounded off to the nearest 10 mph for easier handling in flight. In short, if your Aerobat airspeed indicator is in knots use the first recommended speed. If it's marked in mph, use the recommended speed given in parentheses.

The maneuvers here cover the general range of g forces from +4.0 to 0 (briefly), and the majority of them can be done within a range of +3.5 to +0.5g's. The stock Aerobat does not have an inverted fuel or oil system, and I believe that the average person should be introduced to the idea of aerobatics in a comfortable environment with no engine power loss or hanging on the belt and harness. Certainly those serious about continuing aerobatics should get further instruction in an airplane that allows the extended negative g's necessary for the performance of more complex maneuvers. Certain maneuvers covered here in an across-the-board introduction to basic aerobatics may not be listed for a particular airplane.

I worked with Joyce Case, Jim Kemper, Bill Thompson, and Ed McKenzie of Cessna in writing the original training manual in 1969 and thoroughly enjoyed being associated with them.

I would like to thank Jim Bryan, who flew aerobatics with me and took a series of pictures throughout several maneuvers that allowed me to accurately illustrate various instrument indications.

My son Bill, a CFI, helped with data taking on several flights in the Aerobat, noting the times and altitudes required for various maneuvers. Thanks to Eleanor Ulton for the good typing and automatic correction of grammar and punctuation errors.

Thanks also to Gordon Lee Hight, one of my aerobatic trainees, who made suggestions for corrections and improvements in the book. Cessna Aircraft Company has kindly given me permission to rewrite the manual as a personal project and has furnished the

original drawings and layouts. Since this book is a different and personal approach it should be understood that it is not a Cessna project or an official view by that company.

You won't be anywhere near ready for competition or airshow aerobatics after this course, but this training will increase your confidence and all-around ability to fly all airplanes.

William K. Kershner

Preface to the Second Edition

The advantages of quality basic aerobatic training are hard to over-state.

Aerobatic/upset training allows the pilot to react to an unusual attitude more quickly and correctly, versus a pilot who hasn't performed a stall since his or her last Flight Review and has never been inverted. Even very experienced (but not upset-trained) pilots can be timid in a push-and-roll scenario, losing precious altitude in a wake turbulence recovery.

Entering a cross-controlled stall/spin at a safe altitude with a competent instructor will open any pilot's eyes to the dangers of having a tailwind on base and trying to salvage a poor traffic pattern.

My thanks to ASA's Editing and Production departments, especially Jennie Trerise, for their help in this endeavor.

The Second Edition of *The Basic Aerobatic Manual* is dedicated to three of the many mentors I've been fortunate to have had: Genie Rae O'Kelley, Ned Kirby-Smith, and Jim Banks.

William C. Kershner
Sewanee, Tennessee

Preface to the Third Edition

Here I would like to note a couple of the changes in U.S. aviation since the last edition.

The rewriting of 14 CFR Part 23 (Airworthiness Standards) results in all newly certified small airplanes being in the Normal category (no more Utility or Aerobatic) with qualified types being approved for aerobatics, including spins. Non-aerobatic airplanes certified under the previous rules could be approved for spins under specific weight and balance situations (when operating in the Utility category). Those certified under the new rules are either limited to chandelles, lazy eights, steep turns, and stalls or are "Normal but certified for aerobatics" (which includes spins). The certifications Normal, Utility, and Aerobatic still apply to all of those older planes.

Because such a high percentage of fatal general aviation accidents are related to loss of control (i.e., stalls/spins), the FAA has worked to lighten the regulatory load for add-on safety equipment, such as angle-of-attack indicators, for existing airplanes. You may come across one of these in the next plane you rent or fly in (see Chapter 8).

The occasional comment about maneuvers related to practical tests are made in the hope that a private pilot, having taken a basic aerobatic course, might be inclined to go for a commercial or flight instructor's certificate.

William C. Kershner
Sewanee, Tennessee

Introduction to Aerobatic Flight

Advantages of Aerobatic Training

In recent years, flight training in the United States has gradually moved away from the idea of being able to fly the airplane in steeper pitch and bank attitudes. In fact, some professional pilots would be at a loss to know what to do if the airplane exceeded certain pitch or bank limits. Under the current system of certification some flight instructors have never been in a developed spin but have been signed off by a fellow instructor after a one-turn “spin” in each direction, both participants more than glad to terminate the exercise at that point and descend the 10,000 feet back down to the airport.

Many flight instructors are seriously concerned about what they would do in the event of a spin or inverted flight occurring because of a student’s, or wake turbulence, action. *Every flight instructor should have at least 5 hours of aerobatic training.* While we’re talking about wake turbulence, don’t think that *any* amount of aerobatic training and experience would guarantee recovery from wake turbulence on takeoff or landing, but it would give you a *better chance* at recovery at higher altitudes. The aerobically trained pilot will roll the airplane upright if inverted by wake turbulence or other factors, minimizing the altitude loss, as compared to the pilot without aerobatic training who would most likely pull through a split S (half loop), losing 1,000 feet or more. Again, though, *aerobatic training* will not *guarantee* recovery. Wake turbulence should always be respected and feared—and always avoided.

A second plus for aerobatic training is an added confidence in other phases of your flying. No longer will that great unknown area past 20° pitch and 60° bank be lurking out there waiting to get you. You will expand your envelope of operation for the airplane. There’s no real proof, but it’s highly possible that as many accidents have been caused by timidity and

over-cautiousness as by recklessness; both are usually the result of lack of knowledge and experience in the full approved operating envelope of the airplane. You can justify the expense of taking an aerobatic course to your spouse by noting that it will make you a safer pilot—which it certainly will.

The third factor is that it will likely be the most enjoyable flying of your career, and this is icing on the cake. It will be challenging as well as enjoyable. (Instrument training is challenging and, for some, enjoyable. Later in this book it will be shown that some aerobatic maneuvers such as aileron rolls, loops, and spins may be done under the hood while your instructor acts as safety pilot.)

As was noted in the Preface, no aerobatic maneuvers should be attempted without first having received dual instruction from a qualified aerobatic instructor. You didn’t read a how-to-fly book, jump in an airplane, and teach yourself to get the machine off the ground and back again. This manual assumes that you have a private certificate so the basics of how to turn, climb, glide, and fly straight and level won’t have to be reviewed.

The course recommended here will consist of six lessons for a total of 5 hours flight time (see the syllabus at the back of the manual). You can set your own pace in going through the course; however, three flights a day should be your maximum.

You shouldn’t try to cram the course through in, say, one day because your rate of learning might not be as great if the new information comes too fast; on the other hand if you fly once every 2 weeks, you’ll spend a lot of time reviewing the maneuvers covered the last flight. Try to fly at least twice a week (one flight a day is better) and use this manual as a review between flights.

Federal Aviation Regulations

In any bona fide aerobic course you will fly in accordance with the Federal Aviation Regulations and following are some points you should consider. Federal Aviation Regulations (FARs) pertaining to aerobic flying are as follows.

14 CFR §91.303 Aerobatic flight.

No person may operate an aircraft in aerobatic flight—

- (a) Over any congested area of a city, town, or settlement;
- (b) Over any open air assembly of persons;
- (c) Within the lateral boundaries of the surface areas of Class B, Class C, Class D, or Class E airspace designated for an airport;
- (d) Within 4 nautical miles of the center line of any Federal airway;
- (e) Below an altitude of 1,500 feet above the surface; or
- (f) When flight visibility is less than 3 statute miles.

For the purposes of this section, aerobatic flight means an intentional maneuver involving an abrupt change in an aircraft's attitude, an abnormal attitude, or abnormal acceleration, not necessary for normal flight.

Parachute Requirements

You and your instructor will wear parachutes while doing aerobics. The parachutes should be in good condition and within the packing dates required by regulation. As unlikely as bailing out is, there's nothing like discovering that you're wearing a fifteen-dollar "bargain" that hasn't been repacked since World War II.

Your instructor will show you how to inspect the parachute before wearing it and will make sure that your parachute has been inspected and repacked by a certified rigger within the required time period. Following are the FARs on the subject.

14 CFR §91.307 Parachutes and Parachuting.

(a) No pilot of a civil aircraft may allow a parachute that is available for emergency use to be carried in that aircraft unless it is an approved type and has been packed by a certificated and appropriately rated parachute rigger—

- (1) Within the preceding 180 days, if its canopy, shrouds, and harness are composed exclusively of nylon, rayon, or other similar synthetic fiber or materials that are substantially resistant to damage from mold, mildew, or other fungi and other rotting agents propagated in a moist environment; or
- (2) Within the preceding 60 days, if any part of the parachute is composed of silk, pongee, or other natu-

ral fiber or materials not specified in paragraph (a)(1) of this section.

(b) Except in an emergency, no pilot in command may allow, and no person may conduct, a parachute operation from an aircraft within the United States except in accordance with part 105 of this chapter.

(c) Unless each occupant of the aircraft is wearing an approved parachute, no pilot of a civil aircraft carrying any person (other than a crewmember) may execute any intentional maneuver that exceeds—

- (1) A bank of 60 degrees relative to the horizon; or
- (2) A nose-up or nose-down attitude of 30 degrees relative to the horizon.

(d) Paragraph (c) of this section does not apply to—

- (1) Flight tests for pilot certification or rating; or
- (2) Spins and other flight maneuvers required by the regulations for any certificate or rating when given by—

- (i) A certificated flight instructor; or
- (ii) An airline transport pilot instructing in accordance with §61.67 of this chapter.

(e) For the purposes of this section, *approved parachute* means—

- (1) A parachute manufactured under a type certificate or a technical standard order (C-23 series); or
- (2) A personnel-carrying military parachute identified by an NAF, AAF, or AN drawing number, an AAF order number, or any other military designation or specification number.

If at any time you should notice the chute you are using has grease or what you think might be corrosive material on it, report it to the instructor right away. It may need to be repacked before being worn again. In addition, a parachute could have been handled by the rip cord and some of the pins moved far enough that inspection would be advisable.

If you are using a backpack parachute, the back cushions of the Aerobat seat have been designed to be easily removed, turned around and attached to the back of the seat back. If a seat pack is used, remove the bottom cushion from the seat.

Area and Altitude Limitations

As noted earlier, you won't be doing aerobics over a town or settlement or over an open air assembly of persons. You won't do them on a Federal airway or in a control zone or at an altitude less than 1,500 feet above ground level. Remember, this is only a minimum—there is no substitute for altitude following an improperly executed maneuver. Being well above this minimum altitude will let you concentrate on properly

completing a maneuver without concern for legal or safety minimums.

Along these lines, you should always clear the area before each maneuver or series of maneuvers. Maybe you've complied with all of the FARs, but it makes for a great rate of adrenaline flow to fly over the top of a loop and find yourself pointed at a military airplane doing its low-level practice in *your* area. The overhead skylights in the Aerobat will help you in clearing the area, as well as being quite useful for positioning the aircraft during the aerobic maneuvers. *Use them.*

Physical Condition

You should be in good physical condition and mentally alert. If you have passed an FAA physical, you're in good enough shape to do basic aerobatics. However, if you have a "bug" or some other temporary problem, you won't be at the peak of mental or physical vigor, no matter what your "usual" condition is.

The instructor will begin your introduction to aerobic flying by limiting the demonstrations of each maneuver to a *minimum* amount of time, allowing you to do the vast majority of the flying. Each maneuver will be fully explained and then demonstrated, and you'll know exactly what to expect. Most people adjust quite rapidly to the attitudes of aerobic flying, and any early nervousness will be eliminated.

The biggest question in the mind of anyone considering aerobatics is, Will I get sick? In a properly sequenced course the chances of nausea are cut to the minimum, but you can help yourself also.

What and how you eat and drink before a flight can have a great deal to do with your reaction to aerobatics. Avoid any heavy or greasy food before flying. For some people, coffee or soft drinks can also be the instigator of nausea problems.

For your first lesson or two, schedule so that you fly at least a couple of hours after eating. This is better for most people than flying on a full *or* empty stomach.

The big point is that *you* will have to let the instructor know when to break off the session, although your sweating or poor coloring may show that things have progressed further than they should.

Most pilots new to aerobatics are highly enthusiastic after the first few maneuvers (and will probably stay that way), but one of the first manifestations of impending trouble, before any noticeable physical symptoms occur, is a sudden decrease of interest in doing another roll or loop. You aren't nauseated and don't have any real physical symptoms, but would just as soon be doing something else. ("On the whole, I'd just as soon be in

Philadelphia.") This is called NSMFA (Not So Much Fun Anymore) and is the point at which you should indicate that it's time to cut it short—physical symptoms are pretty sure to follow if more maneuvers are done. It's always better to go back to the airport early and think you could have done a few *more* maneuvers, than to go back late and wish you'd done *fewer*.

If you are having nausea problems that first or second flight, don't get discouraged; a fair percentage of aerobic trainees do have minor problems or "loss of enthusiasm" during the first flight or two, but by watching their diet before flying and keeping those flights short, they work their way out of the problem and, on the last few flights, can run a full series of maneuvers without any trouble at all.

A couple of added factors that might help are (1) scheduling in the afternoon for a while if you're having problems on the morning flight (or vice versa) and (2) chewing gum during aerobatics to help keep the stomach occupied. (Don't swallow the gum during a particularly involved maneuver.) The rate of chewing can tell the instructor your excitement index—sometimes the gum will take quite a beating.

One aerobic instructor, when asked what method he used to cope with airsickness on the first few flights, replied, "I let the trainee fly the airplane until I feel better."

Incidentally, if you have a cold or a sinus problem, perhaps you'd better fly another day because you will be climbing and descending pretty fast in some of the maneuvers. In any case, let your instructor know if at any time you start feeling a little under the weather, so you can have a few minutes of straight and level flying.

Acceleration (g) Forces

You may have had the word on acceleration forces, or g's, for some time, but still it might be well to review the situation, since a 20°-banked turn might have been the wildest flying you've done lately.

The acceleration discussed here is not the kind you normally associate with drag races but the force that results when you change direction—and this force can result while either flying the airplane or walking. Needless to say, you'll be doing a considerable amount of changing directions during aerobatics and will encounter extra g's plenty of times. Specifically, the forces you'll be most interested in are those acting parallel to the vertical axis of the airplane. Here are some points that you may have forgotten.

While reading this, if you are standing still or sitting in a chair or flaked out in the hammock, you have

the normal gravity force of 1 g acting on you. For some people, this force of 1 g is nearly too much and they lie around a lot. (If you are reading this while on a carnival ride, or while being fired in an ejection seat, ignore the first sentence in this paragraph.)

In a constant-altitude, properly coordinated, 60°-banked turn, you and the airplane will be under an acceleration force (load factor) of 2 positive g's (Figure 1-1).

The 2 g's you experience in the 60°-banked turn are *positive*; that is, they are working on you and the airplane from top to bottom. The 1 g you are experiencing every day is also positive. However, people who hang around on tree limbs by their legs (with their heads down) have 1 negative g working on them because gravity is working from their feet to their heads. When you and the airplane are flying upside down in steady level flight, you have a 1 negative g working on you (Figure 1-2).

If you are pulling +3 g's in the airplane (say, in doing a loop), every part of your body weighs 3 times your normal weight and your blood will tend to move down into your legs and feet.

At higher positive accelerations, the draining of blood from the head can temporarily cause a grayout (some loss of vision), a blackout (total loss of vision), or finally, loss of consciousness. The maneuvers you'll be doing in this course, however, will not exceed +4 g's and you will probably not notice any effects. For instance, if you are an average pilot, +2 or +3 g's will give you the sense of being firmly pushed in your seat and your hands and feet will feel heavy if you try to move them. At +4 g's you get good evidence that acceleration forces are at work. Things get a little gray if you are relaxed and your cheeks feel like they are sagging.

Wait a minute! The last paragraph said no effects would be likely to be noticed at +4 g's. This is true. The pilot, who's doing the flying, doesn't notice the effects of acceleration forces like a passenger does. The pilot is concentrating on the maneuver and may be tensed up a bit; the other occupant, having nothing to do but watch the changing of directions of flight, may start to gray out. The pilot will likely feel no effects at all, which brings up a good point: You can raise your tolerance by tensing up your muscles, particularly your stomach muscles. Navy dive bomber pilots in World War II used to yell as they pulled out of a dive; this tensed the muscles nicely, but probably did nothing for the peace of mind of the gunner, since he was facing backward and couldn't see what was going on.

At about +6 g's the average pilot will have just about no vision and with *extended* time might lose

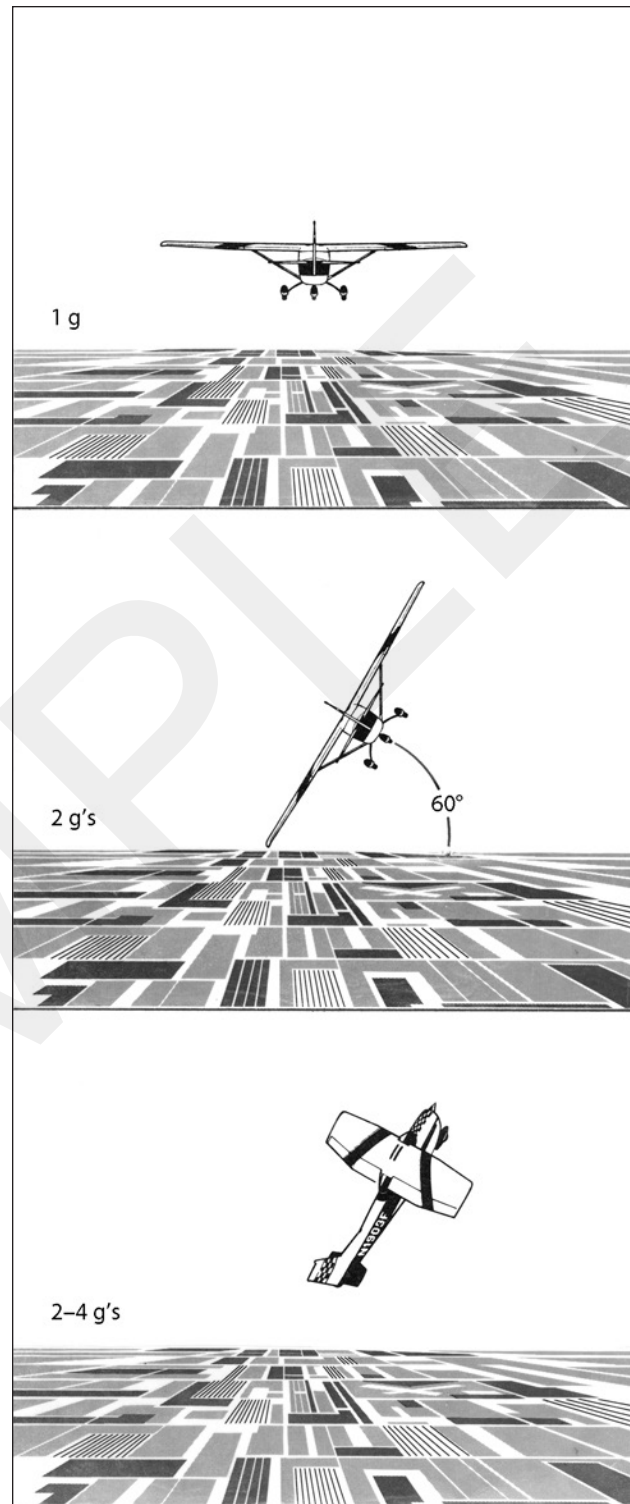
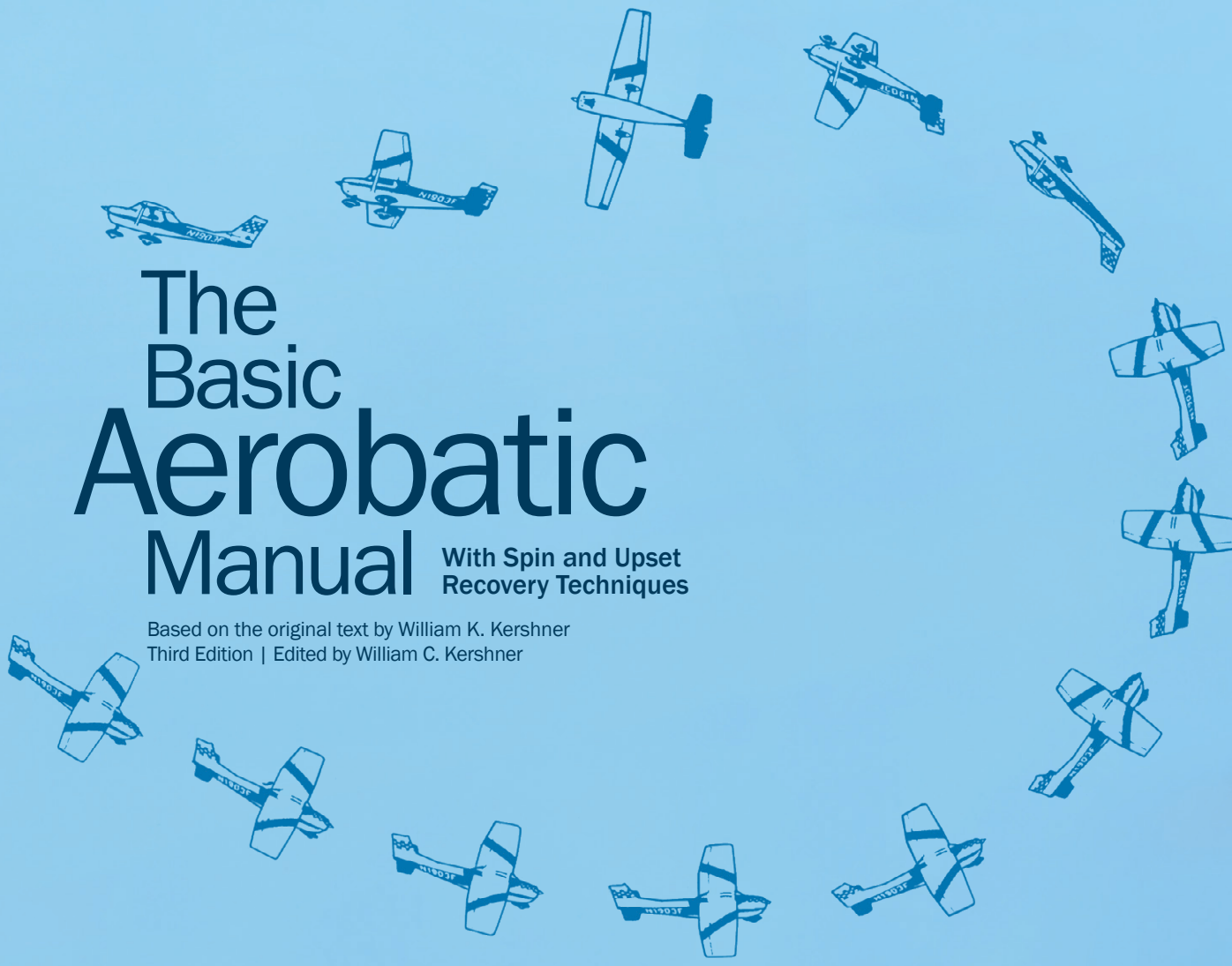


Figure 1-1. Acceleration forces (g's) in various flight maneuvers.

consciousness—but you won't be going to that high a g force in an introductory course.

Negative g's are harder on you than positive g's, and your tolerance will be less. At -2 or -3 g's your face feels full and a headache is in the offing. You are



The Basic Aerobatic Manual

With Spin and Upset Recovery Techniques

Based on the original text by William K. Kershner
Third Edition | Edited by William C. Kershner

The Basic Aerobatic Manual, Third Edition, is a complete reference for the beginning aerobatic student, with invaluable unusual attitude and spin recovery information for the more straight-and-level flyer. This book emphasizes techniques for the Cessna Aerobat models, but the described maneuvers easily translate to other aerobatics-certified airplanes.

Starting with stalls, chandelles and lazy-8's, the student is guided through spins and the Three Fundamentals of basic aerobatics: the aileron roll, loop, and the snap roll. Once these basics are learned, the combination maneuvers (the cloverleaf, for example) are covered in-depth.

This third edition includes a new chapter on loss of control in-flight (LOC-I), the leading cause of fatal general aviation accidents, to complement the chapter on unusual attitudes (upset) recovery for pilots especially focused on flight safety. Returning to controlled flight solely by reference to instruments is examined closely. The chapter on spins and spin recovery benefits from the knowledge gained in over 7,000 spins, each having from 3 to 25 turns, in the Cessna Aerobat.

William K. Kershner started his solo aerobatic career in a Stearman N2S at the age of 17. As a flight instructor, he later operated an aerobatic school in Sewanee, Tennessee using a Cessna 152 Aerobat, until his death in January 2007.

Other books by William K. Kershner:

The Student Pilot's Flight Manual
The Instrument Flight Manual
The Advanced Pilot's Flight Manual
The Flight Instructor's Manual
Logging Flight Time (aviation stories)



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