U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: FLIGHT TEST GUIDE FOR CERTIFICATION OF PART 23 AIRPLANES

Date: 2/9/89 **Initiated by:** ACE-100 **AC No:** 23-8A **Change:**

1. PURPOSE.

a. This advisory circular (AC) provides information and guidance concerning acceptable means, but not the only means, of showing compliance with Part 23 of the Federal Aviation Regulations (FAR) concerning flight tests and pilot judgments. Accordingly, this material is neither mandatory nor regulatory in nature and does not constitute a regulation.

b. This AC is one method being utilized to achieve national standardization in normal, utility, acrobatic, and commuter airplane certification.

c. This material is intended as a ready reference for Part 23 airplane manufacturers, modifiers, Federal Aviation Administration (FAA) design evaluation engineers, flight test engineers, and engineering flight test pilots, including Delegation Option Authorization (DOA), Designated Alteration Station Authorization (DAS), and Designated Engineering Representative (DER) personnel.

2. CANCELLATION. AC 23-8, Flight Test Guide for Certification of Normal, Utility, and Acrobatic Category Airplanes, dated October 20, 1987, is cancelled.

3. GENERAL. This AC covers flight test items of interest during type certification. Other engineering disciplines, such as airframes, systems and equipment, and propulsion are addressed as they pertain to flight test criteria.

4. BACKGROUND. AC 23-8, Flight Test Guide for Certification of Normal, Utility, and Acrobatic Category Airplanes, was published to replace FAA Order 8110.7, Engineering Flight Test Guide for Small Airplanes, dated June 20, 1972, and to consolidate existing flight test policy. AC 23-8 did not cover commuter category airplanes.

5. APPLICABILITY.

a. These methods and procedures are promulgated, in the interest of standardization, for use during all normal, utility, acrobatic, and commuter category airplane flight test certification activities. This material is not to be construed as having any legal status and must be treated accordingly. The procedures set forth herein are one acceptable means of compliance with applicable sections of Part 23.

(4) Margin. The stall warning margin between 5 knots and the greater of 10 knots or 15% of the stalling speed, is applicable when the speed is reduced at the rate of one knot per second. Stall warning margin at greater deceleration rates should not be less than 5 knots above the stall or above a speed at which warning would become objectionable in the normal operating range.

b. Procedures. The stall warning tests should be conducted in conjunction with the stall tests required by §§ 23.201 and 23.203.

c. Data Acquisition and Reduction. The speed at which stall warning is obtained should be recorded. This speed should be compared to the corresponding stall speed for the required stall warning margin of between 5 and the greater of 10 knots or 15% of the stalling speed above the corresponding stalling speed.

90.-99. RESERVED.

Section 8. SPINNING

100. SECTION 23.221 (as amended by amendment 23-7) SPINNING.

a. Explanation.

(1) Spin. A spin is a sustained auto rotation at angles of attack above stall. The rotary motions of the spin may have oscillations in pitch, roll and yaw superimposed upon them. The fully-developed spin is attained when the trajectory has become vertical and the spin characteristics are approximately repeatable from turn to turn. Some airplanes can autorotate for several turns, repeating the body motions at some interval, and never stabilize. Most airplanes will not attain a fully-developed spin in one turn.

(2) Category Spins. Section 23.221 addresses four situations:

(i) Normal category spins.

(ii) Utility category spins.

(iii) Acrobatic category spins.

(iv) Airplanes characteristically incapable of spinning.

(3) Incapable of Spinning. If an airplane cannot be induced to spin, it may be considered "characteristically incapable of spinning." Section 23.221(d) gives the conditions of the test for this type of airplane.

(4) Utility Category Spins. Utility category airplanes must meet the spin requirements of either the normal or acrobatic category. Thus, the spin requirements reduce to either normal or acrobatic category requirements, each with its own objectives and tests.

b. Discussion and Procedures Applicable to Both Normal and Acrobatic Category Spins.

(1) Weight and C.G. Envelope. See paragraph 7a of this AC for discussion of weight and c.g. envelope exploration.

(2) Control Deflections. Control surface deflections should be set to the critical side of the allowable tolerances, for example, if the rudder deflection is $20^{\circ} \pm 2^{\circ}$ left and right, it should be rigged at 18° left and right for the testing if the recovery phase is critical or 22° left and right if the entry phase is critical.

(3) Emergency Egress. It is the responsibility of the applicant to provide adequate provision for crew restraint, emergency egress and use of parachutes (reference § 21.35(d)).

(4) Chutes and Ballast. A spin chute that has been structurally and functionally tested is recommended. NASA Technical Paper 1076, "Spin-Tunnel Investigation of the Spinning Characteristics of Typical Single-Engine General Aviation Airplane Designs," dated November 1977, may be of assistance in sizing the spin chute. In the past, rapidly movable jettisonable ballasts have been suggested but this may not effect recovery in practical use. Final certification of the spin characteristics should be conducted with the external spin chute removed unless it is determined that spin chute installation has no significant effect on spin characteristics.

(5) Build-Up. When any doubt exists regarding the recovery characteristics of the test airplane, a build-up technique should be employed consisting of spin entries and recoveries at various stages as the maneuver develops. Excessive aerodynamic control wheel back pressure indicates a possibility of unsatisfactory spin characteristics. Any control force lightening or reversal is an indication of possible deep stall entry. See subparagraph c(7) for definition of excessive back pressure. A yaw rate instrument is valuable in detecting progress toward a fully-developed spin condition or an uncontrollable maneuver. Unusual application of power or controls has sometimes been found to induce uncontrollable spins. Leading with elevator in recovery and cutting power as the airplane rolls into a spin have been known to induce uncontrollable spins.

(6) Entry. Spins should be entered in the same manner as the stalls in §§ 23.201 and 23.203 with trim at 1.5 V_{S1} or as close as practical. As the airplane stalls, with ailerons neutral, apply full-up elevator and full rudder in the direction of spin desired. Refer to paragraphs 100c and 100d for further discussion of spin entries.

(7) Recovery. Recoveries should consist of throttle reduced to idle, ailerons neutralized, full opposite rudder, followed by forward elevator control as required to get the wing out of stall and recover to level flight, unless the manufacturer determines the need for another procedure.

(8) Trimmable Stabilizer. For airplanes that trim with the horizontal stabilizer, the critical positions should be investigated.

(9) Altitude Engines. For airplanes with high-altitude engines, the effect of altitude should be investigated.

(10) Initial Investigation. In all cases, the initial spin investigation should be accomplished at as high an altitude above the ground as reasonably possible and a predetermined, pre-briefed "hard" altitude established to be used as the emergency egress altitude. In other words, if the airplane cannot be recovered by that altitude, all occupants should exit the airplane without hesitation. The altitude selected should take into account the opening characteristics of the parachutes, the difficulty of egress, the estimated number of turns to get out and the altitude loss per turn, the distance required to clear the airplane before deploying the parachutes, etc.

c. Discussion and Procedures Applicable to Normal Category Spins.

(1) Objective. The basic objective of normal category spin testing is to assure that the airplane will not become unrecoverable within one turn if a spin should be encountered inadvertently and that recovery can be effected without exceeding the airplane design limitations. Type certification testing requires recovery capability from a one-turn spin while operating limitations prohibit intentional spins. This one-turn "margin of safety" is designed to provide adequate controllability when recovery from a stall is delayed. Section 23.221(a) does not require investigation of the controllability in a true spinning condition for a normal category airplane. Essentially, the test is a check of the controllability in a delayed recovery from a stall. Intentional, inadvertent, normal, and accelerated stalls should be considered.

(2) Uncontrollable Spins. Uncontrollable spins for normal category airplanes are defined as spins that persist after normal recovery control application is completed and one additional turn has passed. For example, if you are spinning left with right aileron (abnormal controls), recover by reducing power to idle, neutralize the ailerons, apply full right rudder followed by forward elevator. At this point, start the count (heading, ground reference, etc.) for one turn. If the manufacturer's recommended spin recovery procedure has a contingency step, such as, "apply forward elevator after rotation stops," then the count should start after the rotation stopping control is applied.

(3) Abnormal Control. The "abnormal" use of controls should not cause the airplane to become uncontrollable. "Pro-spin" is used to describe the use of the controls in the direction of the spin and is considered normal use of the controls; i.e., spinning left with left aileron, full back elevator, full left rudder and power on. "Anti-spin," "aileron against," and "abnormal use of controls" is control usage that is opposite the normal usage of controls. These conditions of control position would be expected to reduce the tendency to spin but, in fact, may aggravate or make the spin worse. The intent of all these tests is to induce all of the types of control usage, whether they are right or wrong, that might be used during the operation of the airplane. Ailerons with and against the spin should be applied at entry and during spins. Elevator and rudder against the spin should be applied during the spin.

(4) Spin Matrix. The effects of gear, flaps, power, accelerated entry, and control abuse should be investigated. A suggested matrix for spin investigation is given in figure 100-1. It is the responsibility of the applicant to explore all critical areas. It may be possible to eliminate the need to conduct some of the additional conditions once the airplane responses are known.

(5) Flaps. Flaps may be retracted after rotation ceases and the dive and pull-out are entered.

(6) Power. For power on normal category spins, the throttle can be reduced to idle after one turn.

(7) Back Pressure. Excessive back pressure is cause for noncompliance. Excessive back pressure is a judgment item and is defined as excessive force required to pitch the airplane down in recovery. Back pressure should not interfere with prompt and normal recovery.

d. Discussion and Procedures Applicable to Acrobatic Category Spins.

(1) Objective. The basic objective of acrobatic category spin testing is to ensure that the airplane will not become uncontrollable when a spin is intentionally entered and:

(i) The controls are used abnormally (as well as normally) during the entry and/or during the spin;

(ii) the airplane will recover in not more than 1 1/2 turns after completing application of normal or manufacturer-prescribed recovery controls; and

(iii) no airplane limitations are exceeded, including positive maneuvering load factor and limit speeds.

(2) Pilot Training. It is assumed that the pilot of the acrobatic category airplane that spins for six turns is doing so intentionally. If spinning is intentional, the pilot should have had proper instruction and proficiency to effect a proper recovery. The pilot should be expected to follow the published procedure to recover from this planned maneuver.

(3) Uncontrollable Spins. Uncontrollable spins are defined as spins that persist after the normal recovery technique is applied and 1 1/2 additional turns have passed. The discussion of "abnormal" use of controls in paragraph 100c(3) also applies to acrobatic category spins.

(4) Spin Matrix. The effects of gear, flaps, power, accelerated entry, and normal and abnormal control use should be investigated. A suggested matrix for spin investigation is given in figure 100-1. It is the responsibility of the applicant to explore all critical areas. It is necessary to expand the matrix to cover six-turn spins. The normal procedure is to continue the same process and add one additional turn each time. It may be possible to eliminate the need to conduct some of the additional conditions once the airplane responses are known.

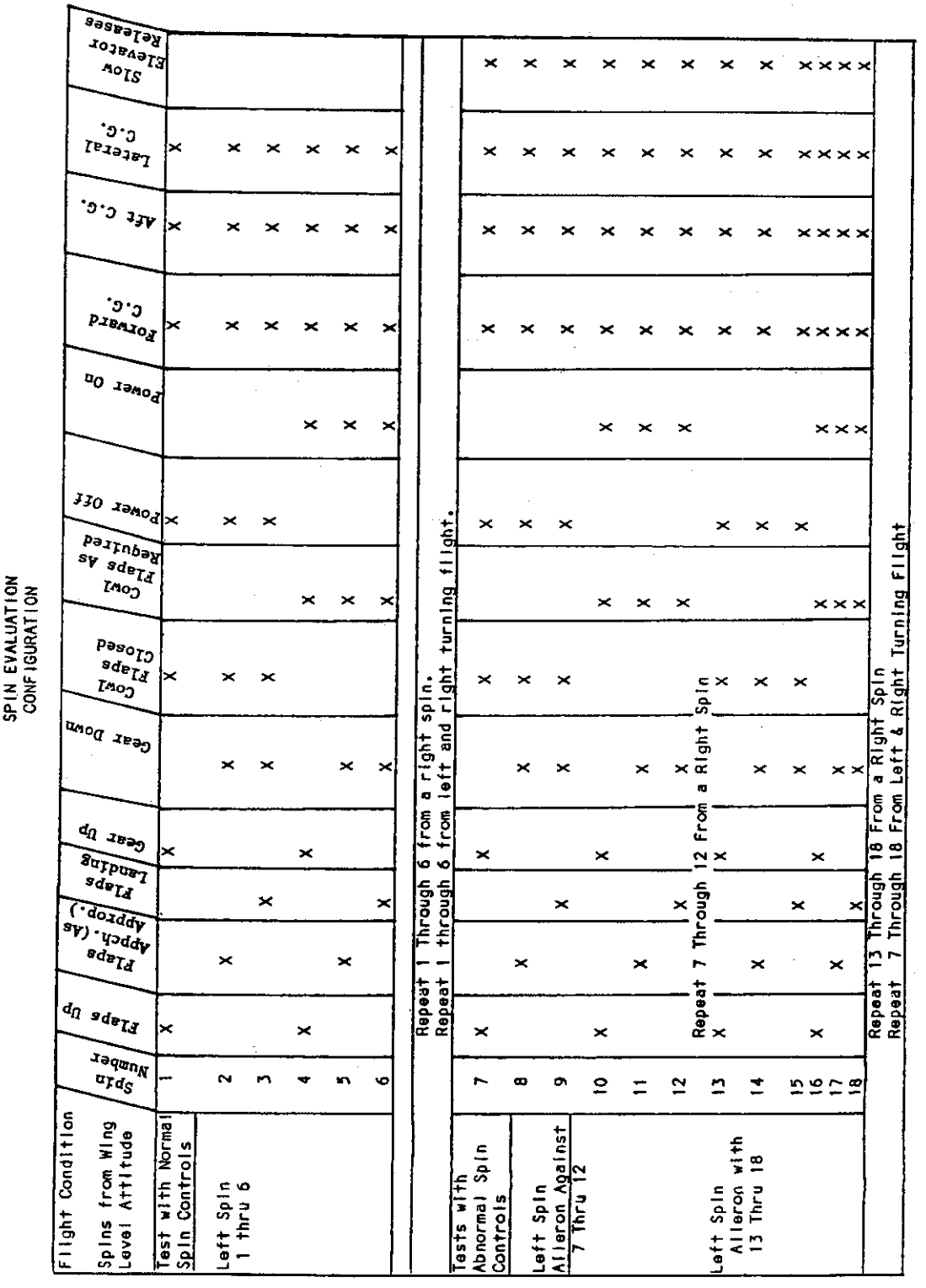

Figure 100-1 - SPIN EVALUATION CONFIGURATION MATRIX