CIVIL AERONAUTICS MANUAL 4b

U. S. Department of Commerce **Civil Aeronautics Administration**

Civil Aeronautics Manuals and supplements thereto are issued by the Office of Aviation Safety, Civil Aeronautics Administration, for the guidance of the public and are published in the Federal Register and the Code of Federal Regulations.

Supplement No. 2 **May 25 1956**

SUBJECT: Revisions to Civil Aeronautics Manual 4b dated September 1954.

This supplement is issued to provide subscribers of CAM 4b with policies and interpretations relating to: (1) Tests to determine the reliability of automatic pilot systems and information relative to their installations; (2) antiskid devices acceptable for installation on civil aircraft; and (3) information concerning the location of landing gear position indicator switches and established criteria by which all systems using electrical power can be evaluated.

The ink revisions contained in Supplement No. 1 have been included in the revised pages attached to this supplement.

Remove and destroy the following pages:	*Insert in lieu thereof the following pages:*
Table of Contents	Table of Contents
2–1	2–1
5 and 6	5 through 6–1
15 and 16	15 through 16–1
23 and 24	23 through 24–1
37 and 38	37 through 38–1
40–1 through 40–3	40–1 through 40–3
43 and 44	43 through 44–2
47 and 48	47 through 48–1
51 through 52–1	51 through 52–3
65 and 66	65 through 66–1

Ink revisions:

Renumber footnote 10b on page 45 as 10f.

The Federal Register citations have been provided after each section as a matter of information.

NOTE: All new or revised material is indicated by brackets [ ].

John F. [signature]

FOR WILLIAM B. DAVIS
Director,
Office of Aviation Safety.

Attachments.

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flight test program. A list containing those tests requiring special instrumentation is shown in Appendix E.

(3) *Data reduction.* If the overall elapsed time for the certification program is to be kept to a minimum, tests requiring considerable data reduction should be conducted as early in the program as possible. Most performance data, particularly landing and takeoff data, fall in this category.

4b.16-3 *Additional flight tests* (*CAA policies which apply to sec. 4b.16* (*b*)).

(a) *General.* [At the option of the applicant, the flight tests specified in Civil Aeronautics Manual 1.76-4 for the ferry flight of a four-engine airplane with one engine inoperative may be conducted during the flight tests for type certification.] Routine CAR tests as prescribed in sections 4b.100 through 4b.743 will be conducted (in accordance with existing procedures) to determine performance, flying qualities, power plant characteristics, etc.

The official functional and reliability tests will be that portion of the tests conducted under the immediate supervision of the Type Certification Board,[1] as prescribed in (c) through (h) of this section, to show compliance with sections 4b.100 through 4b.743.

Supplementary experience consisting of other flight tests and experience with an airplane (of the same) type will be taken into consideration in establishing the extent of the official portions of the tests. This supplementary experience may be obtained by the manufacturer, military services, airlines, etc.

(19 F. R. 4446, July 20, 1954, effective Sept. 1, 1954, amended 20 F. R. 6677, Sept. 10, 1955, effective Sept. 30, 1955.)

[1] A Type Certification Board is set up by the CAA field offices on each new type aircraft project.

T. C. Board, together with a list of the differences between the airplane on which the experience was obtained and the official test airplane. When supplementary experience is obtained on a large fleet of airplanes (for example, military operations) of the same or a comparable type (see (d) (6) of this section), these records may consist of statistical summaries in lieu of complete records for each individual airplane.

(3) At the conclusion of the official tests, a summary report should be prepared by the T. C. Board and forwarded to Washington for inclusion in the Type Inspection Report.

(g) *Administration.* The CAA Flight Test Agent in charge will act as coordinator of all flight activities of the T. C. Board during the official program and the agent or an alternate designated by him will participate in all flights. He will collaborate with the manufacturers' pilots in all these activities, particularly in regard to flight plans and procedures. The manufacturers' pilots should be in command of all flights, but CAA pilots will fly the airplane at least sufficiently to accomplish item (d) (3) of this section.

(1) Other CAA personnel (e. g., representatives of other divisions and specialists) will participate in the flight tests when deemed necessary by the T. C. Board to accomplish the purposes of the tests.

(2) When supplementary experience is obtained in airline operations, a CAA Aviation Safety Agent will be assigned to follow the operations, review the operator's records, and supplement these by reports to the T. C. Board.

(h) *Test airplane.* To facilitate completion of the type certification procedure one airplane may be used for the official functioning and reliability tests while another airplane (or airplanes) is used for the routine CAR tests. In such cases the test time on at least one airplane should be sufficient to accomplish the objective of (b) (2) of this section.

(i) *Modified types.* The procedure outlined in (h) applies to new type designs. When a design employs components identical to those used in previous designs, credit may be given for the supplementary experience available for such components. When a design is modified (for example, several versions of the same basic type with different engines, propellers, etc.), the modified features and components should be treated in accordance with (d) (6) of this section.

(19 F. R. 4447, July 20, 1954, effective Sept. 1, 1954.)

4b.16–4 *Flight tests (CAA policies which apply to sec. 4b.16).* The policies outlined in section 4b.402–1 (c) and section 4b.402–1 (l) (3) will apply.

(20 F. R. 2279, Apr. 8, 1955, effective Apr. 30, 1955.)

4b.18–1 *Approval of aircraft materials, parts, processes and appliances (CAA rules which apply to sec. 4b.18).* Aircraft materials, parts, processes and appliances made the subject of Technical Standard Orders shall be approved upon the basis and in the manner prescribed in Part 514 [3] of the Regulations of the Administrator, "Technical Standard Orders—C Series—Aircraft Components."

(17 F. R. 10101, Nov. 7, 1952, effective Dec. 1, 1952.)

4b.18–2 *Application of Technical Standard Orders—C Series (CAA policies which apply to sec. 4b.18).*

(a) *Purpose of Technical Standard Orders.* Technical Standard Orders are a means by which the Administrator adopts and publishes the specifications for which authority is provided in section 4b.18 (a) of this chapter.

(b) *Applicability of Technical Standard Order Requirements.*

(1) The applicability of and effective dates for TSO'd items are set forth in each TSO.

(2) Each Technical Standard Order sets forth the conditions under which materials, parts, processes and appliances approved by the Administrator prior to establishment of an applicable TSO, may continue to be used in aircraft.

(3) The establishment of a Technical

[3] Part 514 is available only through the Federal Register where it appeared on October 12, 1951, 16 FR 10403. Copies of individual TSO's contained therein are available upon application to the Aviation Information Staff, Civil Aeronautics Administration, Department of Commerce, Washington 25, D. C.

Standard Order for any product does not preclude the possibility of establishing the acceptability of a similar product as part of an aircraft, engine or propeller, under the type certification or modification procedures, if there is established a level of safety equivalent to that provided in the Civil Air Regulations as implemented by the appropriate Technical Standard Order and the product is identified as a part of the airplane, engine or propeller.

(c) *Administration of the Technical Standard Order (TSO) System.* The principles which apply in administering the Technical Standard Orders system are as follows:

(1) Technical Standard Orders will reference performance provisions of recognized government specifications, or established industry specifications which have been found acceptable by the CAA. If no satisfactory specification exists, the Orders will include criteria prepared by the Administrator. In preparing criteria of this type, the Administrator will give consideration to recommendations made by the industry.

(2) Minimum performance requirements established by the Civil Aeronautics Administration and published in Technical Standard Orders will serve as a means by which component equipment and materials intended for use in certificated aircraft will be accepted.

(3) TSO's set forth the minimum requirements for safety. Every effort will be made by the CAA to keep the requirements at the minimum levels of safety, and TSO's will not be used to set forth "desirable" standards.

(4) It will be the responsibility of the person submitting a statement of conformance to the CAA, certifying that his product meets the requirements of the TSO, to conduct the necessary tests demonstrating compliance therewith. This person will be held responsible for maintaining quality control adequate to assure that products which he guarantees to meet the requirements of a TSO do, in fact, meet these standards. The CAA will not formally approve such products as meeting the requirements of TSO's nor exercise direct inspection control over them. The statement of conformance with the provisions of a Technical Standard Order normally will be accepted by the CAA as sufficient indication that the applicable requirements have been fulfilled.

Any TSO'd item which is modified must continue to comply with the requirements of the TSO, and the person authorizing the modification will be responsible for such compliance.

(d) *Numbering of Technical Standard Orders.* Each Technical Standard Order will be assigned a designation consisting of the letters, "TSO," a series code letter "C", indicating aircraft materials, parts, processes, or appliances and a serial number to be assigned in sequence for each of the TSO's issued in the "C" series, e. g., TSO-C-1, "Smoke Detectors." Revisions are indicated by the addition of letters a, b, c, etc., after the number.

4b.100-1 *Procedure for demonstrating compliance with the flight requirements (CAA policies which apply to sec. 4b.100 (a)).*

(a) *Responsibility.* The burden of showing or implementing compliance with the requirements for an airworthiness or a type certificate rests with the applicant. The applicant should at his own expense and risk, conduct such official flight tests as determined by the CAA to demonstrate compliance with the minimum requirements. During the type inspection the applicant should make available the airplane for that purpose as well as all of the personnel and equipment necessary to obtain the required data.

(b) *Tolerances permitted for flight tests.*

(1) *General.* The tolerances in (b) (2) of this section are the allowable deviation from specified flight conditions for a particular test. They are not allowable tolerances on specific requirements, nor are they to be considered as allowable inaccuracy of measurement or of the method of determination. As an example, when demonstrating stability with specified

trim speed of 1.4 V_{s_1}, the trim speed may be 1.4 $V_{s_1} \pm 3$ *m. p. h. or 3 percent;* however, no positive tolerance is permitted when demonstrating the minimum prescribed trim speed of 1.4 V_{s_1}.

(i) Where variation in the parameter on which a tolerance is allowed will have an appreciable effect on the test, the result should be corrected to the standard value of the parameter; otherwise, no correction is necessary. The applicant may adhere to closer tolerances if he so desires.

(ii) The following list indicates the cases in which correction for tolerances should be made:

Test	Weight	C. G.	Air speed	Power	Wind
Airspeed calibration	------	-----	-----	-----	-----
Stall speeds	X	-----	-----	-----	-----
All climbs	X	-----	-----	X	-----
Landings	X	-----	X	-----	X
Takeoff	X	-----	X	X	X
Accelerate	X	-----	X	X	X
Decelerate	X	-----	X	-----	X
Stability and control.	------	-----	-----	-----	-----
Minimum control speed.	------	-----	-----	X	-----

Time, distance, and airspeed at engine cut.
Slope of field.
Direction of run.

(4) In addition, humidity, wind direction, and wind velocity should be recorded adjacent to the runway at a height of 6 feet above the runway surface.

(19 F. R. 4451, July 20, 1954, effective Sept. 1, 1954.)

4b.115-2 *Approval of automatic propeller feathering installations for use in establishing accelerate-stop distance (CAA policies which apply to sec. 4b.115).* The accelerate-stop disance should be determined with the automatic propeller feathering installation feathering the propeller of the critical engine and with the other throttles closed at the instant of attainment of V_1. (See secs. 4b.10-2, 4b.401-1, 4b.700-1, and Civil Air Regulations Part 4b Interpretation No. 1.)

(19 F. R. 1817, Apr. 2, 1954, effective Apr. 2, 1954.)

4b.115-3 *Reverse thrust used in accelerate-stop distance (CAA policies which apply to sec. 4b.115).* The policies outlined in section 4b.402-1 (k) will apply.

(20 F. R. 2277, Apr. 8, 1955, effective Apr. 30, 1955.)

[4b.115-4 *Accelerate-stop distance with an antiskid device installed (CAA policies which apply to sec. 4b.115).* The policies outlined in section 4b.337-4 will apply.]

(21 F. R. 2558, Apr. 19, 1956, effective May 15, 1956.)

4b.116-1 *Approval of automatic propeller feathering installations for use in establishing the takeoff path (CAA policies which apply to sec. 4b.116).* The takeoff path may be modified by permitting a feathered propeller instead of windmilling after the necessary time interval has elapsed from the instant of engine failure to complete feathering of the propeller. If it can be shown that the net work produced by the feathering propeller from the instant of engine failure to completion of feathering under all types of engine failure is positive using a datum based on feathered propeller drag, then it is permissible to assume that the propeller of the failed engine is in the feathered drag condition from the instant of attainment of the takeoff climb speed V_2. (See secs. 4b.10-2, 4b.401-1, and 4b.700-1.)

(19 F. R. 1818, Apr. 2, 1954, effective Apr. 2, 1954.)

Discussion of Policies Relating to the Determination of the Takeoff Path in Section 4b.116-2

The takeoff path elements in section 4b.116 are intended to reflect, as closely as possible, the probable order in which a pilot would make changes to the airplane configuration in the actual case of an engine failure. They are conservative in their nature in an effort to simplify the testing required to establish the flight path. For example, it is assumed that the pilot will initiate gear retraction at the takeoff safety speed, V_2, immediately after the wheels leave the ground but that climbing performance does not increase during the retraction period over that with the gear fully extended. In the case of nonautomatic propeller feathering systems it is assumed that the pilot would not initiate propeller feathering, if an engine fails during the ground run, prior to attaining a height of 50 feet, and further that the climb performance of the airplane remains the same as with the propeller windmilling until the propeller feathering cycle is completed. However, in the case of an airplane with a slow retracting gear, propeller feathering may be started at the 50-foot height prior to the completion of the gear retraction as noted in section 4b.116 (c). It is also assumed that the cowl flaps on the inoperative engine will be closed when the airplane enters the third takeoff climb segment with the gear retracted and propeller feathered.

4b.116-2. *Determination of the takeoff path (CAA policies which apply to sec. 4b.116).*

(a) The recommended procedure for obtaining the takeoff path is to determine the ground and climb portions separately and piece the corrected data together. The takeoff flight path should be demonstrated in accordance with the following provisions:

(1) Three accelerations should be made during which the airplane is accelerated from a complete stop using all engines to speeds bracketing speed V_1 at which speed the critical engine fuel mixture is cut and the acceleration continued to speed V_2 with the inoperative engine propeller windmilling[7] in the takeoff pitch setting. If V_1 is less than V_2, a takeoff should be made on one of the above runs when the critical engine is failed at the lowest V_1 speed.

(2) The takeoff flap setting should be maintained throughout the takeoff flight path. If more than one flap setting is to be used for takeoff, additional tests should be included to cover the flap range (see sec. 4b.118–1(d)(2)).

(3) See section 4b.115–1 (a) (4) for instrumentation requirements.

(4) A special tolerance of not greather than ±2 percent of the maximum takeoff weight is allowable for the ground portion of the accelerate distance.

(*b*) *General test program.*

(1) *Accelerate to takeoff safety speed,* V_2 *section 4b.116 (a).*

(i) *Configuration.* These tests should be conducted in the configuration that follows:

Weight—maximum takeoff and one lower.
C. G. position—most forward.
Wing flaps—takeoff position.
Landing gear—extended.
Operating engine(s)—takeoff r. p. m. and manifold pressure, cowl flaps in takeoff position (see sec. 4b.118–1 (d) (1)).
Critical inoprative engine—fuel mixture cut on engine most critical performancewise (see sec. 4b.118–1 (e) (2)), propeller windmilling in takeoff pitch (feathered if automatic feathering device is installed) and cowl flaps in takeoff position (see sec. 4b.118–1 (d) (1)).

(ii) *Test procedure and required data.* The airplane should be accelerated from a complete stop to the V_1 speed with all engines operating. The critical engine fuel mixture should be cut at the V_1 speed and the acceleration should be continued until V_2 speed is reached with the propeller of the inoperative engine windmilling in the takeoff pitch. The airplane's path relative to the runway should be recorded against time in a manner to determine the horizontal distance-time history. In addition the following data should be recorded:

Pressure altitude.
Ambient air temperature.
Airplane gross weight.
R. P. M.
Manifold pressure.
Torque pressure.
Mixture setting.
Cowl flap position.
Wing flap position.
Time, distance, and speed at engine, cut.
Time, distance, and speed when V_2 is reached.
Slope of field.
Direction of run.

In addition, humidity, wind direction, and wind velocity should be recorded adjacent to the runway at a height of 6 feet above the runway surface.

(2) *Initial takeoff flight path segment test, section 4b.116 (b).*

(i) *Configuration.* This test should be conducted in the configuration that follows:

Weight—maximum takeoff and one lower.
C. G. position—optional (see sec. 4b.118–1 (c) (2)).
Wing flaps—takeoff position.
Landing gear—extended.
Operating engine(s)—takeoff r. p. m. and manifold pressure or full throttle, mixture setting for takeoff, carburetor air heat control at cold and cowl flaps in takeoff position (see sec. 4b.118–1 (d) (1)). Critical inoperative engine—throttle closed on engine most critical performancewise (see sec. 4b.118–1 (e) (2)), propeller windmilling in takeoff pitch,

[7] When a satisfactory fully automatic propeller feathering device is installed on the airplane, advantage of such a device may be used in showing compliance with this section. See section 4b.116–1 for reference to policies covering automatic propeller feathering systems.

(feathered if automatic feathering device is installed), mixture setting at idle cut-off and cowl flaps in take-off position (see sec. 4b.118–1 (d) (1)).

(ii) *Test procedure and required data.* The airplane should be climbed at the takeoff safety speed, V_2. See section 4b.118–1 for test procedure and required data in connection with climb tests.

(3) *Second takeoff flight path climb segment test, section 4b.116 (c).*

(i) *Configuration.* This test should be conducted in the configuration that follows:

Weight—maximum takeoff and one lower.

C. G. position—optional (see sec. 4b.118–1 (c) (2)).

Wing flaps—takeoff position.

gliding approach" is an approach at essentially constant indicated air speed for a sufficient length of time prior to reaching the 50-foot point to simulate a continuous approach at this speed.

Sections 4b.122 (b), (c), and (d) are concerned primarily with preventing airplane contact with the runway surface at a very high speed in order to take advantage of the greater deceleration provided by most wheel brake installations than is available from the drag of the airplane while still airborne. Flight Engineering Report No. 1, "Investigation of the Landing Distance Required by CAR 04.7503 for a Typical Airplane," covers an investigation undertaken to determine the effect of various factors which were considered in drafting section 4b.122 and indicates the critical dependence of the landing distance here defined upon the contact speed. The purposes of section 4b.122 (d) would be defeated if a distance is obtained by making contact at high speed which would require an exceptional degree of skill on the part of the pilot, or to base a distance upon exceptionally favorable conditions such as wind or the nature of the surface of the runway.

4b.122–2 *Determination of the landing distances* (*CAA policies which apply to sec. 4b.122*).

(a) When a particular airplane cannot comply with that part of section 4b.122 (d) regarding exceptional degree of skill on the part of the pilot in landing from the 50-foot height with power off, compliance with the regulation should be shown by applying sufficient power during the approach to permit satisfactory landing.

(b) In the tests required by sections 4b.123 through 4b.124 generally one set of data at one altitude should be sufficient to determine the landing distances for altitudes from sea level to 8,000 feet. If a greater range of airport altitudes is desired, the tests should be conducted at two or more altitudes.

(19 F. R. 4454, July 20, 1954, effective Sept. 1, 1954.)

4b.122–3 *Reverse thrust used in determination of landing distance* (*CAA policies which apply to sec. 4b.122*). The policies outlined in section 4b.402–1 (l) will apply.

(20 F. R. 2277, Apr. 8, 1955, effective Apr. 30, 1955.)

[4b.122–4 *Determination of the landing distance with an antiskid device installed* (*CAA policies which apply to sec. 4b.122*). The policies outlined in section 4b.337–4 will apply.]

(21 F. R. 2258, Apr. 19, 1956, effective May 15, 1956.)

4b.123–1 *Excessive wear of brakes or tires* (*CAA interpretation which applies to sec. 4b.123* (b)). "Excessive wear" is interpreted as skidding of a tire or excessive heating of the brakes which requires replacement during a series of five official test landings.

(19 F. R. 4454, July 20, 1954, effective Sept. 1, 1954.)

4b.123–2 *Determination of the landing distance (landplanes)* (*CAA policies which apply to sec. 4b.123*).

(a) The landing tests should be demonstrated in accordance with the following provisions:

(1) Landings should be made over an imaginary 50-foot obstacle at the maximum landing weight and at a lower weight at one altitude.

(2) During the landing demonstrations, the glide path should be established by the pilot as set forth in section 4b.122. The forward thrust should not be increased beyond the 50-foot obstacle. The ground roll should lie as close to a rectilinear path as possible including the airplane stop point. During each demonstration landing, the airplane should be brought to a complete stop.

(3) *Instrumentation.*

(i) Instrumentation should include a means to record the airplane's glide path relative to the ground and the ground roll against time in a manner to determine the horizontal and vertical distance-time histories.

(ii) A means should be provided to measure the wind velocity and direction, pressure altitude, and ambient air temperature. The wind measurement should be made at the height of 6 feet above the runway surface. If wind effect on runway lengths is shown in the

Airplane Flight Manual (see sec. 4b.740-1 (d) (2) (x)), the manual data should be based on reported wind velocities for a 50-foot tower height. Figure 2 should be used to calculate the wind velocity at the 50-foot height from the wind velocity measured at 6 feet above the runway surface.

(iii) The ground roll distance from contact to full stop should be established by observers if it is difficult to establish the exact contact point by graphical means.

(4) A special tolerance of not greater than ±2 percent of the maximum landing weight is allowable for the landing distance tests.

(b) *Configuration.* The landing tests should be demonstrated in the configuration that follows:

Weight—maximum landing and one lower.
C. G. position—most forward for braked landings.
Wing flaps—landing position.
Landing gear—extended.

(c) *Test procedure and required data.*

(1) Three landings should be conducted at each weight with the airplane stabilized in a glide at a calibrated air speed of not less than 1.3 V_{s_0} approximately 1,000 feet (longitudinally) prior to reaching an altitude of 50 feet. Forward thrust should not be increased beyond the 50-foot obstacle; braking should not exceed manufacturer's approved maximum brake pressure and should be applied in such a manner as not to produce excessive wear of brakes and tires as evidenced by five measured landings. If more than one flap setting is to be used for landing, additional tests should be conducted to cover the flap range. (See sec. 4b.118-1 (d) (2).)

(2) The airplane path relative to the runway should be recorded against time in a manner to determine the horizontal and vertical distance-time history. In addition, the following data should be recorded:

Pressure altitude.
Ambient air temperature.
Airplane gross weight.
R. P. M.
Manifold pressure.
Torque pressure.
Carburetor air temperature.
Mixture setting.
Cowl flap position.
Wing flap position.
Slope of field.
Direction of landing run.

(3) Humidity, wind direction, and wind velocity should be recorded adjacent to the runway at a height of 6 feet.

(19 F. R. 4454, July 20, 1954, effective Sept. 1, 1954.)

4b.123-3 *Reverse thrust used in landing distance—landplanes (CAA policies which apply to sec. 4b.123 (c)).* The policies outlined in section 4b.402-1 (l) will apply.

(20 F. R. 2277, Apr. 8, 1955, effective Apr. 30, 1955.)

[4b.123-4 *Procedure in determination of landing distance with an antiskid device installed (CAA policies which apply to sec. 4b.123).* The policies outlined in section 4b.337-4 will apply.]

(21 F. R. 2558, Apr. 19, 1956, effective May 15, 1956.)

4b.124-1 *Determination of the landing distance (seaplanes) (CAA policies which apply to sec. 4b.124).* Policies outlined in sections 4b.122-2 and 4b.123-2 will apply.

(19 F. R. 4454, July 20, 1954, effective Sept. 1, 1954.)

4b.125-1 *Determination of the landing distances (skiplanes) (CAA policies which apply to sec. 4b.125).* Policies outlined in sections 4b.122-2 and 4b.123-2 will apply.

(19 F. R. 4454, July 20, 1954, effective Sept. 1, 1954.)

4b.130-1 *Procedure for demonstrating controllability qualities (CAA policies which apply to sec. 4b.130).* The general controllability and maneuverability qualities of the airplane should be observed and noted throughout the flight test program. The amount of force required to be exerted on the controls in conducting such maneuvers specified in section 4b.130 should also be noted.

(19 F. R. 4454, July 20, 1954, effective Sept. 1, 1954.)

Discussion of Policies Relating to Procedure for Demonstrating Longitudinal Control in Section 4b.131-1

Section 4b.131 (b) requires changes to be made in flap position and/or power which are likely to be encountered during an approach when it becomes necessary to go around for another attempt at landing. Its purpose is to insure that any of these changes are possible assuming that the pilot finds it necessary to devote at least one hand to the initiation of the desired operation without being overpowered by the primary airplane controls. It aims at a design such that no excessive change in trim results from the application or removal of power or the extension or retraction of wing flaps. Compliance with its terms also requires that the relation of control force to speed be such that reasonable changes in speed may be made without encountering very high control forces.

Section 4b.131 (c) is concerned with the eventuality of going around during an approach for landing in which event it is obviously desirable to be able to retract the wing flaps quickly and automatically at such a rate that there will be no loss of altitude if power is applied simultaneously with the initiation of flap retraction no. The design feature involved in this requirement is the rate of flap retraction.

4b.131-1 *Procedure for demonstrating longitudinal control (CAA policies which apply to sec. 4b.131).* The flight tests specified in (a) through (h) of this section should be made in flaps appropriate for flight condition.

Trim speed—1.4 V_{s_1}.

(c) *Test procedure and required data.* This test may be conducted at any optional altitude (see sec. 4b.100–3 (c)). See section 4b.160 (c) regarding test procedure.

(1) The speed of the airplane should be reduced from the trim condition with the wings held level until the first of the following occurs:

(i) Full rudder or aileron deflection.

(ii) 180 lbs. rudder force.

(iii) Stall is reached.

(2) If full rudder or aileron deflection, or the 180 lbs. rudder force occurs first, the power should be reduced and the test repeated until sufficient control is available to complete the stall. The power may be reduced on the operating engine(s) before reapplying power on the operating engine or engines for the purpose of regaining level flight. The following data should be recorded at that point:

Pressure altitude.
Ambient air temperature.
Indicated air speed.
Engines, r. p. m. and manifold pressure.
Torque pressure.
Carburetor air temperature.
Rudder force (if desirable).

(3) If stall is reached first, the same data should be recorded.

(19 F. R. 4460, July 20, 1954, effective Sept. 1, 1954.)

Discussion of Policies Relating to Stall Warning in Section 4b.162–1

Occurrence of stall warning at some specific speed margin above the stalling speed is no longer required. It has been found that certain other characteristics may exist which make an airplane less susceptible to inadvertent stalling than one in which a specific speed margin has been provided between the occurrence of stall warning and the actual stall.

4b.162–1 *Stall warning (CAA policies which apply to sec. 4b.162).*

(a) The adequacy of stall warning should depend on the relative ease with which an airplane might be inadvertently stalled following the occurrence of stall warning. For example, if unmistakable warning occurs only 2 percent above the stall speed but undue pilot effort is required to reduce the airspeed to the stall, the speed margin of 2 percent may be adequate. On the other hand, if conscious effort is required to avoid stalling the airplane, a positive type of warning initiated at a relatively high speed above the stall may be required.

(b) Suggested suitable stall warnings are, buffeting which may be defined as general shaking or vibration of the airplane or elevator shake of sufficient magnitude to be unmistakable; or a stall warning instrument such as a stick shaker. A visual stall warning device which requires the attention of the crew within the cockpit is not considered acceptable by itself.

(19 F. R. 4460, July 20, 1954, effective Sept. 1, 1954.)

4b.170–1 *Procedure for demonstrating longitudinal stability and control on the ground (CAA policies which apply to sec. 4b.170).* Taxiing tests at velocities up to 70 percent of the stalling speed should be conducted on smooth and rough ground which may likely be encountered under normal operating conditions. Particular attention should be paid to the following:

(a) *Taxiing over rough ground.* There is some evidence to indicate that critical loads can be built up in taxiing over rough ground, even when the shock-absorbing system is entirely satisfactory with respect to capacity for landing purposes.

(b) *Brakes.* Their adequacy when maneuvering on the ground and their tendency to cause nosing-over should be investigated. Any bad tendency will normally be exaggerated when taxiing in a strong side or tail wind.

(19 F. R. 4460, July 20, 1954, effective Sept. 1, 1954.)

4b.170–2 *Longitudinal stability and control with reverse thrust (CAA policies which apply to sec. 4b.170).* The policies outlined in section 4b.402–1 (a), (d), and (e) will apply.

(20 F. R. 2277, Apr. 8, 1955, effective Apr. 30, 1955.)

[4b.170–3 *Longitudinal stability and control with an antiskid device installed (CAA policies* *which apply to sec. 4b.170*). The policies outlined in section 4b.337-4 will apply.]

(21 F. R. 2558, Apr. 19, 1956, effective May 15, 1956.)

4b.171-1 *Procedure for demonstrating directional stability and control on the ground* (*CAA policies which apply to sec. 4b.171*).

(a) Compliance with the requirement of section 4b.171 (a) may be demonstrated during tests for the establishment of the cross wind component velocity in accordance with section 4b.173.

(b) Compliance with the requirement of section 4b.171 (b) may be demonstrated during power off landings in other tests.

(c) Compliance with the requirement of section 4b.171 (c) may be demonstrated during taxiing prior to takeoff or after landing from other flight tests.

(19 F. R. 4460, July 20, 1954, effective Sept. 1, 1954.)

4b.171-2 *Directional stability and control with reverse thrust* (*CAA policies which apply to sec. 4b.171*). The policies outlined in section 4b.402-1 (a), (d), and (e) will apply.

(20 F. R. 2277, Apr. 8, 1955, effective Apr. 30, 1955.)

[4b.171-3 *Directional stability and control with an antiskid device installed* (*CAA policies which apply to sec. 4b.171*). The policies outlined in section 4b.337-4 will apply.]

(21 F. R. 2558, Apr. 19, 1956, effective May 15, 1956.)

4b.172-1 *Shock absorbing mechanism tests* (*CAA policies which apply to sec. 4b.172*). The shock absorbing mechanism should be checked for satisfactory operation while taxiing, taking off and landing during other tests in the type certification program.

(19 F. R. 4460 July 20, 1954, effective Sept. 1, 1954.)

4b.173-1 *Crosswind demonstration* (*CAA policies which apply to sec. 4b.173*).

(a) A crosswind component of not less than 0.2 V_{s_0} should be established during type tests. Consequently, two results are possible:

(1) A crosswind component may be established at a value which is not marginal with the airplane's handling characteristics. This value should be included in the Operating Procedures section of the Airplane Flight Manual. The operation of the aircraft in crosswinds greater than the value specified is not necessarily a hazard. Thus operation in crosswinds of a greater value is entirely within the discretion of the operator.

(2) A critical crosswind component may be established at a value which is considered the maximum up to which it is safe to operate the airplane on the ground, including takeoffs and landings. This value should be shown in the Operating Limitations section of the Airplane Flight Manual. Operation of the airplane in crosswinds above the maximum safe value is considered hazardous and the operator should do so only on the same emergency basis that a pilot would be justified in exceeding any of the operating limitations such as air speed, engine r. p. m., c. g. limitations, etc.

(3) An operator may of course restrict the operation of his airplane to crosswind components of any value equal to or less than that established during the type certification tests.

(b) *Configuration.* This test should be conducted in the configurations that follow:

Weight—maximum takeoff and landing.

C. G. position—most aft.

Flaps—takeoff and maximum landing positions.

(c) *Test procedure and required data.* At least three takeoffs and landings should be made in crosswind components of 0.2 V_{s_0} mph (or greater at applicant's option) to demonstrate satisfactory controllability and handling characteristics. The magnitude and direction of the crosswing should be established by the use of appropriate meteorological instruments.

(19 F. R. 4460, July 20, 1954, effective Sept. 1, 1954.)

4b.173-2 *Ground handling characteristics with reverse thrust* (*CAA policies which apply to sec. 4b.173*). The policies outlined in section 4b.402-1 (a) and (d) will apply.

(20 F. R. 2278, Apr. 8, 1955, effective Apr. 30, 1955.)

4b.180-1 *Water handling qualities* (*CAA policies which apply to sec. 4b.180*). Policies outlined in section 4b.182-2 will apply.

(19 F. R. 4461, July 20, 1954, effective Sept. 1, 1954.)

4b.181-1 *Crosswind demonstration* (*CAA policies which apply to sec. 4b.181*). Policies outlined in section 4b.173-1 will apply.

(19 F. R. 4461, July 20, 1954, effective Sept. 1, 1954.)

4b.182–1 *Procedure for demonstrating control and stability on the water (CAA policies which apply to sec. 4b.182).*

(a) In order to check water stability, taxiing tests should be made in a crosswind determined in accordance with section 4b.181.

(b) Porpoising tendencies should be investigated and reported for extreme loading conditions.

(c) The ability to maneuver up to and while

TABLE 1. TURNBUCKLE SAFETYING GUIDE

Cable size	Minimum Breaking Strength, Pounds				Type of wrap	Diameter of safety wire	Material (Annealed Condition)
	MIL-C-1511 Steel (Carbon) Flexible, Preformed		MIL-C-5424 Steel (Corrosion-Resisting) Flexible, Preformed				
	7 x 7	7 x 19	7 x 7	7 x 19			
Inch						*Inch*	
1/16	480		480		Single	0.040	Copper, brass, galvanized or tinned steel, soft iron, or monel.
3/32	920		920		Single	.040	Copper, brass, galvanized or tinned steel, soft iron, or monel.
1/8		2000		1760	Single	.040	Stainless steel.
1/8		2000		1760	Double	.040	Copper, brass, galvanized or tinned steel, soft iron, or monel.
5/32 and greater		2800		2400	Double	.040	Galvanized or tinned steel, soft iron, stainless steel, or monel.
5/32 and greater		2800		2400	Double	.051	Copper, brass.

NOTES

1. The swaged and unswaged turnbuckle assemblies are covered by AN Standard Drawings.
2. Certain of the AN Std. swaged terminal parts specify a safety wire hole size of .047 in. This hole may be reamed sufficiently to accomodate the .040 and .051 diameter wires.
3. The double wrap procedure given in Navy Specification PO-42A, Amendment No. 1, or the safetying procedure described by Air Force-Navy Aeronautical Design Standard AND 10482, may be used in lieu of the method shown in Figure 5.

(20 F. R. 2278, Apr. 8, 1955, effective Apr. 30, 1955.)

4b.329-3 *Approval of control system components (CAA policies which apply to sec. 4b.329 (a)).* The Administrator does not issue specific approvals as such for cables, cable fittings, turnbuckles, splices, pulleys, etc., for general use on aircraft. Approval is limited to its use as part of a specific airplane design. Conformance with established industry or military specifications or adequate substantiation of the manufacturer's own design, are the procedures utilized in complying with the "approved type" requirement.

(20 F. R. 2279, Apr. 8, 1955, effective Apr. 30, 1955.)

4b.329-4 *Cable terminals (CAA policies which apply to sec. 4b.329 (a)).* The selection of cable terminal locations and their proximities should minimize the possibility of interferences with structure, fairleads, other terminals, etc., and the possibility of pairing wrong cables during maintenance or overhaul.

(20 F. R. 2279, Apr. 8, 1955, effective Apr. 30, 1955.)

4b.329-5 *Bellcrank and idler installation (CAA policies which apply to sec. 4b.329 (b)).* The design of such items as bellcrank arms, tab drums, idlers, etc., should minimize the possibility of inadvertent installation in the reversed direction, or, as an alternative, to preclude the possibility of jamming or interference that might result from such reversed installation.

(20 F. R. 2279, Apr. 8, 1955, effective Apr. 30, 1955.)

4b.329-6 *Ball and roller bearings (CAA policies which apply to sec. 4b.329 (b) (3)).* The "approved ratings" of ball and roller bearings referred to are the ratings establishedin ANC-5, "Strength of Metal Aircraft Elements".

(20 F. R. 2279, Apr. 8, 1955, effective Apr. 30, 1955.)

4b.334–1 *Procedure for testing landing gear retracting system (CAA policies which apply to sec. 4b.334).*

(a) *General, section 4b.334 (a).* The ability to extend and retract the landing gear at a speed of at least 1.6 V_{s_1} should be demonstrated. If no other satisfactory means of decelerating the airplane are provided (such as dive brakes or other high drag devices), the ability of the landing gear retracting mechanism and wheel well doors to withstand the flight loads should be demonstrated under the following conditions:

Power required for level flight.
Airspeed, at last 0.67 V_C.
Landing gear extended.

(b) *Emergency operation, section 4b.334 (c).* Extending the landing gear by use of the emergency system for demonstrating compliance with the requirement of this section may be accomplished during other tests in the flight program.

(c) *Operation test, section 4b.334 (d).* The time required to retract the landing gear at speed V_2 (see sec. 4b.116 (b)) should be demonstrated in flight under the following conditions:

Weight—optional.
C. G. position—optional.
Operating engine(s)—takeoff power.
Critical inoperative engine—propeller windmilling on engine most critical from the gear retraction standpoint.

It is also desirable to obtain the time required to extend the landing gear for purposes of information.

(19 F. R. 4961, July 20, 1954, effective Sept. 1, 1954.)

[4b.334–2 *Landing gear position indicator switches (CAA interpretations which apply to sec. 4b.334 (e)).* The phrase "means shall be provided for indicating to the pilot" includes a landing gear position indicator as well as the switches necessary to actuate such indicator. The switches must be so located and coupled to the landing gear mechanical system as to preclude the possibility of an erroneous indication of "down and locked" if the landing gear is not in a fully extended position, or "up and locked" if the landing gear is not in the completely retracted position. Location of the switches so that they are operated by the actual landing gear locking latch or device is an acceptable method of compliance with the requirements of this section.]

(21 F. R. 2747, Apr. 28, 1956, effective May 25, 1956.)

Discussion of Policies Relating to Brake Tests in Section 4b.337–1

The requirements of section 4b.337 are based upon the fact that compliance with the operating rules of section 40.70 of this subchapter will require great dependence upon the presence and proper functioning of brakes unless the runways involved are unusually long.

The nature and extent of the tests to show compliance with section 4b.337 (a) will necessarily depend upon a great many things such as the general arrangement of the landing gear, the design of the brake system, the extent to which the capacity of the brakes is used in establishing the landing distance required by section 4b.122, the amount of available performance data for the brakes, etc. The simplest possible procedure appears to be to determine the average deceleration during a landing ground roll without the use of brakes and then establish the landing distance required by section 4b.122 by using the brakes to the extent necessary to double the mean deceleration so established. It appears likely, however, that this procedure would result in excessive landing distance and might seriously limit the use of the airplane in operation.

4b 337–1 *Brake tests (CAA policies which apply to sec. 4b.337).* If it is desired by the applicant to make the maximum possible use of the brakes in establishing the landing distance, and if also the contribution of the brakes to the total deceleration is relatively large, the brake system should be designed to permit the application of slightly less than half the braking deceleration developed under the conditions specified in this section. The following dual system is recommended: Dual wheel elements (drums or disc units), transmitting elements, power sources, master cylinders, etc., connected to a single pedal on each rudder pedal, such that the failure of any single one of these would leave half the total braking capacity symmetrically disposed about the plane of symmetry of the airplane. With such a system it should be possible to show compliance with section 4b.337 (a) by means of calculation based upon the test data necessary to establish the landing distance plus the brake data calculated by the aircraft manufacturer.

If the system is designed so that under the conditions here specified appreciably less than half the total braking capacity remains or if the remaining capacity is asymmetrically disposed, tests should be conducted to determine that half the mean deceleration may in fact be developed and/or that the airplane may be safely controlled directionally while doing so.

(a) *General, section 4b.337 (a).* Such tests should be conducted as is deemed necessary to show compliance with the subject regulation. The deceleration rates should be determined as described in section 4b.123–2 (b) (3).

(b) *Brake controls, section 4b.337 (b).* General brake control force and operation should be noted throughout the flight test program to determine that they are satisfactory.

(c) *Parking brake controls, section 4b.337 (c).* During engine run-up prior to takeoff for other tests, the parking brake control should be set, and without further attention, a demonstration should be made to determine that sufficient braking is maintained to prevent the airplane from rolling on a paved runway while takeoff power is applied on the most critical engine.

(19 F. R. 4461, July 20, 1954, effective Sept. 1, 1954.)

4b.337–2 *Brake systems.* (*CAA policies which apply to sec. 4b.337.*) In order to obtain a minimum landing distance under section 4b.122 and at the same time meet the deceleration requirement of section 4b.337 (a) (2) in event of failure of the normal brake system, it is a common practice to provide an alternate brake system. When hydraulic (or pneumatic) brakes are used in the normal brake system, this alternate means usually consists of a duplicate hydraulic or pneumatic brake system and is commonly referred to as the "emergency brake system." The following items should be considered in the design of such systems:

(a) *Relationship between normal and emergency brake systems.* The systems for actuating the normal brake and the emergency brake should be so separated that a failure in, or the leakage of fluid from, one system will not render the other system inoperative. A hydraulic brake assembly may be common to both the normal and emergency brake systems if it is shown that the leakage of hydraulic fluid resulting from failure of the sealing elements in the brake assembly would not reduce the braking effectiveness below that specified in section 4b.337 (a) (2).

(b) *Brake control valves.* In the normal brake system of all aircraft, the brake control valves should be of a type such that the pilots may exercise variable control of the pressure to the brakes. The foregoing provision need not corresponding to the actual accelerate-stop conditions which prevailed during the airplane type certification tests.

(4) If, in compliance with (1) of this paragraph, velocity-time data are submitted in lieu of torque-speed data, then sufficient spot-check calculations of the velocity-time data should be made to insure an accuracy comparable to the accuracy of torque-speed data. Inasmuch as torque-speed data are useful for airplane modification and design purposes, it is desirable that comparable and complete torque-speed data be included in the data submitted.

(5) Dynamometer time history recordings of brake pressure, torque, speed, and calculations for aerodynamic drag, tire rolling friction, and dynamometer mass correction, and all pertinent airplane data, should be submitted, together with an analysis showing the detailed calculations and charts necessary to establish the speed-distance relationship and comparison with the original airplane deceleration test data.

(f) *Landing distance test.* In order to substantiate landing distances, at least three dynamometer runs, using the critical combinations of landing weight and contact speed, should be conducted on the same brake unit. Landing distance data, compiled in accordance with the method described in (e) for accelerate-stop evaluation, should be submitted. The landing distance data, which are comparable to those of (e) for the accelerate-stop data, should compare favorably with the corrected airplane flight test results obtained with the original brakes in order to substantiate the adequacy of the replacement brakes, insofar as landing distances are concerned.

(g) *Aircraft functional tests.* The brakes should be tested on the airplane to determine their functional characteristics as indicated in (a) (2). Functioning characteristics should be observed during taxi and engine run-up conditions and at least three normal takeoffs and landings, at the maximum landing weight, should be conducted. During these tests, the brakes should be checked for any undesirable characteristics such as "grabbing," "fading," etc., and should at least be visually inspected, without dismantling, at the completion of the test in order to determine any evidence of malfunction or failure. If no malfunctioning has occurred, this visual inspection is adequate, but if malfunctioning does occur, a thorough inspection should be conducted. If any characteristics arise which indicate that stopping distances would exceed the original values in the CAA Approved Airplane Flight Manual, then the Administrator may require actual camera recorded airplane deceleration tests or any other tests deemed necessary to establish the adequacy of the brakes.

(19 F. R. 4463, July 20, 1954, effective Sept. 1, 1954.)

[4b.337-4 *Antiskid devices and installations (CAA policies which apply to sec. 4b.337).*

[(a) *Eligibility.* Antiskid devices meeting the airworthiness portions of Military Specification MIL-B-8075 (ASG) and any amendments [10a] thereto, are acceptable for installation on civil aircraft. Requests for deviations from these specifications should be submitted to the CAA Regional Office, Aircraft Engineering Division. The installation of the antiskid device should comply with the requirements specified in paragraph (b) of this section. The antiskid device and its installation will be approved for use on civil aircraft when the tests specified in paragraph (c) of this section have been satisfactorily demonstrated.

[(b) *Installation.*

[(1) *Data required.* An engineering evaluation of the antiskid installation as installed on the airplane, including all necessary components, should be conducted. This analysis and complete descriptive data should be submitted to the CAA. The data should include hydraulic and electric schematic diagrams of the installation, assembly drawings of antiskid system units, test results or stress analysis substantiating structural strength of attachments and modification of the axle or other structural members, installation drawings, recommended instructions pertaining to installation, maintenance and operation and analysis of flight test data and results. Schematic drawings should refer to all units in the normal and emergency brake systems. The engineering evaluation should also assure that the anti-

[10a] [Proposed amendments may be obtained from the Civil Aeronautics Administration, Washington 25, D. C.]

skid system does not cause undesirable and adverse yaw characteristics.

[(i) Engineering evaluation should account for a bounce condition wherein the wheels may leave the runway after the brakes have been applied, for a condition wherein the wheels stay on the runway but the oleos are extended (if the system utilizes landing gear oleo compression in its operation), and for a condition in which the wheels of one main gear may not be in contact with the runway for a considerable time while the wheels of the other main gear are firmly on the runway. If the antiskid installation incorporates the "landing with brake pedals depressed" feature, then this type of operation should also be considered.

[(ii) It should be shown that the brake cycling frequency imposed by the antiskid installation will not result in excessive loads on the landing gear because of proximity to resonant landing gear frequencies.

[(2) *Systems.* The entire brake system (including both the basic brake system and the antiskid system) should conform to section 4b.337. The single failure criterion of section 4b.337 should be extended to include the antiskid system.

[(i) In the event of a probable malfunction within the antiskid system which would result in loss of the antiskid feature in one or more brake units, those brake units affected should automatically revert to normal braking.

[(ii) An indicating means should be provided to warn the pilot or copilot in the event of antiskid malfunction. For simple mechanical type antiskid installations wherein any single probable malfunction is considered remote and which will render only one braked wheel inoperative insofar as antiskid operation is concerned, the indicating means need not be located in the cockpit.

[(iii) A means should be provided so that the pilot or copilot can readily deactivate the antiskid system. For simple mechanical type antiskid installations wherein any single probable malfunction is considered remote and which will render only one braked wheel inoperative insofar as antiskid operation is concerned, the deactivating means need not be located in the cockpit.

[(iv) Antiskid installations should not cause surge pressures in the brake hydraulic system which would be detrimental to either the normal or emergency brake system and components.

[(v) The antiskid equipment should insure satisfactory operation on slippery runways as well as on dry hard surfaced runways without additional antiskid adjustments.

[(c) *Tests and analyses.*

[(1) When an antiskid system is included as original equipment on an airplane, it is not required that field length data,[10b] with antiskid inoperative, be determined.

[(2) Tests and analyses for the approval of an antiskid system to be used with a previously approved brake installation, without consideration for reduction of runway distances, should be conducted in accordance with this paragraph. When equivalent alternate procedures are developed and approved, they may be used in lieu of the method specified in this paragraph. If credit for shorter field lengths is requested on the basis of an antiskid installation, then complete flight tests should be conducted in accordance with sections 4b.115, 4b.122, 4b.123, 4b.170 and 4b.171.

[(3) When an antiskid system is installed, the braking performance and airplane stopping distances should be at least equivalent to those obtained during the accelerate-stop and landing type certification tests. The tests to be conducted are based on the high speed condition as being critical, both for airplane braking as controlled by the antiskid system, and for the functional integrity of an acceptable antiskid device. However, should it become necessary for a particular type of installation, these tests may be modified as warranted.

[(i) Conduct at least one accelerate-stop test at each of the following speeds: 80, 90, and 100 percent of the highest V_1 speed for which the airplane is certificated.[10c] The maximum landing weight, or the lowest weight above

[[10b] It is desirable to determine field length data with the antiskid inoperative in order that airplane operation may be conducted with antiskid inoperative if so desired by the operator.]

[[10c] In order to assure stopping distances equivalent to those shown in the Airplane Flight Manual, camera recording, or equivalent recordation methods should be used. To ascertain that the measured stopping distances are equivalent to those in the Airplane Flight Manual it will be necessary to compare the measured antiskid data with the data obtained during the manufacturer's original certification tests for the weight used in the antiskid tests at the highest speed for that weight shown in the Airplane Flight Manual.]

maximum landing weight necessary to keep the airplane from leaving the runway at the highest V_1 speed, should be used in the above three tests. When appropriate, the decelerate portions of the accelerate-stop tests may be demonstrated by landings with wing flaps in takeoff position in lieu of accelerating the airplane to V_1 speed on the runway. (See also sec. 4b.115–1.)

[(ii) Conduct at least one landing deceleration test at each of the following weights: maximum landing weight, an intermediate landing weight and normal minimum landing weight.[10d] All landings should be made from the highest corresponding contact speeds used in determining CAA Approved Airplane Flight Manual field lengths.

[(4) Conduct controllability tests in accordance with sections 4b.170 and 4b.171 (except for the emergency braking condition) after the occurrence of any single malfunction within the antiskid system (excluding the device and those components which were determined to be satisfactory based on laboratory tests). Single probable malfunctions, which analysis indicates may be likely to occur, should be simulated during landing or simulated landing deceleration tests. If analysis shows clearly that a particular malfunction would not adversely affect controllability, that malfunction need not be simulated in flight tests.

[(5) Conduct taxi tests to demonstrate that repeated rapid full brake pedal application and release does not result in excessive delay in brake reapplications and that ground handling maneuvering characteristics and sensitivity of braking effect are satisfactory.

[(6) Conduct tests and analyses to determine the effect of automatic cyclic brake action on the emergency brake system fluid supply. The fluid volume (reserved for emergency use in the reservoir or emergency accumulators of the basic brake system) may be adequate for manual braking but may be adversely affected by an antiskid installation. Hence, an engineering evaluation should be conducted to show that the antiskid system will not have an adverse effect on braking when the airplane is stopped by means of the emergency brake system, or to show that the antiskid system is automatically made inoperative when emergency braking is used.

[(7) If, during the tests specified in this paragraph, adjustments or modifications to the antiskid device or its installation proved necessary and indicated the possibility of encountering unreliable operation due to maintenance difficulties or the need for frequent adjustments, then accelerated service functioning and reliability tests should be conducted as deemed necessary.]

(21 F. R. 2558, Apr. 18, 1956, effective May 15, 1956.)

4b.350–1 *Noise and vibration characteristics (CAA policies which apply to sec. 4b.350 (g)).* Noise and vibration characteristics should be observed throughout the flight test program. If possible, noise levels should be measured and recorded in decibels.

(19 F. R. 4463, July 20, 1954, effective Sept. 1, 1954.)

4b.351–1 *Procedure for demonstrating pilot compartment visibility (CAA policies which apply to sec. 4b.351).*

(a) *Nonprecipitation conditions*. Such tests as are deemed necessary to show compliance with section 4b.351 (a) should be conducted.

(b) *Precipitation conditions, section 4b.351 (b).*

(1) The operation of the windshield wiper should be checked in actual or simulated precipitation conditions in order to demonstrate that adequate vision is provided for takeoff and landing at speeds up to 1.6 V_{S_1}.

(2) The windshield de-icing system should be checked for distribution and operation.

(19 F. R. 4463, July 20, 1954, effective Sept. 1, 1954.)

4b.351–2 *Vision with reverse thrust (CAA policies which apply to sec. 4b.351).* The policies outlined in section 4b.402–1 (g) and (h) will apply.

(20 F. R. 2279, Apr. 8, 1955, effective Apr. 30, 1955.)

4b.353–1 *Control tests (CAA policies which apply to sec. 4b.353).* Such tests as are deemed necessary to show compliance with the control movements and locations specified in section 4b.353 should be conducted.

(19 F. R. 4464, July 20, 1954, effective Sept. 1, 1954.)

[[10d] If it can be shown by the accelerate-stop distance tests conducted and the data obtained in subdivision (i) of this subparagraph that the landing distances when using normal landing braking techniques, would not exceed the landing distances approved without antiskid devices, then the landing distance tests specified in subdivision (ii) of this subparagraph need not be conducted.]

4b.356–1 *External doors (CAA policies which apply to sec. 4b.356).* The provisions of section 4b.356 should be applied to all cabin and crew compartment external doors usable for entrance or egress. It is not restricted to the main cabin door. Cargo and service doors not suitable for emergency egress need only comply with section 4b.356 (e) and safeguarding against opening in flight as a result of mechanical failure.

(20 F.R. 2279, Apr. 8, 1955, effective Apr. 30, 1955.)

4b.356–2 *Auxiliary latching devices (CAA policies which apply to sec. 4b.356 (b)).* (a) The use of auxiliary latching devices is permitted. Such devices would include dual locking handles, other types of locking and safetying devices, and two position handles, and where one operation such as pushing or pulling on the handle unlocks the latching mechanism and the second operation of turning the handle unlatches the door for opening. Auxiliary safetying devices should be used only as an additional safety factor and should not be used as a means of correcting an inadequate design of the primary locking or latching means. The advantages to be gained from the installation of auxiliary or dual safety devices (safety chains and dual handle main locking means) should be weighed against the need to easily and rapidly open the door in case of emergencies so that the overall level of safety is as high as practicable.

(b) All locking or safety means, including safety chains and latches of any kind, should be so positioned and designed that their presence, location and means of operation are obvious to one not familiar with door designs.

(1) The means of fastening safety devices should be sufficiently simple to make removal easy.

(2) Any emergency release mechanism installed to release the safety device should operate with a simple motion and upon the application of relatively small forces.

(3) All locking devices should be readily operable from both inside and outside of the airplane and be appropriately marked both inside and outside.

(c) Auxiliary safety devices meeting the standards of (b) may be fastened in place during the entire flight. It will not be necessary to have such devices unlatched during takeoff and landing. Auxiliary safety devices such as safety chains or bars that do not meet the standards of paragraph (b) of this section may be used provided operating instructions are installed at or near the device and a placard is installed requiring the removal of such devices prior to takeoff and landing.

(20 F.R. 2279, Apr. 8, 1955, effective Apr. 30, 1955.)

4b.356–3 *Power operated external doors (CAA policies which apply to sec. 4b.356(b)).* Power operated doors should be so designed that the door can be opened by manual means even when power is inactivated. The loss of power should not cause the door to become unlatched.[10e]

(20 F.R. 2279, Apr. 8, 1955, effective Apr. 30, 1955.)

4b.356–4 *Means for safeguarding against inadvertent opening in flight (CAA policies which apply to sec. 4b.356 (b)).* Auxiliary latching devices may be used to reduce the probability of inadvertent opening in flight provided they meet the standards and conditions covered in section 4b.356–2.

(a) It is acceptable to create a limited access zone in front of the door to eliminate the possibility of a passenger using the door handle as a steadying means and thereby inadvertently opening the door. Although providing a restricted zone by means of a barrier may appear to conflict with the requirements of section 4b.362 (g) for an unobstructed passageway to Type I and II emergency exits, it is considered that it would contribute sufficiently to the overall safety of the aircraft occupants to be permitted. This device may be a rope, chain, rigid bar or gate. Such installations should be waist high to provide the maximum benefits for an adult and the end fastenings should be simple to make removal easy. It is not considered acceptable to install full-length auxiliary doors, but waist-high rigid gates would be acceptable provided they open toward the door and will not block the opening of the cabin door in any way. The locking means should

[10e] Since emergency landings, such as the wheels-up condition, may reasonably result in the severance of electrical wires or rupture of hydraulic and pneumatic lines, the power which may be needed for operation of the doors or exits may be lost. Similarly, it is conceivable that under emergency conditions, the electrical power source may be purposely interrupted to reduce the possibility of fire.

may be made with fuel only. Otherwise, preliminary tests should be made with noninflammable fluid first and the results then checked using fuel. The following procedures and methods should be observed for demonstrating the operation of the fuel jettisoning system:

(1) *Fire hazard.*

(i) Fuel in liquid or vapor form should not impringe upon any external surface of the airplane during or after jettisoning. Colored fuel, or surfaces so treated that liquid or vaporous fuel changes the appearance of the airplane surface may be used for detection purposes. Other equivalent methods for detection may be acceptable.

(ii) Fuel in liquid or vapor form should not enter any portion of the airplane during or after jettisoning. The fuel may be detected by its scent, combustible mixture detector or by visual inspection. In supercharged aircraft the presence of liquid or vaporous fuel should be checked with the airplane unpressurized.

(iii) There should be no evidence of fuel valve leakage after it is closed.

(iv) If there is any evidence that wing flap positions, other than that used or the test may adversely affect the flow pattern, the airplane should be placarded "Fuel should not be jettisoned except when flaps are set at —°."

(v) The applicant should select for demonstration the tanks or tank combinations which are critical for demonstrating the flow rate during jettisoning.

(vi) Fuel jettisoning flow pattern should be demonstrated from all normally used tank or tank combinations on both sides of airplane whether or not both sides are symmetrical.

(vii) Fuel jettisoning rate may be demonstrated from only one side of symmetrical tank or tank combinations which are critical for flow rate.

(viii) Fuel jettisoning rate and flow pattern should be demonstrated when jettisoning from full tanks using fuel.

(2) *Control.*

(i) Changes in the airplane control qualities during the fuel jettisoning tests should be noted.

(ii) Discontinuance of fuel jettisoning should be demonstrated in flight.

(3) *Residual fuel.* The residual fuel should be measured by draining the tanks from which fuel has been jettisoned in flight, measuring the total drained fuel and subtracting from the total the unusable fuel quantity for each tank to determine if there is sufficient reserve fuel after jettisoning to meet section 4b.437. This may be a ground test.

(b) *Configuration.* Fuel jettisoning tests should be conducted in the configurations that follow:

(1) *Glide.*

Weight—maximum takeoff.
C. G. position—optional.
Wing flaps—retracted or in a position desired for approval.
Landing gear—retracted or extended as desired by applicant.
Engines—power off, propellers windmilling.
Cowl flaps—optional.
Airspeed—1.4 V_{s_1}.

(2) *Climb.*

Weight—maximum takeoff.
C. G. position—optional.
Wing flaps—retracted or in a position desired for approval.
Landing gear—retracted or extended.
Operating engine(s)—maximum continuous power, cowl flaps optional.
Critical inoperative engine—throttle closed on engine most critical for fuel flow pattern, propeller feathered, cowl flaps closed.
Airspeed—one engine inoperative best rate of climb speed.

(3) *Level flight.*

Weight—maximum takeoff.
C. G. position—optional.
Wing flaps—retracted or in a position desired for approval.
Landing gear—retracted or extended.
Engines—power required for airspeed of 1.4 V_{s_1}.
Cowl flaps—optional.

(c) *Test procedure and required data.* When the airplane is trimmed in the configuration specified in items (b) (1) and (b) (2), the jettisoning valves should be opened and allowed to remain open until all jettisoning liquid has been disposed. If the configuration of (b) (3) is critical, tests should also be conducted for this

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condition. This procedure may be carried out in segments if desired. The following data should be recorded:

Time to jettison fuel.
Fuel gauge quantity at reasonable time intervals.
Pressure altitude.
Indicated airspeed.
Engines, r. p. m. and manifold pressure.
Carburetor air temperature.

(19 F. R. 4464, July 20, 1954, effective Sept. 1, 1954.)

4b.440–1 *Procedure for demonstrating oil cooling (CAA policies which apply to sec. 4b.440 (e))*. Procedures for conducting cooling tests are those outlined in sections 4b.452–1 and 4b.453–1.

(19 F. R. 4464, July 20, 1954, effective Sept. 1, 1954.)

4b.449–1 *Procedure for demonstrating propeller feathering (CAA policies which apply to sec. 4b.449)*. Tests should be conducted to demonstrate that the oil reserve for propeller feathering is adequate to accomplish the feathering procedure. This may be done on the ground by using an auxiliary source of oil for lubricating the engine during its operation.

(19 F. R. 4464, July 20, 1954, effective Sept. 1, 1954.)

4b.450–1 *Cooling with reverse thrust (CAA policies which apply to sec. 4b.450)*. The policies outlined in section 4b.402–1 (j) will apply.

(20 F. R. Apr. 8, 1955, effective Apr. 30, 1955.)

4b.452–1 *Procedure for demonstrating cooling climb (CAA policies which apply to sec. 4b.452)*.

(a) If the applicant is not able to provide data for the location of the engine having the hottest cylinder heads and bases, the following procedure should be accomplished. The cylinder heads and bases on one engine should be fully instrumented for the purpose of determining the location of the hottest cylinder head and base to be checked during the climb cooling. Thermocouples should be installed on one head of each of the remaining engines at the location shown to be critical on the fully instrumented engine. The hottest of the critical cylinder heads may be determined by measuring the temperatures of each of the engines under simulated climb conditions. The engine having the hottest cylinder head should be chosen as the engine to be tested for the cooling demonstration. Instruments for determining the oil inlet and cylinder base temperatures should be installed on this engine. The cooler operating outboard engine should be considered to be the critical inoperative engine unless there is reason to believe that another engine is more critical. The cooling tests should be conducted in an atmosphere which is free of any visible moisture.

(b) *Configuration*. This test should be conducted in the configuration that follows:

Weight—maximum takeoff.
C. G. position—optional.
Wing flaps—optional.
Landing gear—optional.
Operating engine(s)—maximum continuous power, mixture setting the same as used in normal operation and cooling controls in CAA hot day cooling position.
Critical inoperative engine—throttle closed on cooler operating outboard engine, propeller feathered and cowl flaps closed.

(c) *Test procedure and required data*.

(1) Prior to commencing the cooling climb, the engine temperatures should be stabilized in level flight at the lower of the two altitudes specified in section 4b.452 (c). During level flight the cooling climb conditions should be simulated by adjusting the airplane configuration to that shown in (b) and maintaining the necessary power on the operating engine(s) to obtain the speed specified in section 4b.452 (d).

(2) When the temperatures have stabilized, i. e., the rate of temperature change is less than 2° F. per minute, the propeller on the inoperative engine should be feathered and the cooling climb commenced at maximum continuous power and at the specified configuration and speed. The climb should be continued for five minutes after occurrence of the highest temperature or until the maximum altitude desired for certification is reached.

(3) The above procedure should be repeated when demonstrating engine cooling for high blower except that temperatures should be stabilized in level flight with simulated climb conditions at an altitude of 1,000 feet below the critical altitude established for the high blower. The weight of the airplane should be such that it will permit a rate of climb equal to that specified in section 4b.120 (c).

(4) The following data should be recorded at no greater than one minute intervals:

Pressure altitude.
Ambient air temperature.
Engines, r. p. m. and manifold pressure.
Carburetor air temperature.
Indicated airspeed.
Hottest cylinder head temperature.
Hottest cylinder base temperature.
Oil inlet temperature.

breathing level at the flight crew stations should be determined in flight tests during which fuselage compartment fire extinguishers are discharged in accordance with established fire control procedures. Since carbon dioxide is heavier than air, a nose down attitude is likely to produce the critical concentrations in the crew compartment. The following conditions should therefore be investigated:

(1) A rapid descent at the "Never Exceed" speed of the airplane with flaps and landing gear up,

(2) A rapid descent with flaps and landing gear down, at the maximum permissible speed for this configuration. If it appears that any other condition is likely to be critical on a particular airplane, it should also be investigated.

(c) In the flight tests specified in (b), it will be permissible to institute emergency ventilating procedures immediately prior to or following the discharge of carbon dioxide, provided such procedures can be accomplished easily and quickly by the flight crew and do not appreciably reduce the effectiveness of the fire protection system.

(d) If the carbon dioxide concentrations determined in accordance with paragraphs (b) and (c) exceed 3 percent by volume (corrected to standard sea-level conditions), protective breathing equipment should be provided for each flight crew member on flight deck duty.

(e) Appropriate emergency operating procedures should be entered in the Airplane Flight Manual.

(15 F. R. 8904, Dec. 15, 1950, effective Dec. 15, 1950.)

[4.606–1 *Safety criteria* [12a] *for electric utilization systems (CAA policies which apply to sec. 4b.606 (a) and (b)).* Electric utilization systems [12b] should be analyzed, inspected or tested to assure conformance to the following safety criteria.

[(a) *Loss of system function.* The system should not be rendered inoperative by any probable malfunction,[12c] if operation of this system is necessary to maintain controlled flight or effect a safe landing for any authorized flight operation.

[(b) *Inadvertent operation of system.* The system should not be inadvertently set into operation by any probable malfunction, if such inadvertent operation can result in the inability to maintain controlled flight or effect a safe landing for any authorized flight operation.

[(c) *Systems serving two or more engines.* No probable malfunction in the system should adversely affect the performance of more than one propulsion engine, consistent with the provisions of section 4b.401 (b).

[(d) *System independence.* No probable malfunction in one system should render another system inoperative, if both systems are necessary in showing compliance with this part.

[(e) *Misleading system indicators.* No probable malfunction in the system should result in a safe indication of an unsafe condition of flight, if such misleading information can result in the inability to maintain controlled flight or effect a safe landing for any authorized flight operation.

[(f) *System overheat.* No probable malfunction in the system should result in overheat of electric equipment, such that hazardous quantities of smoke are generated within the cabin, or such that a fire hazard is created, unless adequate means are provided to detect and correct the overheat condition during flight.

[(g) *Electric shock exposure.* No probable malfunction in the system should expose crew or passengers to harmful electric shock, during any normal activity on the aircraft.]

(21 F. R. 2747, Apr. 28, 1956, effective May 25, 1956.)

[[12a] When applying these criteria to particular systems, it should be clear that the degree of hazard resulting from a type of malfunction may vary considerably with the type of aircraft in which the system is installed, or with the nature of the operation in which the aircraft is utilized. Examples of systems which should be considered under certain of the above criteria are as follows: (a) Basic flight instruments, minimum navigation equipment; (b) propeller reversing system, trim-tab system, dive brake system, landing gear actuation systems; (c) fuel control valve system, propeller control system; (d) landing gear indicating system, radio navigation system, instrument landing system, gyroscopic instrument systems. Additional safety criteria are contained in sections of this part applicable to particular systems and components of the airplane.]

[[12b] An electric utilization system is a system of electric equipment, devices and connected wiring, which utilizes electric energy to perform a specific aircraft function. The system includes all electric components beyond the nearest bus or sub-bus from which electric energy is supplied. Examples of such systems are: propeller control system, electric flight instrument system, radio navigation equipment system, fuel valve control system, flap and landing gear actuating systems.]

[[12c] A probable malfunction is any single electrical or mechanical malfunction or failure within a utilization system which is considered probable on the basis of past service experience with similar components in aircraft applications. This definition should be extended to multiple malfunctions when: (1) The first malfunction would not be detected during normal operation of the system, including periodic checks established at intervals which are consistent with the degree of hazard involved or (2) the first malfunction would inevitably lead to other malfunctions.

[This definition of "probable malfunction" applies wherever this term is used in this section.]

4b.611-1 *Procedure for checking arrangement and visibility of instrument installations (CAA policies which apply to sec. 4b.611).* The arrangement and visibility of the instruments should be checked throughout the type tests in order to supply the information which is necessary to complete the pertinent portions of Form ACA 283-4b, Type Inspection Report.

(19 F. R. 4466, July 20, 1954, effective Sept. 1, 1954.)

4b.612-1 *Airspeed indicating system calibration (CAA policies which apply to sec. 4b.612 (a)).*

(a) Unless a calibrated referenced airspeed system is provided, the airplane's system should be calibrated throughout as wide a range as necessary to cover the intended flight tests. The tests in (c) are for the purpose of showing compliance with section 4b.612(a) and not intended to cover the speed range of the flight tests. If an alternate airspeed indicating system is provided, it should also be calibrated.

(1) The tests should be conducted in stabilized flight at airspeeds throughout the speed range for the airplane configurations to be tested. The airplane's airspeed indicator should be calibrated against a reference airspeed system or against a groundspeed course.

(2) A reference airspeed system should consist of either of the following:

(i) An airspeed impact pressure and static pressure measurement device or devices that are free from error due to airplane angular changes relative to the direction of the free stream or due to slipstream variation resulting from changes in airplane configuration or power. In addition the device or devices should have a known calibration error when located in the free stream, or

(ii) Any other acceptable airspeed calibration method, for example, the altimeter method of airspeed calibration. However, when using the altimeter method care should be exercised to measure the airplane's altitude accurately—especially at speeds below 125 m. p. h.

[(3) When establishing the airplane's true airspeed by means of the groundspeed course, flight between the two reference points should be made at constant airspeed in two successive runs in opposite directions to eliminate the effect of wind. The runs should be made only in stable wind. The time to make the runs should be obtained by means of some calibrated device. The speed runs should not be made nearer the ground surface than a wing span's length.]

(20 F. R. 6677, Sept. 10, 1955, effective Sept. 30, 1955.)

(4) If an alternate system is provided it may be calibrated against either the reference system or the airplane's system.

(b) *Configuration.* Airspeed calibration tests should be conducted in the configurations that follow:

Weight—between maximum takeoff and maximum landing.
C. G. position—optional.
Wing flaps and landing gear retracted.
Wing flaps in landing position and landing gear extended.
Engine—optional power.
Mixture setting—optional
Cowl flaps—optional.

(c) *Test procedure and required data.* Any one or any desired combination of the procedures in (1) through (3) of this paragraph may be used for calibrating the airspeed instrument. The airspeed should be measured or determined simultaneously from the airplane's and the reference system during stabilized runs for at least five speeds spaced throughout the speed range, the lowest not to exceed 1.3 V_{s_1}. The highest speed should not exceed V_{NO}, placard speed, or speed in level flight using maximum continuous power, whichever is lower. The speed spread between the test speeds should be limited to 10 m. p. h. from 1.3 V_{s_1} to 1.6 V_{s_1} or placard speed, and 30 m. p. h. from 1.6 V_{s_1} to V_{NO}.

(1) *Speed course.* The airspeed and altitude should be stabilized before entering the speed course. Constant airspeed should be maintained during each run. The runs should be made in both directions for each speed over the speed course. The following data should be recorded:

Time of day at beginning of run.
Time to make run.
Pressure altitude.
Ambient air temperature.
Airspeed at several intervals during run.
Wing flap position.
Landing gear position.
Course distance.

(2) *Reference airspeed system.* Stabilized runs at the test speeds listed in (c) should be made. The airspeed from the airplane's airspeed system and the reference airspeed system should be read simultaneously. The following data should be recorded:

Time of day.
Airplane's indicated airspeed.
Reference indicated airspeed.
Pressure altitude.
Ambient air temperature.
Wing flap position.
Landing gear position.

(3) *Other acceptable airspeed calibration methods.* Stabilized flight runs at the test speeds should be made and the necessary data recorded to establish the airplane's airspeed system error and the configuration of the airplane.

(19 F. R. 4466, July 20, 1954, effective Sept. 1, 1954, amended Apr. 30, 1955.)

4b.612–2 *Static air vent system (CAA policies which apply to sec. 4b.612 (b)).*

(a) If the altimeter installation is of the pressure type its operation will be affected by any error that exists in the static air pressure. Since the accuracy of the altimeter is of utmost importance the static air vent system should be calibrated. If separate or alternate vent systems are employed for the altimeter and airspeed indicator, separate calibrations are required. Where the altimeter, rate of climb indicator, and airspeed indicators are vented to the same static systems, the altimeter calibration may be made in conjunction with the airspeed calibrations.

(b) The theoretical relationship between airspeed error and altimeter error is given in Figure 4 (p. 69) so that an altimeter calibration may be derived from the airspeed calibration if both use the same static vent provided that the total head installation is such as to provide true readings over the range of angles involved.

(19 F. R. 4466, July 20, 1954, effective Sept. 1, 1954.)

4b.612–3 *Calibration of magnetic direction indicator (CAA policies which apply to sec. 4b.612 (c)).* It is recommended that the magnetic direction indicator be calibrated while the airplane is on the ground with its engine and electrical equipment operating. The calibration data should be included in Form ACA 283–4b

(19 F. R. 4466, July 20, 1954, effective Sept. 1, 1954.)

[4b.612–4 *Automatic pilot systems (CAA policies which apply to sec. 4b.612 (d)).* To preclude hazardous conditions which may result from any failure or malfunctioning of the automatic pilot system, or its inadvertent use by the human pilot, the conditions of paragraphs (a) through (e) and paragraph (h) of this section should be investigated by flight test.

[(a) A signal about any axis equivalent to the cumulative effect of any single failure (or if multiple axis failures can result from the malfunction of any single component, combined signals about all affected axes) should be induced into the automatic pilot system during normal climb,[13] cruise, and descent regimes. When corrective action is taken 3 seconds after the airplane response[14] to the malfunction neither the simulated failure nor the subsequent corrective action should create loads beyond an envelope of 0 to 2 *g*, or speeds beyond V_{NE} (or M_{NE} where appropriate), or dangerous deviations from the flight path, except that the positive g limitation may be increased up to the positive design maneuvering load factor if it has previously been determined analytically that neither the simulated failure nor subsequent corrective action would result in loads beyond the design limit loads of the airplane.

[(1) Recovery should be demonstrated either by overpowering or by manual use of an emergency quick disconnect device after the 3-second delay. The pilot should be able to return the airplane to its normal flight attitude under full manual control without exceeding the loads or speed limits defined in this paragraph and without engaging in any dangerous maneuvers during recovery. If an emergency quick disconnect button is not installed on the control wheel it should be possible to overpower servo forces plus resultant airloads in all configurations and attitudes of flight demonstrated, including maximum speed for which approval

[13 The configuration for normal climb will be that for operational all-engine climb with 75 percent maximum continuous power and flaps retracted.]

[14 Adequate instrumentation should be installed to register response of the airplane to the induced malfunction. One acceptable method would be by measurement of airplane acceleration.]

is sought, without exceeding the following control forces measured at the pilot's controls: pitch 50 pounds; roll 30 pounds (force applied at rim); yaw 150 pounds. The maximum altitude loss experienced during these tests should be entered in the Airplane Flight Manual under "Emergency Operating Procedures."

[(b) The automatic pilot system should be able to perform its intended function throughout all appropriate maneuvers. All such maneuvers should be accomplished smoothly and without subjecting the airplane to loads greater than those described in paragraph (a) of this section.

[(c) If the automatic pilot system includes an approach coupler it should be able to perform its intended function, and the following should apply:

[(1) Throughout an approach no signal or combination of signals simulating the cumulative effect of any single failure or malfunction in the automatic pilot system should produce hazardous deviations in the flight path or any degree of loss of control if corrective action is initiated one second after the airplane responds to the malfunction.

[(i) The airplane should be flown down the ILS (or along a flight path simulating the ILS) in the approach configuration. At a predetermined point a failure should be induced in the automatic pilot system. One second after the airplane responds to the malfunction, the pilot should take corrective action by either overpowering or manually disconnecting the automatic pilot (utilizing the emergency quick disconnect button on the control wheel). The vertical distance below the glide path, measured from the point at which level flight is regained, should be entered in the Airplane Flight Manual under "Emergency Operating Procedures."

[(2) An engine failure during a normal ILS approach should not cause a lateral deviation of the airplane from the flight path at a rate greater than three degrees per second.

[(3) If approval is sought for ILS approaches initiated with one engine inoperative, the automatic pilot should be capable of conducting the approach, and the provisions of subparagraph (1) of this paragraph should be complied with.

[(4) A visual means should be provided between the automatic pilot and the flight path coupler to indicate to the pilot when the automatic pilot is uncoupled from the airborne navigational reference.

[(d) For an automatic pilot without an approach coupler, where the applicant desires approval for low approaches, the conditions outlined in paragraphs (c) (1), (2), and (3) should apply.

[(e) If an automatic trim system is incorporated into the automatic pilot, it should be so designed and installed that any failure will not create a hazardous condition to either automatic or manual flight.

[(f) When an emergency quick disconnect device is installed on the automatic pilot, the release buttons should be located on both the pilot's and copilot's control wheels, on the side of the wheel opposite from the throttles.

[(g) The automatic pilot system should be so installed that its operation will not be adversely affected by spurious signals from other sources, or as a result of normal variations in the automatic pilot system power source, or feedback by other equipment operating from the same power source (see secs. 4b.625 (b) and 4b.650 (c)).

[(h) The automatic pilot system should be so installed and adjusted that the servo stall forces established during certification tests can be maintained in normal operation. This may be assured by conducting flight tests throughout the envelope of servo stall forces. Those tests conducted to determine that the automatic pilot system will adequately control the aircraft should establish the lower stall force limit; and those tests to determine that the automatic pilot will not impose dangerous loads or deviations from the flight path should be conducted at the upper stall force limit.

[(i) A positive means should be provided to indicate to the pilot when the automatic pilot is ready for operation or when the gyroscopic components are uncaged, unless it is impossible (as a result of design features) to engage the automatic pilot before it is ready for operation.

[(j) The following information should be placed on the Aircraft Specification:

[(1) Servo motor and gear train model numbers

[(2) Servo unit pulley sizes

[(3) Upper and lower limiting stall forces measured at the servo motors

[(k) The following information should be placed in the Airplane Flight Manual:

[(1) Under the Operating Limitations section, airspeed limitations and other applicable operating limitations.

[(2) Under the Operating Procedures section, normal operation information.

[(3) Under the Emergency Operating procedures section, a statement of altitude lost in the *cruising configuration* (see subparagraph (a) (1) of this section); a statement of altitude lost on ILS approaches (see paragraph (c) (1) (i) of this section); and any other applicable emergency procedure information.]

(21 F. R. 2124, Apr. 3, 1956, effective Apr. 14, 1956.)

4b.624-1 *Automatic reset circuit breaker* (*CAA policies which apply to sec. 4b.624*). Automatic reset circuit breakers (which automatically reset themselves periodically) should not be applied as circuit protective devices.[15] They may be used as integral protectors for electrical equipment (e. g., thermal cut-outs) provided that circuit protection is also installed to protect the cable to the equipment.

(20 F. R. 2280, Apr. 8, 1955, effective Apr. 30, 1955.)

4b.632-1 *Red passing lights* (*CAA policies which apply to sec. 4b.632* (*a*)). When it is desired to improve the conspicuity of the aircraft, a steady red light, commonly known as a passing light, may be installed. This light is not considered to be a position light and therefore need not be type certificated. When installed, its location should be one of the following:

(a) Within the left landing light unit.

(b) On the centerline of the aircraft nose.

(c) In the leading edge of the left wing, outboard of the propeller disc.

(16 F. R. 3212, Apr. 12, 1951, effective Apr. 15, 1951.)

4b.642-1 *Procedure for testing flare ejection* (*CAA policies which apply to sec. 4b.642* (*b*)). When flares are released, they should clear the aircraft structure when the airplane is flown at a speed of 1.4 V_{s_1} with the wing flaps and land-

[15] Circuit protective devices are normally installed to limit the hazardous consequences of overloaded or faulted circuits. These devices are resettable (circuit breakers) or replaceable (fuses) to permit the crew to restore service when nuisance trips occur or when the abnormal circuit condition can be corrected in flight. If the abnormal circuit condition can *not* be corrected in flight, the decision to restore power to the circuit involves a careful analysis of the flight situation. It is necessary to weigh the essentiality of the circuit for continued safe flight against the hazards of resetting on a possibly faulted circuit. Such evaluation is properly an aircraft crew function which can not be performed by automatic reset circuit breakers. To assure crew supervision over the reset operation, circuit protective devices should be of such design that a manual operation is required to restore service after tripping.

required to takeoff and clear a 50-foot obstacle will be necessary. It is recommended that these data be given for a range of temperatures (see sec. 4b.117) and runway gradients sufficient to permit proper dispatching under the rules of Part 40 of this subchapter, etc., in addition to the standard day temperature data.

(vi) *Takeoff information.* Takeoff flight paths through the final climb segment, flight path slope or data supplementary to that obtained in subparagraph (v) that may be used for dispatching purposes should be included. These should be for the same range of temperatures (see sec. 4b.117) and runway gradients as (v).

(vii) *Minimum takeoff climb speed, V_2.* This speed should be listed for the range of weights, altitudes and conditions covered in subparagraphs (v) and (vi). The distance to accelerate to these speeds should also be included to provide data necessary for gradient problems involving runways with variable gradients of sufficient magnitude that average gradients cannot be assumed.

(viii) *Critical engine failure speed, V_1.* This speed or speeds V_1 for the range of weights, altitudes and conditions covered in subparagraphs (v) and (vi) if applicable should be given. The distances to accelerate to these speeds should also be included to provide data necessary for gradient problems involving runways with variable gradients of sufficient magnitude that average gradients cannot be assumed.

(ix) *Minimum runway length required for landing.* With respect to this item, the following data would be considered appropriate: Landing distance from height of 50 feet. Minimum effective landing runway length—scheduled stops. (See Part 40 of this subchapter.) Minimum effective landing runway length—alternate stops. (See Part 40 of this subchapter.)

(x) *Wind effect in landing and takeoff.* If it is desired to take advantage of wind in determining landing and takeoff distances all data should be based upon wind velocities reported at a height of 50 feet above the runway; i. e., the runway length would be calculated for one half of the reported headwind velocity, or one and one-half times the reported tailwind velocity, measured at a height of 50 feet corrected for wind gradient to the height of the center of aerodynamic drag of the airplane. A note clearly stating the above stipulations should be included in the manual.

(xi) *Rates of climb and climbing speeds.* These rates and speeds should be specified for the desired range of weights and altitudes, together with the corresponding airplane configuration (flap position, gear position, etc.), and should be given for the following when applicable:

(*a*) First segment takeoff climb (sec. 4b.120 (a)).

(*b*) Second segment takeoff climb (sec. 4b.120 (b)).

(*c*) Third segment takeoff climb (sec. 4b.116 (d)).

(*d*) Final segment takeoff climb (sec. 4b.116 (e)).

(*e*) One-engine inoperative en route climb (sec. 4b.120 (c)).

(*f*) All engine en route climb (sec. 4b.119 (a)).

(*g*) Two-engine inoperative en route climb (sec. 4b.121).

(*h*) Approach climb (sec. 4b.120 (d)).

(*i*) Landing climb (sec. 4b.119 (b)).

(xii) *Engine power curve.* A copy of the CAA approved power chart of BHP vs. MP at RPM and BHP vs. altitude at RPM and at MP should be included.

(xiii) *Performance charts.* Any instructions or examples for use of the performance charts should be included.

(xiv) *Removal of performance data.* The Performance Section of the Airplane Flight Manual should not be removed from the Airplane Flight Manual. However, any tables, charts, etc., that an air carrier operator prepares which are based on airplane flight manual performance material for convenience in determination of load limitation data need not be carried in the Airplane Flight Manual even though approved by the CAA if the operator does not care to do so.

(e) *Weight and balance data.*

(1) *General.* Inasmuch as it is desired to eliminate the necessity of submitting revisions of the Airplane Flight Manual to the CAA for approval whenever an item of equipment is altered or added, this section of the manual will not be included in the formally "approved" portion of the document. However, a note to the effect that the airplane should be operated in accordance with the approved loading schedule should be included in the Limitations section. (See (b) (1).)

(2) *Responsibility for control of weight and balance.* It is the intention of the Civil Aeronautics Administration to place the responsibility for the control of weight and balance with the manufacturer and operator. The manufacturer will furnish a weight and balance report for each new airplane which may be included in the manual but not in the "approved" portion. The Civil Aeronautics Administration's representative will not approve each individual report but will make only occasional spot checks to ascertain that the manufacturer's weight control procedure is adequate. The manufacturer will be expected to furnish complete information with the airplane not only regarding its actual weight and balance, but also to include sketches, samples and other data that will assist the operator in checking the balance after alterations.

(3) *Conventional airplanes.* The following material is believed to be complete and adequate for a conventional airplane.

(i) *Weight limits.* A list and explanation (where necessary) of the various weight limits should be given.

(ii) *C. G. limits.* The approved operating c. g. range should be specified.

(iii) *Empty weight and emply weight C. G. location.*

(iv) *Equipment list.* All equipment included in the empty weight should be listed.

(v) *Weight computations.* The computations necessary to determine the empty weight c. g. location, including identification of balance datum should be shown.

(vi) *Loading schedule.*

(vii) *Loading schedule instructions.* Complete instructions in the use of the loading schedule should be provided.

(4) *Unconventional airplanes.* In the case of unconventional airplanes or airplanes with special features, the information specified in subparagraph (3) should be modified or amplified as necessary to cover the case.

(f) *Supplements.* As a general rule, when major alterations are made by an operator (or owner) to an airplane involving appreciable changes to the Airplane Flight Manual it is advisable for the operator to prepare a separate supplement to the original manual under his own name covering the items that are different from the original manual. Then subsequent revisions to the manual by the manufacturer or operator will pertain only to their respective portions of the manual and should eliminate possible confusion.

(g) *Submittal.* Three copies of the above material, less the Weight and Balance Data Section, should be submitted to the appropriate

Civil Aeronautics Administration regional office by the applicant for an original approval. The three copies will be signed by the regional Chief, Aircraft Division; one copy will be returned to the applicant, one will be forwarded to the Washington office and the other retained by the regional office. A single copy of the title page to be used for Chief's signature may be substituted for the applicant's copy if desired. In cases where the revisions to the manual are of primary importance to safety in flight, the pertinent Aircraft Specification will contain a description of the change to ensure that all manuals are revised. A revision of this type would usually be the subject of an Airworthiness Directive note. One copy of the Weight and Balance Section should be included in the manual by the applicant for each airplane at the time of certification.

(16 F. R. 1052, Feb. 6, 1951, effective Feb. 6, 1951, amended 19 F. R. 4446, July 20, 1954, effective Sept. 1, 1954.)

4b.740-2 *Reverse thrust operating limitations and procedures (CAA policies which apply to sec. 4b.740).* The policies outlined in section 4b.402-1 (b) will apply.

(20 F. R. 2281, Apr. 8, 1956, effective Apr. 30 1956.)

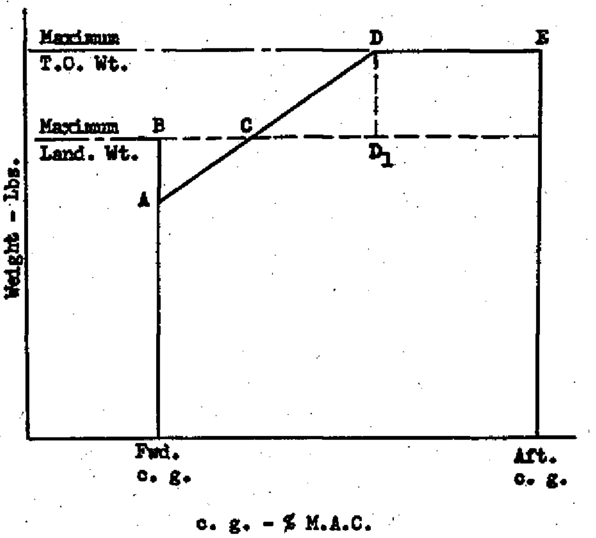

Figure 1. Weight—c. g. Positions

Option 1—*Climb requirement based on forward c. g. stalling speed.*

(a) Tests may be conducted at one c. g. position only, that is "B".

(b) In lieu of (a), tests should be conducted at "A" and "C".

Option 2—*Climb requirement based on stalling speed varying with c. g.*

(a) Tests should be conducted along "A", "C", "D_1", etc., in order to adequately establish the variation of the stalling speed with c. g.

(19 F. R. 4450, July 20, 1954, effective Sept. 1, 1954.)