



U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

**Subject: FLIGHT TEST GUIDE
FOR CERTIFICATION OF
PART 23 AIRPLANES**

Date: 11/16/2011
Initiated By: ACE-100

AC No: 23-8C
Change:

1. Purpose.

a. This advisory circular (AC) sets forth an acceptable means, but not the only means, of showing compliance with Title 14 of the Code of Federal Regulations (14 CFR) part 23 concerning flight tests and pilot judgements. Material in this AC 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 category airplanes. This AC applies to Subpart B and various sections under Subparts A, D, E, F and G from § 23.1 through § 23.1589. This AC consolidates existing policy documents, and certain ACs that cover specific paragraphs of the regulations, into a single document.

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 Organization Delegation Option (DOA).

2. Applicability.

a. The methods and procedures contained in this AC are available for use during all normal, utility, acrobatic, and commuter category airplane flight test certification activities. This material does not have any legal status and must be treated accordingly. The procedures set forth are one acceptable means of compliance with applicable sections of part 23.

b. Like all AC material, these guidelines are not mandatory and do not constitute a regulation. They came from previous FAA experience in finding compliance with the airworthiness requirements. They represent the methods and procedures found acceptable by that experience. Since these methods and procedures are only one acceptable means of compliance, individuals should be guided by the intent of the methods provided in this AC.

Any alternate means proposed by the applicant will be given due consideration. Applicants should contact their aircraft certification office (ACO) to determine the acceptability of proposed methods.

c. This AC covers the latest part 23 amendments through Amendment 23-62. Each paragraph has the applicable part 23 amendment shown in the title. Prior amendments may require separate procedures and guidance. Applicants should contact their ACO for information concerning policies applicable to prior amendments of part 23 and Civil Air Regulations (CAR 3).

d. Sections entitled "Reserved" will be filled in when the material is developed.

e. This AC is applicable only to the original applicant seeking issuance of a type certificate (TC), an amended TC, or a supplemental type certificate (STC) for the initial approval of the new type design or a change in the approved type design. This material is not to be construed as having any legal status and should be treated accordingly. This version of the AC covers policy available through November 16, 2011. Policy that became available after that date will be covered in future amendments to the AC.

3. Cancellation. The following AC is cancelled: AC 23-8B, Flight Test Guide for Certification of Part 23 Airplanes.

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

5. Background.

a. 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. AC 23-8A updated the original AC 23-8 by adding information and guidance for commuter airplanes. AC 23-8B updated the Flight Test Guide to incorporate information and guidance through 14 CFR part 23, Amendment 23-51. The AC also incorporated material harmonized with the European Joint Aviation Authorities (JAA).

b. The latest revision to the Flight Test Guide, AC 23-8C, contains guidance material for turbojets certificated under part 23. For almost two decades, part 23 jets used extensive special conditions to address the special issues associated with high performance, high altitude turbojet airplanes. However, in the past five years, the number of new jet certification programs in part 23 has increased more than 100 percent over the program numbers of the past three decades. The need to incorporate these special conditions into part 23 stems not only from the existing number of new jet programs, but expected future programs. This AC is updated to accompany the addition of jet requirements to part 23.

6. Paragraphs Keyed to Part 23. Each paragraph has the applicable part 23 amendment shown in the title. As part 23 changes occur, the appropriate revisions will be made to the affected paragraphs of this AC.

7. Related Publications. Certification personnel should be familiar with FAA Order 8110.4 "Type Certification," and FAA Order 8100.5A, "Aircraft Certification Service Mission, Responsibilities, Relationships, and Programs." In this AC, reference is made to other FAA ACs which provide guidance on various aspects of type certification and supplemental type certification. The documents listed below are provided as a quick reference source of documents that are acceptable for use in 14 CFR part 23 certification programs/projects.

a. Copies of current FAA ACs are available on the Internet at http://www.faa.gov/regulations_policies/advisory_circulars/

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|------|-----------|---|
| (1) | 20-67 | Airborne VHF Communications Equipment Installations |
| (2) | 20-124 | Water Ingestion Testing for Turbine Powered Airplanes |
| (3) | 20-118 | Emergency Evacuation Demonstration |
| (4) | 20-138B | Airworthiness Approval of Positioning and Navigation Systems |
| (5) | 23.629-1 | Means of Compliance with Section 23.629, Flutter |
| (6) | 23-1309-1 | System Safety Analysis and Assessment for Part 23 Airplanes |
| (7) | 23-1419-2 | Certification of Part 23 Airplanes for Flight in Icing Conditions |
| (8) | 90-79 | Recommended Practices and Procedures for the Use of Electronic Long-Range Navigation Equipment |
| (9) | 91-49 | General Aviation Procedures for Flight in North Atlantic Minimum Navigation Performance Specifications Airspace |
| (10) | 121-13 | Self-Contained Navigation Systems (Long Range) |
| (11) | 20-88 | Guidelines on Marking Aircraft Powerplant Instruments (Displays) |

- (12) 23-16 Powerplant Guide for Certification of Part 23 Airplanes and Airships
- (13) 23-17 Systems and Equipment Guide for Certification of Part 23 Airplanes
and Airships

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Earl Lawrence
Manager, Small Airplane Directorate
Aircraft Certification Service

(2) *Sawtooth Glides*. A method of determining glide performance is sawtooth glides. These glides can be flown using the same basic procedures in § 23.65 of this AC minus the power considerations. For simplification, the test need only be flown at an intermediate altitude and gross weight generating one speed for the pilot to use. The best lift over drag speed is frequently higher than the best rate of climb speed; therefore, the airspeed range to flight test may be bracketed around a speed 10 to 15 percent higher than the best rate of climb speed.

(3) *Performance Data*. A chart or table should be constructed for the AFM that presents the literal (over-the-ground) gliding distances for the altitude range expected in service, at the best demonstrated glide speed. As a minimum, a statement of nautical miles (NM) per 1,000 feet loss of altitude at the demonstrated configuration and speed at MTOW, standard day, no wind, should be given.

13. § 23.75 Landing.

a. Explanation.

(1) *Purpose*. The purpose of this requirement is to evaluate the landing characteristics and to determine the landing distance. The landing distance is the horizontal distance from a point along the flight path 50 feet above the landing surface to the point where the airplane has come to a complete stop, or to a speed of three knots for seaplanes or amphibians on water.

(2) *Companion Requirements*. Sections 23.143(a)(6), 23.153, 23.231, and 23.233 are companion requirements and, normally, tests to determine compliance would be accomplished at the same time. Additionally, the requirements of § 23.473 should be considered.

(3) *Approach and Landing*. The steady approach, the pilot skill, the conditions, the vertical accelerations, and the airplane actions in § 23.75(a), (b), and (c) are concerned primarily with not requiring particularly skillful or abrupt maneuvers after passing the 50-foot point. It has generally been considered that some power may be used during a steady gliding approach to maintain at least 1.3 V_{S1} control sink rate on final approach. For those airplanes using power during approach, power may be decreased after passing the 50-foot point and there should be no abrupt maneuvers using the longitudinal control. For those airplanes approaching with power off, the longitudinal control may be used as necessary to maintain a safe speed for flare. In both cases, there should be no change in configuration and power should not be increased. The landing distance and the procedure specified in the AFM are then based on the power used for the demonstration. The power used and the technique used to achieve the landing distances should be clearly stated in the AFM. This applies to portions of the approach prior to and after the 50-foot height.

(4) *Adverse Landing Conditions*. The airplane should be satisfactorily controllable when landing under the most unfavorable conditions to be encountered in service, including crosswinds, wet runway surfaces, and with one engine inoperative. Demonstration of landing with an adverse crosswind of at least 0.2 V_{SO} is addressed in § 23.233. Operations on wet (but not contaminated) runway surfaces have been simulated by disconnecting the nosewheel steering on large part 23 airplanes. The effect of weight on the landing distance due to its influence on controllability of reverse thrust should be considered. The criticality of the adverse landing conditions should guide the level of complexity applicants use in determining controllability. Existing flight test practices have proven adequate for propeller driven part 23 airplanes, but they may not be adequate for small jets. Additional guidance may be found in AC 25-7B. Part 23 jets typically have higher landing speeds and little drag to help slow the airplane. Landing

accidents dominate the non-fatal accidents for small jets. This is a critical phase of flight for small jets and adequate attention should be given to adverse landing conditions such as wet runways.

(5) *Landing Gear Loads.* Sink rate at touchdown during landing distance determination should be considered and should not exceed the design landing gear loads established by § 23.473(d).

(6) *Landing Distance Credit for Disking Drag and Reverse Thrust.* Most turboprop installations embody provisions for reduction of propeller blade pitch from the "flight" regime to a "ground" regime to produce either a significant level of disk drag or reverse thrust or both, following touchdown on landing. For purposes of this discussion, disk drag is defined as not less than zero thrust at zero airspeed. Section 23.75(f) permits means other than wheel brakes to be used in determining landing distance, when the conditions specified in § 23.75(f) are met. Such disk drag or reverse thrust may be acceptable in showing compliance with § 23.75(f) provided the means is safe and reliable.

(i) *Reliable.* Compliance with the "reliable" provision of the rule may be accomplished by an evaluation of the pitch changing/reversing system in accordance with § 23.1309. The methods of AC 23.1309-1 should be used in the evaluation even though type-certificated engine or propeller systems may not have been subjected to the AC 23.1309-1 analysis during certification. Additionally, Society of Automotive Engineers (SAE) document ARP-926A, "Fault/Failure Analysis Procedure," will assist in conducting reliability and hazard assessments.

(a) For commuter category airplanes, § 23.1309 requires the system to be designed to safeguard against hazards to the airplane in the event the system or any component thereof malfunctions or fails. An acceptable means for showing compliance with the requirement would be to conduct a FMEA of the system. An acceptable analysis would show that the effects of any system or component malfunction or failure would not result in a hazard to the airplane and that the propeller reversing system is reliable. SAE document, ARP-926A, contains acceptable criteria for conducting such an analysis.

(b) Safe and reliable should also mean that it is extremely improbable that the system can mislead the flight crew or will allow asymmetric power settings, that is, forward thrust on one engine versus reverse thrust on the other. In achieving this level of reliability, the system should not increase crew workload or require excessive crew attention during a very dynamic time in the landing phase. Also, the approved performance data should be such that the average pilot can duplicate this performance by following the AFM procedures.

(ii) *Safe.* Compliance with the "safe" provisions of § 23.75(f)(1) will require an evaluation of the complete system, including operational aspects, to ensure no unsafe feature exists.

(iii) *Disk Drag for Multiengine Installations with Flight Idle and Ground Idle.* Symmetrical power/thrust may be used, with power levers at flight-idle position during air run, and at ground-idle position after touchdown. Procedures for consistently achieving ground idle should be established to ensure that the operational pilot gets the power lever back to ground idle, thus providing consistent results in service. Two of the designs that have been found acceptable for ground-idle positioning are a dedicated throttle gate or tactile positioning of the throttle. In effecting thrust changes following touchdown, allowance should be made for any time delays that reasonably may be expected in service, or which may be necessary to assure that the airplane is firmly on the surface. Refer to b(2) for commuter category time delays. Associated procedures should be included in the AFM. If the disk drag or some other

powerplant-related device has a significant effect on the landing distance, the effect of an inoperative engine should be determined and published in the AFM performance section.

(iv) *Disking Drag for Single-Engine Installations with Flight Idle and Ground Idle.* Landing distances should be determined with the power levers at flight-idle position during air run, and at ground-idle position after touchdown. Procedures for consistently achieving ground idle should be established. Two of the designs that have been found acceptable for ground-idle positioning are a dedicated throttle gate or tactile positioning of the throttle. In effecting thrust changes following touchdown, allowance should be made for any time delays that reasonably may be expected in service, or which may be necessary to assure that the airplane is firmly on the surface. Associated procedures should be included in the AFM.

(v) *Reverse Thrust for Multiengine Airplanes.* In the approval of reverse thrust for turboprop and turbojet airplanes, due consideration should be given for thrust settings allowed, the number of operating engines, and control of the aircraft with one engine inoperative. If the landing distance depends on the operation of any engine and the landing distance would be noticeably increased (2 percent has been found acceptable) when a landing is made with that engine inoperative, then the landing distance should be determined with that engine inoperative. However, if the use of compensating means (such as reverse thrust on the operating engine) will result in a landing distance not more than that with each engine operating, then the landing distance does not need to be determined with that engine inoperative. This assumes that there are no other changes in configuration, for example, flap setting associated with one engine inoperative, that will cause an increase in landing distance. In effecting thrust changes following touchdown, allowance should be made for any time delays that reasonably may be expected in service, or which may be necessary to assure that the airplane is firmly on the surface. Refer to b(2) for commuter category time delays. Associated procedures should be included in the AFM.

(vi) *Reverse Thrust for Single-Engine Airplanes.* In effecting thrust changes following touchdown, allowance should be made for any time delays that reasonably may be expected in service, or which may be necessary to assure that the airplane is firmly on the surface. Associated procedures should be included in the AFM.

(7) *Balked Landing Transition.* For the power conditions selected for the landing demonstration (except one engine inoperative), and other steady state conditions of speed and rate of sink that are established during the landing approach, it should be possible, at the 50-foot point, to make a satisfactory transition to the balked landing climb requirement of § 23.77 using average piloting skill without encountering any unsafe conditions.

(8) *Expansion of Landing Data for a Range of Airport Elevations.* When the basic landing tests are accomplished between sea level and approximately 3,000 feet, the maximum allowable extrapolation limits are 6,000 feet above and 3,000 feet below the test field elevation. If you desire to extrapolate beyond these limits, one of two procedures may be employed. These procedures are given in paragraph 23.53b(7).

b. Procedures.

(1) *Technique.* The landing approach should be stabilized on target speed, power, and the airplane in the landing configuration prior to reaching the 50-foot height to assure stabilized conditions when the airplane passes through the reference height. The engine fuel control should be adjusted to the maximum flight-idle fuel flow permitted on airplanes in service unless it is shown that the range of adjustment has no effect on landing distance. A smooth flare should be made to the touchdown point. The landing roll should be as straight as possible and the airplane brought to a complete stop (or three knots for seaplanes) for each landing test. Normal pilot reaction times should be used for power reduction, brake application, and use of other drag/deceleration devices. Refer to b(2) for commuter category time delays. These reaction times should be established by a deliberate application of appropriate controls as would be used by a normal pilot in service. They should not represent the minimum times associated with the reactions of a highly trained test pilot.

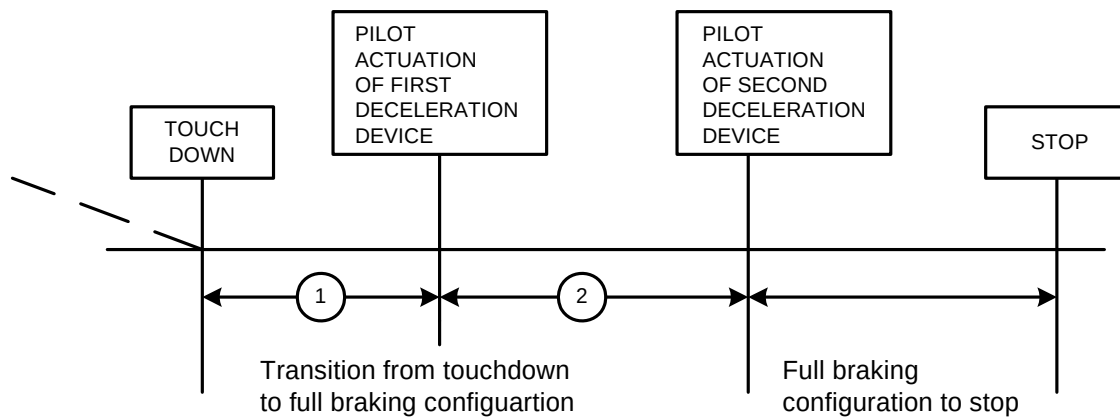
(2) *Commuter Category Time Delays.*

(i) The time delays shown in figure 16 should be used.

(ii) For approved automatic deceleration devices (for example, autospoilers, etc.) for which performance credit is sought for AFM data expansion, established times determined during certification testing may be used without the application of the one-second minimum time delay required in the appropriate segment above.

(3) *Applicant's Procedures.* The procedures to be followed should be those recommended by the applicant.

Figure 16 - Landing Time Delays



① - This segment represents the flight test measured average time from touchdown to pilot actuation of the first deceleration device. For AFM data expansion, use one second or the test time, whichever is longer.

② - This segment represents the flight test measured average test time from pilot actuation of the first deceleration device to pilot actuation of the second deceleration device. For AFM data expansion, refer to item ① above.

Segment ② is repeated until pilot actuation of all deceleration devices has been completed and the airplane is in the full braking configuration.

(4) *Number of Landings.* At least six landings should be conducted on the same wheels, tires, and brakes to establish the proper functioning required by § 21.35(b).

(5) *Winds.* Wind velocity and direction should be measured adjacent to the runway during the time interval of each test run. Refer to paragraph 23.21a(5) of this AC for wind velocity and direction tolerances.

(6) *Weight.* Landing tests should be conducted at maximum landing weight.

(7) *Approach Angles Greater than Three Degrees.* If the applicant chooses an approach angle greater than three degrees, landing distances that result from utilizing a three-degree approach angle should be determined and published in the AFM to enable operators to comply with related operational rules.

c. Data Acquisition.

(1) The data to be recorded for landing distance tests are:

(i) Vertical and horizontal path of the airplane relative to the runway. Two methods that have been used are 1) runway observers and 2) time histories, though runway observers are typically used for small, simple airplanes. Sink rate at touchdown and descent gradients may be computed from time histories.

(ii) Pressure altitude.

(iii) Ambient air temperature.

(iv) Airplane weight (fuel used or time since engine start).

(v) Engine power or thrust data.

(vi) Cowl flap position.

(vii) Wing flap position.

(vii) Runway slope.

(ix) Direction of landing run.

(x) Wind direction and velocity at a height of six feet adjacent to the runway near the touchdown point.

(xi) Landing procedures noted for inclusion in the AFM.

(2) Means of acquiring the required data are listed below:

(i) Time history data is obtained by use of a takeoff and landing camera, electronic equipment such as differential GPS, or a phototheodolite having a known surveyed location. If landing gear loads are a concern, sink rate at touchdown may be computed, or alternately, vertical load factor may be measured by an accelerometer at the c.g.

(ii) Pressure altitude may be obtained with a calibrated sensitive altimeter.

(iii) Ambient air temperature should be obtained with a calibrated temperature sensor.

(iv) The airplane weight may be computed from a known weight at start of test minus the fuel used to the time of test.

(v) Engine power or thrust data may be determined using calibrated airplane powerplant instruments to provide the basic parameters required.

(vi) Cowl flap position may be obtained from a calibrated indicator or a measured position.

(vii) Wing flap position may be obtained from a calibrated indicator or a measured position.

(viii) Slope of the runway can be obtained from the official runway survey or other suitable data obtained using accepted survey practices.

(ix) Direction of the landing run will be the direction of the runway used or an accurate compass indication.

(x) The wind direction and velocity should be obtained with an accurate compass and a calibrated anemometer. Wind data obtained from airport control towers should not be used.

14. § 23.77 Balked Landing Climb.

a. Explanation (Normal, Utility, and Acrobatic Category). Reciprocating engine airplanes with a MTOW of 6,000 pounds (2730 kg) or less.

(1) *Purpose.* The configuration that is specified for this climb requirement ordinarily is used in the final stages of an approach for landing. The objective of requiring the prescribed climb capability is to ensure that the descent may readily be arrested, and that the airplane will be able to "go around" for another attempt at landing, in the event conditions beyond control of the pilot make such action advisable or necessary.

(2) *Flap Retraction.* As an alternative to having the flaps in the landing position, compliance with the balked landing climb requirement may be demonstrated with flaps in the retracted position, provided the flaps are capable of being retracted in two seconds or less. Also, provided the airplane's flight characteristics during flap retraction satisfy the constraints imposed by the regulation; that is, flaps must be retracted with safety, without loss of altitude, without sudden change in angle-of-attack, and without need for exceptional piloting skill. Evaluation should include satisfactory demonstration of ability to promptly arrest the descent by application of takeoff power in conjunction with rapid retraction of the flaps during final approach to landing.

(3) *Flaps That Will Not Fully Retract in Two Seconds.* If the flaps will not fully retract in two seconds, the climb available with the flap position at the end of two seconds may be used and the position noted in the AFM. Other considerations should include flight characteristics, ease of operation and reliability. If the flap is not mechanical, the flap mechanism should be reliable in order to receive credit for a partially retracted flap.

b. Procedures. Climb performance tests are conducted to establish compliance with the prescribed climb requirement and for inclusion in the AFM. The procedures outlined under § 23.65 are equally applicable to the balked landing climb, except that the cooling and other

considerations that recommend exploration of a speed range by conducting sawtooth climbs do not apply to the balked landing climb. In lieu of sawtooth climbs, the balked landing climb performance may be established as the average of not less than three continuous run pairs at the climb speed selected by the applicant.

c. Explanation (Normal, Utility and Acrobatic Aircraft with MTOW greater than 6,000 pounds (2730 kg) and Turbine Engine Aircraft and Commuter Category Aircraft). Sections 23.77(b)(1) and 23.77(c)(1) state that the engines are to be set at the power or thrust that is available eight seconds after initiation of movement of the power controls from minimum flight idle to the takeoff position. The procedures given are for the determination of this maximum power for showing compliance with the climb requirements of § 23.77.

d. Procedures. (Aircraft with a MTOW greater than 6,000 pounds and turbine-engine aircraft.)

(1) *Engine Trim.* Trim engines to the minimum idle speed/power to be defined in the airplane maintenance manual.

(2) *Engine Power Tests.* Engine power tests should be conducted at the most adverse landing elevation and temperature condition, or the range of landing altitude and temperature conditions if the most adverse cannot be readily determined.

(i) In the critical air bleed configuration, if applicable, stabilize the airplane in level flight with symmetrical power on all engines, landing gear down, flaps in the landing position, at a speed of V_{REF} at an altitude sufficiently above the selected test altitude so that time for descent to the test altitude with all throttles closed will result in minimum flight-idle power at test altitude.

(ii) Retard throttles to flight idle and descend at V_{REF} , as defined in § 23.73, to approximately the test altitude. When power has stabilized, advance throttle(s) in less than one second to obtain takeoff power.

(iii) The power that is available eight seconds after the initiation of movement of the power controls from the minimum flight idle position is the maximum permitted for showing compliance with the landing climb of § 23.77 for each of the bleed combinations tested.

(iv) If AFM performance is presented so there is no accountability for various bleed conditions, the power obtained with the most critical air bleed should be used for landing climb performance for all operations, including the effects of anti-ice bleed.

e. Data Acquisition and Reduction. The information presented under § 23.65 of the regulation applies to the balked landing climb.