



IAC

AEROBATICS

IN RVs

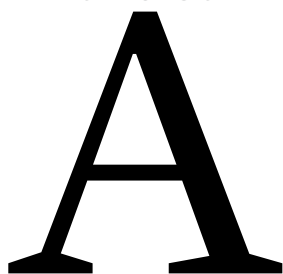
FOR PILOT ENJOYMENT AND PROFICIENCY



BY DICK "VAN" VANGRUNSVEN



RV AEROBATIC HISTORY



Almost as long as I can remember, I've had an interest in aerobatic flight. As a kid growing up in the '40s and '50s, World War II fighter planes and then the first-generation jets were of endless fascination. They were not only fast but also powerful and maneuverable. So, it was only natural that after learning to fly I would attempt aerobatics in our Taylorcraft. Though humble loops and spins were not the realm of fighter pilots, it added a bit of spice to otherwise plodding along at 90 mph.

As life evolved, when I was able to apply my engineering education to the design of homebuilt planes, they emerged as mid high-performance aerobatic sport planes. "Homebuilts" and "aerobatics" were almost synonymous terms then, as typified by most of the homebuilt biplane designs that dominated in the '60s and '70s. Many of the fast cross-country designs, like the Glasairs, RVs, and Lancairs, that followed were also aerobatic.

However, the term aerobatic is rather broad, encompassing any form of maneuvering from the most basic FAA definition to extreme air show and Unlimited competition aerobatics. RV aerobatics qualify somewhere around mid-range, best described as sport or perhaps recreational aerobatics. Beyond exhibition, aerobatics has two general areas of appeal: pilot enjoyment and proficiency. The enjoyment aspect is subjective in that some pilots enjoy the freedom of motion and visual excitement, while others find aerobatics to be uncomfortable and, yes, sickening. The proficiency aspect is more objective because, through learning and practicing aerobatics, pilots can gain skills that better prepare them to handle unusual attitudes that they might accidentally encounter in routine flight. Through aerobatic training, pilots explore the limits of both their aircraft and themselves, and thereby become safer pilots.

Most models of RVs are aerobatic; they were designed for that purpose. They have rapid control response rates for aggressive maneuvering, enough power for good aerobatic performance, and the structural integrity needed to withstand aerobatic flight loads. Relative to most GA aircraft, RVs handle so well and maneuver so easily that pilots can become overconfident before their skills have developed. This can lead to situations where pilots can exceed their limits of judgment and skill, and/or the performance limits of their airplanes. For this reason, it is essential that before attempting aerobatics in an RV, pilots should thoroughly familiarize themselves with their aircraft and get dual aerobatic instruction from a competent instructor.

Van's Aircraft has always promoted its airplanes as aerobatic, and I regularly flew aerobatic air show routines in them for more than 30 years. Despite this, Van's had historically taken a reserved position about the use of RVs in competition aerobatics. This position was

largely based on my personal experience and preferences many years ago. Also, over most of the 40-plus years that builders have been flying their RVs, only a small number have shown interest in competition aerobatic flying.

Two factors conspired to affect my reservations: the specific required maneuvers in some competition categories, and the aerobatic zone, or box. During air show exhibitions, I could use the RV's high-speed energy to my advantage for more demanding maneuvers. The same maneuvers performed during competitions would need to be compressed to fit in the box. If similar entry speeds were maintained, higher g-loads would be imposed.

Most early RVs were equipped with high-pitch props suited to their high cruise speeds. Thus, at lower speeds better suited for flying in the box, these planes were at a disadvantage in vertical maneuvers. My concern was that pilots would try to use their high-speed energy and thus impose high g-loads in an effort to maneuver aggressively enough to stay in the box. This was in the days when the Pitts Special was king, and was perceived to be indestructible. Hard pushing, pulling, and kicking of the controls appeared to be the norm. I didn't want RVs to be abused in this manner. Quite frankly, my reserved position was greatly influenced by statements heard from, and apparent attitudes of, competition pilots. Comments like "Use bigger engines" and "Make them (airframes) stronger" indicated that some pilots had little respect for known and published design limits. I didn't want to encourage the use of RVs in that environment.

Whether my reaction was right or wrong, I had reasons for my reservations about competition aerobatic use of my designs. In keeping with our "total performance" mantra, RVs are meant for general purpose sport flying that could include aerobatic flight, but excelling in competition aerobatics was never a primary design goal.

AIR SHOW AEROBATICS

In air show exhibition flying, I was able to use my RV's speed/inertia to my advantage and show what I felt to be the maximum maneuvers my planes were capable of, without any pressure to exert high g-loads due to space constraints. Also, as their name implies, air shows are about showmanship and audience appeal. Competition aerobatics require a high degree of discipline, accuracy, and precision. In retrospect, I now realize that it is much easier to "look good" in air shows than in competition.

VAN'S AIR SHOW ROUTINE

For more than 30 years I flew local and regional air show performances in my RV-1, RV-3, RV-4, RV-6, and RV-8. My interest in flying air shows was primarily that of enhancing kit sales by demonstrating their aerobatic capabilities. It was a great experience, and I savor many fond memories of those times.

During the majority of my time flying air shows, my planes were not equipped with inverted fuel and oil systems. This limited me to mostly positive g maneuvers and required a certain finesse to make rolling maneuvers look good without starving the engine. Normal routines included all of the basic rolls, hesitation rolls, and loop maneuver combinations. To highlight the performance acumen of my planes, I included some things like:

Loop within a loop: A large open loop with a small tight loop (inverted to inverted) at the top, followed by a large open downline.

Vertical 8: With a gravity-fed engine, this consisted of a tight Immelmann turn followed immediately by a loop, half-roll, and a completion of the lower half-loop.

High speed/low speed: When flying a two-plane act, we would make a 50 mph slow flight pass with one plane while the other zipped past at 200-plus mph, leaving no doubt about the wide speed range, one of our "total performance" trademarks.

I always tried to keep end zone turn-arounds as close in as possible to maximize the action. I also tried to avoid repeating maneuvers just for the sake of filling a longer time slot. As air show planes became more spectacular, my RVs couldn't match their performance. Thus, I concentrated more on appealing to the interest of pilots who could

appreciate the aerobatic performance of these more-or-less general purpose sport planes, rather than appealing to the "smoke and thunder" spectators. In general, my routines were along the lines of gentleman's aerobatics, with a modest noise level and graceful maneuvers.

AIRFRAME DESIGN LIMITS

All RV models rated for aerobatics have g-ratings of +6g and -3g, at an aerobatic gross weight considerably below their specified maximum gross weight. The maximum gross weight limit specifications of E-AB aircraft are sometimes altered by the homebuilder. Often this is done to gain back useful load that had been lost to the high empty weights of their "as built" planes. As the registered manufacturer of the individual E-AB aircraft, the homebuilder has the authority to do this, whether or not there is any structural substantiation for doing so. Particularly because the airframe strength of an E-AB aircraft has not been verified, as it has been for certificated aircraft, any arbitrary builder alteration of aerobatic gross weight limits should never be done. Some individual RVs may not be able to carry two pilots and remain within factory specified aerobatic gross weight limits.

Every airplane is a compromise. If built and equipped for luxurious cross-country cruising, airframe weights often grow and aerobatic useful loads and performance diminish. The best aerobatic RVs are the lightest RVs.

FUEL WEIGHT

All aerobatic RVs, other than some examples

All RV models listed by Van's Aircraft as having aerobatic structural limits are suitable for IAC Primary and Sportsman level competitions, and even Intermediate level in the hands of more experienced pilots.

of the RV-3 with fuselage fuel, have wing fuel tanks. There is a common misconception that fuel weight carried in wing tanks does not affect the bending loads on wing spars or other flight components, and that it need not be included in aerobatic gross weight calculations. While the weight of fuel carried in the wings does affect some aspects of the wing bending moment, it cannot be dismissed as having no adverse effect. Van's Aircraft's stated position is that the gross aerobatic weights specified include the fuel weight, whether it is in wing or fuselage tanks.

SNAP ROLL MANEUVERS

RVs are capable of performing snap rolls, but these tend to be less crisp and of a lower roll rate than many other aerobatic aircraft. Also, I found that when trying to improve their crispness by performing them at near maneuvering speed limits, more than 4g was experienced. Since this was a higher level than I was comfortable with, I saw this as one more deterrent to competition flying. I did not include snaps in my air show



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routrines other than when done at low speeds, such as at the tops of loops. I feel safe saying that regardless of pilot skills, RVs cannot perform crisp snap rolls like those routinely exhibited by new aerobatic designs. That said, some competition aerobatic pilots have shown that RVs can do snap rolls satisfactorily for requirements of the Intermediate class. Snap rolls are not required in Primary or Sportsman classes, so this should not be viewed as an obstacle to participation.

TAIL SLIDES

Intentional tail slides are not recommended. RV tail surfaces have not been designed or tested for reverse loadings that may be encountered during extended tail slide maneuvers. Hammerhead turns, essentially zero-airspeed maneuvers, are acceptable as they are not intended to induce reverse direction airflow over the tail surface. The reason is that during hammerhead turn maneuvers, a positive airflow from the propeller slipstream is anticipated over the tail surfaces at all times. Since tail slides are not required maneuvers up through Intermediate class, this caution should not be a deterrent to RVs in IAC competitions.

AFT CG

All RV models have specified aft CG limits for aerobatics in addition to the limits specified for nonaerobatic flight. Flown solo, remaining within the aft aerobatic limit should not be a problem. However, when flown with both seats occupied, remaining within the aft limits needs to be carefully monitored. Variation in the aircraft's engine, prop, interior appointments, and even paint density can affect the empty CG position. Obviously, the weights and moments of the pilots and parachutes need to be carefully calculated. It is entirely possible that with both seats occupied, some RVs will not be within aerobatic CG limits unless occupied by very light pilots. This is a physical reality

resulting from the above factors, and no amount of wishful thinking or cursing the designer will alter this fact. For CG reasons, some individual RVs may not be suitable for dual aerobatic flight.

TIP-UP CANOPY JETTISON

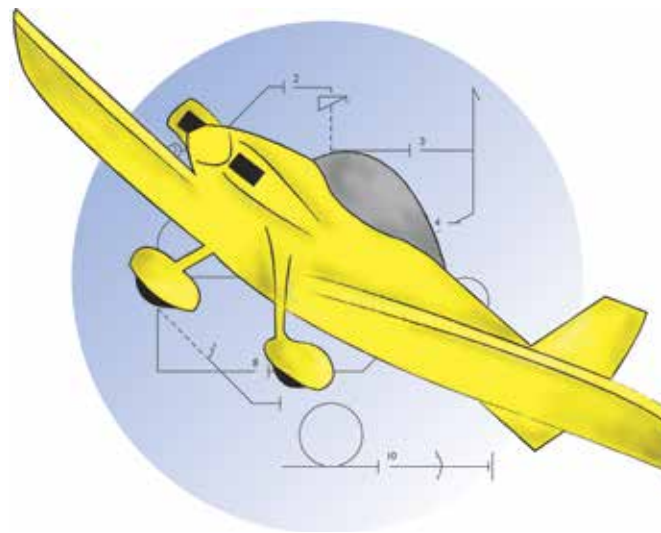
The design of the forward-hinged tip-up canopy used on the RV-6 and RV-7 includes an emergency jettison feature. To our knowledge, this feature has never been used in an actual emergency. Some builders of the RV-6 and RV-7 have not installed, or have compromised, this feature through builder deviation from the construction drawings. Aerobatic pilots concerned about the possible need to use this feature need to be sure their specific aircraft is in compliance with the design. The IAC requires that competition aircraft with tip-up canopies are to have an emergency jettison feature. Also, because most RV-6/7 canopies use lift struts to assist opening, these struts should be disconnected or removed before competition aerobatic flight, to permit the canopy to easily separate from the fuselage after the jettison mechanism has been activated. The RV-14 tip-up canopy design is such that the lift struts are independent of the jettison mechanism, so they need not be disconnected.

SPINS

Van's recommends limiting spins in RV-6, RV-7, and RV-14 aircraft to two turns or less. This is because after two turns the rotation rate is high, causing the recovery to take longer and to be more difficult to stop on a heading. In addition, the rapid spin rotation rate can have a disorientating effect on pilots. Since Primary and Sportsman mandatory sequences do not require spins of greater than one-and-a-half turns, this should not pose a limitation.

SUMMARY

All RV models listed by Van's Aircraft as having aerobatic structural limits are suitable for IAC Primary and Sportsman level



WANT MORE AEROBATICS?

ARE YOU BORED WITH "straight-and-level"? Do you think you might be happier upside down? If so, you'll want to check out the International Aerobatic Club, the EAA division dedicated to promoting and enhancing the safety and enjoyment of aerobatics. Whether you fly aerobatics for fun or in competition, or if you want to, or even if you simply like to watch, we invite you to consider adding the International Aerobatic Club to your EAA membership. For more information, visit www.EAA.org/iac.

competitions, and even Intermediate level in the hands of more experienced pilots. This assertion presupposes that the aircraft are not significantly overweight and have not been constructed with airframe modifications that have affected structural integrity or imposed maneuvering or controllability limitations. Another important point is that pilots remember that RVs should not be considered suitable for strenuous competition aerobatics and should not be flown at competition levels likely to impose g-loads in excess of design limits. In the lower levels of aerobatic competition, skilled and precise flying can produce high scores without requiring complex maneuvers and excessive g-loads. With this as a goal, pilots can gain this added level of enjoyment and use from their very versatile RV-3Bs, -4s, -6s, -7s, -8s, and -14s.

Earlier I mentioned that the performance and handling qualities of RVs can cause new (to RVs) pilots to become overconfident and attempt aerobatics beyond their skill levels. Self-taught and impromptu aerobatics can be extremely hazardous. The laws of gravity and the solidity of the Earth are terribly unforgiving. Over the years there

have been many, many lives lost in RVs resulting from impromptu low-level aerobatics and related reckless flying. There is only one way to do aerobatics, in RVs or otherwise, and that is the right way. The IAC approach is definitely one of the few right ways. In contrast to the “cowboy aerobatic” accidents mentioned, IAC accidents are very

rare. Do it right, have a lot of fun, and become a safer pilot. *EAA*

Dick “Van” VanGrunsven, EAA 3204, is the founder of Van’s Aircraft and the designer of the RV series of kit planes. His EAA membership traces back to 1957 when he was 17 years old. He has been flying homebuilts since 1962 and his own designs since 1966.

PREPARING YOUR RV FOR AEROBATICS

BY RON SCHRECK

Properly preparing your RV for aerobatics varies depending upon the level of aerobatics you intend to fly. Recreational or sport aerobatics require a minimum of equipment, while success at the higher levels will require a greater investment. When you finish reading this you should be able to make three lists: stuff I need, stuff I don’t need, and stuff that would be nice to have someday when I have the time and/or money.

Note: Equally important to preparing your airplane for aerobatics, preparation of the pilot should not be overlooked. An excellent resource for pilot preparation can be found at www.EAA.org/sportaviation under This Month’s Extras. So, let’s discuss the items you may consider when equipping your RV for aerobatics.

PARACHUTES

While there is no FAR requirement for a solo pilot to wear a parachute during aerobatic flight, when carrying a passenger both the pilot and passenger must wear an approved parachute. Pilots flying at IAC events are always required to wear a parachute.

Most RV pilots seem to prefer the backpack chutes. Even after removing the seat back cushion the backpack chute does place you slightly closer to the instrument panel, but most adapt to the new seating position quickly. Many RV-4 pilots, by exception, prefer the seat pack chute as the backpack puts them even closer to a panel that many feel is too close to begin with. The seat pack chute is quite hard, and you may add some cushioning on top of the pack if headroom allows. While a new chute is a significant investment, a used chute in good condition may be a real bargain. There is an urban legend that states that a parachute has a service life of 20 years, but this has no basis in fact. Continued service life of any given parachute is to be established by a certificated parachute rigger and is based upon the condition of the parachute and compliance with established standards without regard for its age.

CANOPY RELEASE MECHANISMS

Of course there is no point in having a parachute if you can’t get out of the airplane in flight. See Van’s article for the specifics of RV canopy release mechanisms.

ATTITUDE REFERENCE SYSTEMS

Aerobatics are done with respect to outside visual references so attitude instruments are of no use, and they will likely tumble after a loop or two anyway. Electric and mechanical attitude instruments, even when caged, can become damaged so it may be advisable to remove the instrument before flying aerobatics. EFIS attitude presentations may also tumble but no harm to the instrument should result. If you fly aerobatics often, it may be advisable to replace your mechanical or electric gyro with a mini EFIS.

G-METER

Knowing your g-loading during aerobatic flight is extremely important. Most pilots eventually learn to know what a 4g

pull feels like without reference to the g-meter, but more aggressive maneuvering requires closer attention to the instrument. Mechanical g-meters, once widely used, are now often replaced by cheaper and more versatile electronic meters like the popular GT-50 from Flight Data Systems.

FUEL INJECTION AND INVERTED FUEL SYSTEMS

Carbureted engines can be flown in recreational aerobatics and even in competition! The carbureted engine will quit producing power immediately when subjected to negative g’s but will resume normal operation once under positive g with a windmilling propeller; this is not detrimental to the engine. Many aerobatic maneuvers can be flown while maintaining positive g. While some figures in competition require momentary negative g to be technically correct, they can be flown entirely under positive g with some deduction by the judges. The serious competitor will want fuel injection to maintain full engine power in all phases of flight. An inverted fuel system with a flop tube in the fuel tank is not necessary. There are no IAC figures that require inverted flight beyond a few seconds, and that’s not long enough for an injected engine to stumble due to fuel starvation. On the other hand, installation of a flop tube in one or both tanks is not a difficult or expensive job.

INVERTED OIL SYSTEM

You should consider some sort of inverted oil system to protect your engine if your aerobatics involve zero or negative g maneuvering. While momentary loss of oil pressure is unlikely to cause any damage to your engine, it will invariably cause loss of oil through the vent tube and make a real mess of your RV’s belly. If you have a constant-speed propeller, loss of oil pressure can cause the propeller to drive to low pitch, which may cause the engine to overspeed. If you have a fixed-pitch propeller and your only concern is to minimize oil loss, installation of an oil separator or only the canister portion of a Christen or Raven inverted oil system may suit your need. A small oil accumulator of the type commonly used on race cars can provide oil pressure during brief periods of negative or 0g flight. Of course for more complete protection from oil pressure loss a full inverted oil system is appropriate.

CONSTANT-SPEED PROPELLER

There are many aerobatic airplanes that do just fine with a fixed-pitch propeller, and the RV is no exception. Considering the cost and complexity of a constant-speed propeller it may be the last thing to consider when equipping for aerobatics. There are two basic types of constant-speed propellers to consider, and the difference is the action of the propeller when oil pressure is momentarily lost. An aerobatic constant-speed propeller uses counterweights on the prop hub to force the blades to high pitch when oil pressure is lost. A non-aerobatic propeller does not have counterweights, and the blades will drive to low pitch when oil is lost and an engine overspeed can result. Aerobatic constant-speed propellers are heavier, more complex, and costlier than nonaerobatic types, which are more commonly preferred.

SIGHTING DEVICE

Aerobatics are flown primarily with reference to the horizon, and most aerobatic figures require the aircraft to be flown along a precise line on a vertical, horizontal, or 45-degree climbing or descending line in reference to the horizon. You will see a variety of sighting devices on one or both wings of most competition aircraft that aid the pilot in positioning the aircraft on the correct line. The serious competitor can fashion a homemade device out of bits of aluminum and carbon fiber arrow shafts. A simple alternative that serves quite well is simply to apply automotive striping tape to the canopy at appropriate angles.

RATCHETING LAP BELT

Normally a ratcheting lap belt is the second belt in a dual seat belt harness system. Per the IAC rules:

“Dual seat belts with separate attach points and a shoulder harness are mandatory for Advanced and Unlimited (power and glider) categories. The same equipment is strongly recommended for Primary, Sportsman, and Intermediate power categories, but is not mandatory except when IAC Technical Monitors deem them necessary for the sequence being flown in these categories.”

I have found that the ratcheting seat belt that I have installed in my RV is the one piece of equipment that has contributed the most to my advancement in aerobatic skill level and enjoyment of the sport! When I tighten that ratchet I no longer just sit in my RV, rather I put it on and the airplane becomes an extension of my body.

A FINAL INSPECTION

As important as equipment is, it is equally important that the aircraft be properly maintained and a thorough inspection of the aircraft be performed prior to aerobatic flight. Prior to practicing or competing at an IAC event your aircraft will be inspected by a designated IAC technical inspector who will use the IAC Official Technical Inspection Form as a guide for inspecting your aircraft.

SUMMARY

How you equip your RV for aerobatics can be approached the same way you may have approached the purchase or build of your RV. First, determine the mission, and if there are multiple missions, determine their priorities. A lucky few may have the resources to equip for serious competition without delay. If your resources are limited or you are unsure if aerobatics is right for you, a more measured approach may be suitable. Whatever you decide and however you proceed, do it with safety always on your mind. If you are up for a challenge, aerobatics may just be what you are looking for. *EAA*

Ron Schreck, EAA 662612, is a former USAF fighter pilot, airline captain, and air show performer. He has more than 13,000 hours’ flight time, with 2,000-plus in his RV-8. Ron is an IAC regional judge and flies his RV at the Sportsman level of IAC competition.