§ 4b.334 Retracting mechanism.

(a) *General.* (1) The landing gear retracting mechanism, wheel well doors, and supporting structure shall be designed for the loads occurring in the flight conditions when the gear is in the retracted position, and for the combination of friction, inertia, brake torque, and air loads occurring during retraction and extension at any air speed up to 1.6 V_{s_1} (flaps in the approach position at design landing weight), and any load factor up to those specified in § 4b.212 for the flaps extended condition.

(2) The landing gear, the retracting mechanism, and the airplane structure including wheel well doors shall be designed to withstand the flight loads occurring with the landing gear in the extended position at any speed up to 0.67 V_c, unless other means are provided to decelerate the airplane in flight at this speed.

(3) Landing gear doors, their operating mechanism, and their supporting structure shall be designed for the conditions of air speed and load factor prescribed in subparagraphs (1) and (2) of this paragraph, and in addition they shall be designed for the yawing maneuvers prescribed for the airplane.

(b) *Landing gear lock.* A positive means shall be provided for the purpose of maintaining the landing gear in the extended position. A means shall be provided to prevent the retraction of the landing gear while the airplane is on the ground.

(c) *Emergency operation.* Emergency means of extending the landing gear shall be provided, so that the landing gear can be extended in the event of any reasonably probable failure in the normal retraction system. In any case the emergency system shall provide for the failure of any single source of hydraulic, electric, or equivalent energy supply.

(d) *Operation test.* Proper functioning of the landing gear retracting mechanism shall be demonstrated by operation tests.

(e) *Position indicator and warning device.* (1) When a retractable landing gear is used, means shall be provided for indicating to the pilot when the gear is secured in the extended and in the retracted positions.

NOTE: An acceptable method for indicating to the pilot when the landing gear is secured in the extended and in the retracted positions is by means of lights. For example, landplanes may display a green light when the landing gear is down and locked; a red light to indicate an intermediate or unlocked landing gear position; and "all lights out" when the landing gear is up and locked. An acceptable method for sensing when the landing gear is secured in the extreme positions is to locate the sensing devices so that they are operated by the landing gear locking latch.

(2) In addition to the requirement of subparagraph (1) of this paragraph, landplanes shall be provided with an aural warning device which will function continuously when one or more throttles are closed if the gear is not fully extended and locked.

(3) If a manual shutoff for the warning device prescribed in subparagraph (2) of this paragraph is provided, it shall be installed so that reopening the throttles will reset the warning mechanism.

(f) *Control.* The location and operation of the landing gear retraction control shall be according to the provisions of § 4b.353.

(g) *Protection of equipment in wheel wells.* Equipment located in wheel wells, which is essential to safe operation of the airplane, shall be protected from the damaging effects of a bursting tire unless it is shown that a tire cannot burst from overheat, or from the damaging effects of a loose tire tread unless it is shown that a loose tire tread cannot cause damage.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 17 F.R. 1093, Feb. 5, 1952; Amdt. 4b–8, 23 F.R. 2591, Apr. 19, 1958; Amdt. 4b–12, 27 F.R. 2992, Mar. 30, 1962]

§ 4b.334–1 Procedure for testing landing gear retracting system (FAA policies which apply to § 4b.334).

(a) *General, § 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.
Air speed, at least 0.67 V_c.
Landing gear extended.

(b) *Emergency operation, § 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, § 4b.334 (d).* The time required to retract the landing gear at speed V_2 (see § 4b.116 (b)) should be demonstrated in flight under the following conditions:

Weight—Optional.
C. G. position—Optional.
Operating engine(s)—Take-off 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.

[Supp. 24, 19 F. R. 4461, July 20, 1954]

§ 4b.334–2 Landing gear position indicator switches (FAA interpretations which apply to § 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.

[Supp. 29, 21 F.R. 2747, Apr. 28, 1956]

§ 4b.335 Wheels.

Main wheels and nose wheels shall be of an approved type. The following provisions shall apply.

(a) The maximum static load rating of each main wheel and nose wheel shall not be less than the corresponding static ground reaction under the design take-off weight of the airplane and the critical center of gravity position.

(b) The maximum limit load rating of each main wheel and nose wheel shall not be less than the maximum radial limit load determined in accordance with the applicable ground load requirements of this part (see §§ 4b.230 through 4b.236).

(c) The brake kinetic energy capacity rating of each main wheel-brake assembly shall not be less than the kinetic energy absorption requirement determined in accordance with this paragraph. The brake kinetic energy absorption requirements shall be based on a rational analysis of the sequence of events which are expected to occur during operational landings at maximum landing weight. This analysis shall include conservative values of airplane speed at which the brakes are applied, braking coefficient of friction between tires and runway, aerodynamic drag, propeller drag or powerplant forward thrust, and if more critical, the most adverse single engine or propeller malfunction. In lieu of a rational analysis it shall be acceptable to establish the kinetic energy absorption requirements for each main wheel brake assembly by the following formula:

$$KE = \frac{0.0334 W V_{s_0}^2}{N};$$

where:
KE=kinetic energy per wheel (ft. lb.);
W=design landing weight (lb.);
V_{s_0}=power-off stalling speed of the airplane (mph) at sea level at the design landing weight and in the landing configuration;
N=number of main wheels.

NOTE: The expression for kinetic energy assumes an equal distribution of braking between main wheels. In cases of unequal distribution the expression requires appropriate modification.

(d) The minimum stalling speed rating of each main wheel-brake assembly, i. e., the initial speed used in the dynamometer tests, shall not be greater than the V_{s_0} used in the determination of kinetic energy in accordance with paragraph (c) of this section.

NOTE: The provision of this paragraph is based upon the assumption that the testing procedures for wheel-brake assemblies involve a specified rate of deceleration, and, therefore, for the same amount of kinetic energy the rate of energy absorption (the power absorbing ability of the brake) varies inversely with the initial speed.

[Amdt. 4b–6, 17 F.R. 1093, Feb. 5, 1952, as amended by Amdt. 4b–6, 22 F.R. 5564, July 16, 1957]

§ 4b.336 Tires.

Landing gear tires shall be of a proper fit on the rim of the wheel, and of load ratings which are not exceeded under the following conditions:

(a) Main wheel tires: Equal static loads on all main wheel tires corresponding with the most critical combination of maximum take-off weight and center of gravity position.

(b) Nose wheel tires: Equal loads on all nose wheel tires corresponding with the following conditions:

(1) The static ground reaction per tire corresponding with the most critical combination of take-off weight and center of gravity position. This load shall correspond with the static rating of the tire.

(2) The dynamic ground reaction per tire at maximum landing weight, assuming the mass of the airplane concentrated at the most critical location of the center of gravity for this weight and exerting a force of 1.0g downward and 0.31g forward, the reactions being distributed to the nose and main wheels by the principles of statics with a 0.31g drag reaction at the ground applied at those wheels which have brakes. This load shall correspond with the dynamic rating of the tire.

(3) The dynamic ground reaction per tire at design takeoff weight, assuming the mass of the airplane concentrated at the most critical location of the center of gravity for this weight, and exerting a force of 1.0g downward and 0.20g forward, the reactions being distributed to the nose and main wheels by the principles of statics with a 0.20 drag reaction at the ground applied at those wheels which have brakes. This load shall correspond with the dynamic rating of the tire.

[Amdt. 4b-3, 21 F. R. 993, Feb. 11, 1956; 21 F. R. 1088, Feb. 17, 1956]

§ 4b.337 Brakes.

(a) *General.* (1) The airplane shall be equipped with brakes of an approved type. The brake ratings shall be in accordance with § 4b.335 (c) and (d).

(2) The brake system shall be so designed and constructed that in the event of a single failure in any connecting or transmitting element in the brake system (excluding the operating pedal or handle), or the loss of any single source of hydraulic or other brake operating energy supply, it shall be possible to bring the airplane to rest under conditions specified in § 4b.122 with a mean deceleration during the landing roll of at least 50 percent of that obtained in determining the landing distance as prescribed in that section.

(3) In applying the requirement of subparagraph (2) of this paragraph to hydraulic brakes, the brake drum, shoes, and actuators (or their equivalents) shall be considered as connecting or transmitting elements, unless it is shown that the leakage of hydraulic fluid resulting from failure of the sealing elements in these units would not reduce the braking effectiveness below that specified in subparagraph (2) of this paragraph.

(b) *Brake controls.* Brake controls shall not require excessive control forces in their operation.

(c) *Parking brake controls.* A parking brake control shall be provided and installed so that it can be set by the pilot and, without further attention, will maintain sufficient braking to prevent the airplane from rolling on a paved, level runway while take-off power on the critical engine is being applied.

(d) *Anti-skid devices.* If anti-skid devices are intalled, the devices and associated systems shall be such that no single probable malfunction will result in a hazardous loss of braking ability or directional control of the airplane.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 17 F. R. 1093, Feb. 5, 1952; Amdt. 4b-3, 21 F.R. 993, Feb. 11, 1956; Amdt. 4b-6, 22 F.R. 5564, July 16, 1957]

§ 4b.337-1 Brake tests (FAA policies which apply to § 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 § 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) [Reserved]

(b) *Brake controls,* § 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,* § 4b.337 (c). During engine run-up prior to take-off 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 take-off power is applied on the most critical engine.

[Supp. 24, 19 F.R. 4461, July 20, 1954, as amended by Supp. 34, 22 F.R. 6963, Aug. 29, 1957]

§ 4b.337-2 Brake systems (FAA policies which apply to § 4b.337).

In order to obtain a minimum landing distance under § 4b.122 and at the same time meet the deceleration requirement of § 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 § 4b.337 (a) (2).

(b) *Brake control valves.* In the normal brake systems 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 necessarily apply to the emergency brake systems although obviously such a provision would be desirable. Flight tests should be conducted to determine that the normal and emergency brake system fulfill the requirements of § 4b.170 (a) and (b).

In the normal brake systems of tail wheel type aircraft or of nose wheel type aircraft equipped with non-steerable nose wheels, provisions should be made for independently controlling the brakes on either side of the main landing gear in order that directional control of the aircraft can be maintained. (See § 4b.171 (c).) In the emergency brake systems of tail wheel type aircraft and in the normal and emergency brake systems of nose wheel type aircraft, it is desirable that independent control of the brakes on either side of the landing gear be provided although such control is optional.

[Supp. 19, 17 F. R. 2223, Mar. 14, 1952]

§ 4b.337-3 Replacement or modified brakes (FAA policies which apply to § 4b.337).

(a) *General.* Replacement or modified brake installations may be approved on the basis of dynamometer tests together with functional flight tests in lieu of measured accelerate-stop and landing distance flight tests if the decelerate performance based on dynamometer data is shown to be equal to or better than the original airplane flight test decelerate performance. Dynamometer tests which simulate actual airplane decelerate-distance tests may incorporate variable kinetic energy absorption rates simulating flight test deceleration conditions, and may include an energy allowance for the aerodynamic drag of the airplane which occurs during the deceleration portion of the accelerate-stop and landing runs. However, if any improvement in decelerate performance over that shown in the original airplane flight manual is desired, then this policy is inapplicable and complete airplane flight tests will be required.

(1) The procedures of paragraphs (c) through (g) of this section may be used

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 FAA 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.

[Supp. 24, 19 F. R. 4461, July 20, 1954]

§ 4b.337–4 Antiskid devices and installations (FAA policies which apply to § 4b.337).

(a) *Eligibility.* Antiskid devices meeting the airworthiness portions of Military Specification MIL–B–8075 (ASG) and any amendments[1] thereto, are acceptable for installation on civil aircraft. Requests for deviations from these specifications should be submitted to the FAA 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 FAA. 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 antiskid 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 § 4b.337. The single failure criterion of § 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) [Reserved].

(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 adjustment.

(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,[2] 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 §§ 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.[3] The maximum landing weight, or the lowest weight above 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 § 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.[4] All landings should be made from the highest corresponding contact speeds used in determining FAA Approved Airplane Flight Manual field lengths.

(4) Conduct controllability tests in accordance with §§ 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

[1] Proposed amendments may be obtained from the Federal Aviation Agency, Washington 25, D.C.

[2] 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.

[3] 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.

[4] 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.

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.

[Supp. 28, 21 F.R. 2558, Apr. 19, 1956, as amended by Supp. 37, 23 F.R. 2789, Apr. 26, 1958]

§ 4b.338 Skis.

Skis shall be of an approved type. The maximum limit load rating of each ski shall not be less than the maximum limit load determined in accordance with the applicable ground load requirements of this part. (See §§ 4b.230 through 4b.236.)

[15 F. R. 3543, Jan. 8, 1950, as amended by Amdt. 4b-6, 17 F. R. 1093, Feb. 5, 1952; Amdt. 4b-8, 18 F. R. 2214, Apr. 18, 1953]

HULLS AND FLOATS

§ 4b.340 General.

The requirements of §§ 4b.341 and 4b.342 shall apply to the design of hulls and floats.

§ 4b.341 Seaplane main floats.

Seaplane main floats shall be of an approved type and shall comply with the provisions of § 4b.250. In addition, the following shall apply.

(a) *Buoyancy.* Each seaplane main float shall have a buoyancy of 80 percent in excess of that required to support the maximum weight of the seaplane in fresh water.

(b) *Compartmentation.* Each seaplane main float shall contain not less than 5 watertight compartments. The compartments shall have approximately equal volumes.

[Amdt. 4b-6, 17 F. R. 1093, Feb. 5, 1952]

§ 4b.342 Boat hulls.

(a) The hulls of boat seaplanes and amphibians shall be divided into watertight compartments so that, with any two adjacent compartments flooded, the buoyancy of the hull and auxiliary floats (and wheel tires, if used) will provide a sufficient margin of positive stability to minimize capsizing in rough fresh water.

(b) For the purpose of communication between compartments, bulkheads with watertight doors shall be allowed.

[16 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 17 F. R. 1093, Feb. 5, 1952]

PERSONNEL AND CARGO ACCOMMODATIONS

§ 4b.350 Pilot compartment; general.

All references to flight crew in this section and §§ 4b.351 through 4b.353 shall mean the minimum flight crew established in accordance with § 4b.720.

(a) The arrangement of the pilot compartment and its appurtenances shall provide safety and assurance that the flight crew will be able to perform all of their duties and operate the controls in the correct manner without unreasonable concentration and fatigue.

(b) The primary flight controls listed on figure 4b-16, excluding cables and control rods, shall be so located with respect to the propellers that no portion of the flight crew or the controls lies in the region between the plane of rotation of any inboard propeller and the surface generated by a line passing through the center of the propeller hub and making an angle of 5° forward or aft of the plane of rotation of the propeller.

PRIMARY

Controls	Movement and actuation
Aileron	Right (clockwise) for right wing down.
Elevator	Rearward for nose up.
Rudder	Right pedal forward for nose right.

SECONDARY

Controls	Movement and actuation
Flaps (or auxiliary lift devices).	Forward for flaps up; rearward for flaps down.
Trim tabs (or equivalent).	Rotate to produce similar rotation of the airplane about an axis parallel to the axis of the control.

FIGURE 4b-16—Aerodynamic controls

(c) When provision is made for a second pilot, the airplane shall be controllable with equal safety from both seats.

(d) The pilot compartment shall be constructed to prevent leakage likely to be distracting to the crew or harmful to the structure when flying in rain or snow.

(e) A door shall be provided between the pilot compartment and the passenger compartment.

(f) The door prescribed in paragraph (e) of this section shall be equipped with

a locking means to prevent passengers from opening the door without the pilot's permission.

(g) Vibration and noise characteristics of cockpit appurtenances shall not interfere with the safe operation of the airplane.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-1, 19 F. R. 2250, Apr. 20, 1954]

§ 4b.350-1 Noise and vibration characteristics (FAA policies which apply to § 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.

[Supp. 24, 19 F.R. 4463, July 20, 1954]

§ 4b.351 Pilot compartment vision.

(a) *Nonprecipitation conditions.* (1) The pilot compartment shall be arranged to afford the pilots a sufficiently extensive, clear, and undistorted view to perform safely all maneuvers within the operating limitations of the airplane, including taxiing, take-off, approach, and landing.

(2) It shall be demonstrated by day and night flight tests that the pilot compartment is free of glare and reflections which would tend to interfere with the flight crew's normal duties.

(b) *Precipitation conditions.* (1) Means shall be provided for maintaining a sufficient portion of the windshield clear so that both pilots are afforded a sufficiently extensive view along the flight path in all normal flight attitudes of the airplane. Such means shall be designed to function under the following conditions without continuous attention on the part of the crew:

(i) In heavy rain at speeds up to 1.6 V_{s_1}, flaps retracted,

(ii) In the most severe icing conditions for which approval of the airplane is desired.

(2) In addition to the means prescribed in subparagraph (1) of this paragraph at least the first pilot shall be provided with a window which, when the cabin is not pressurized, is openable under the conditions prescribed in subparagraph (1) of this paragraph, and which provides the view specified in that subparagraph. The design shall be such that when the window is opened sufficient protection from the elements will be provided against the impairment of the pilot's vision.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-1, 19 F. R. 2250, Apr. 20, 1954]

§ 4b.351-1 Procedure for demonstrating pilot compartment visibility (FAA policies which apply to § 4b.351).

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

(b) *Precipitation conditions, § 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 take-off and landing and at speeds up to 1.6 V_{s_1}.

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

[Supp. 24, 19 F. R. 4463, July 20, 1954]

§ 4b.351-2 Vision with reverse thrust (FAA policies which apply to § 4b.351).

The policies outlined in § 4b.402-1 (g) and (h) will apply.

[Supp. 25, 20 F. R. 2279, Apr. 8, 1955]

PERSONNEL AND CARGO ACCOMMODATIONS

§ 4b.351-3 Minimum area of visibility in the flight crew compartment (FAA policies which apply to § 4b.351 (a)).

The area of visibility established in this section for the pilot, and an equivalent area for the copilot, should be the minimum for showing compliance with the visibility provisions of § 4b.351 (a).

(a) *Reference eye position.* A single point established in accordance with the provisions of this paragraph constitutes the reference eye position (i. e., a point midway between the two eyes) from which the central axis may be located. The reference eye position is located 5 inches aft of the rearmost extremity of the elevator control device when the control is in its most rearward position (i. e., against the up elevator control stops), see figure 1, and 30.5 inches ±0.5 inch above the point of maximum depression of the seat cushion with:

(1) The pilot seat in a normal operating position from which all controls can be utilized to their full travel, by an average subject, and which will provide for vertical adjustment of the seat of

not less than 2½ inches above and 2½ inches below this initial vertical position.

(2) The seat back in its most upright position.

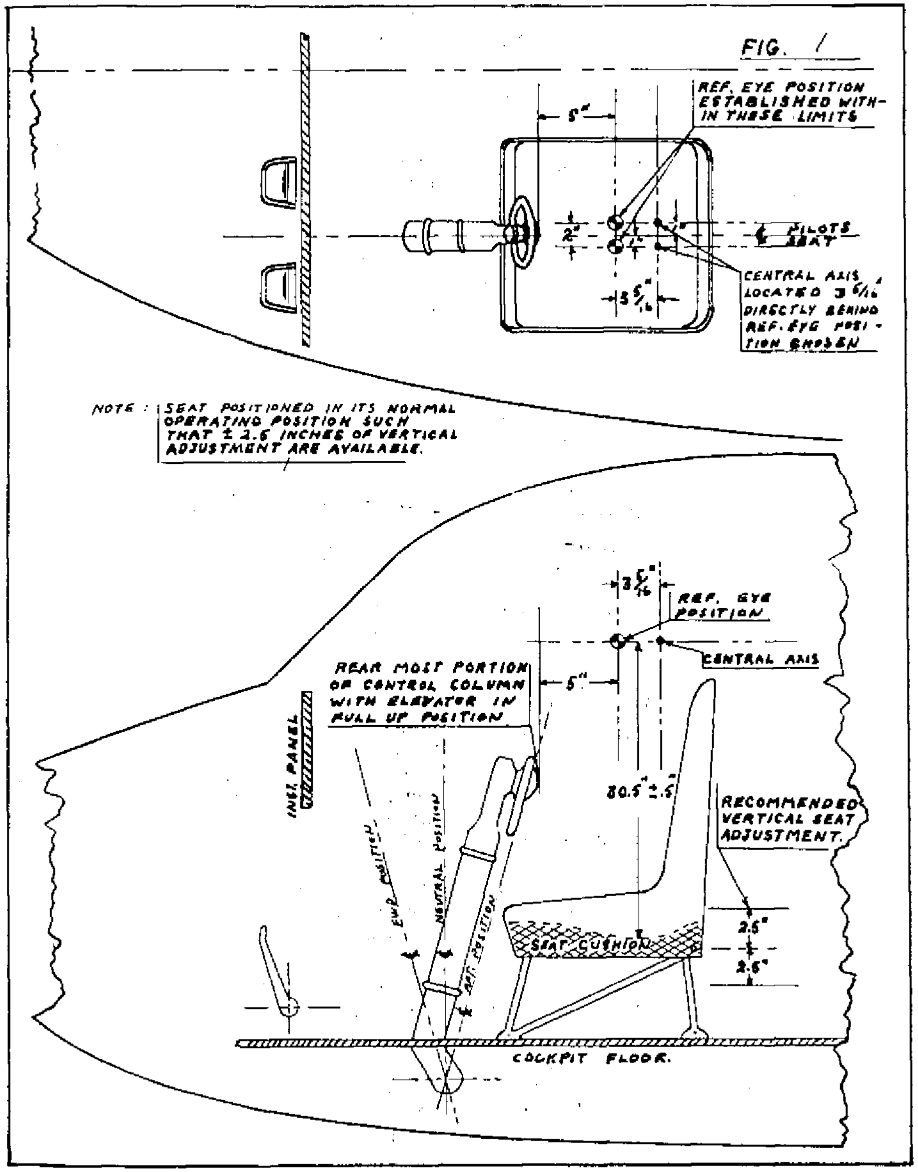
(3) The seat cushion depression being that caused by a subject weighing 170 to 200 pounds.

(4) The longitudinal axis of the airplane level.

(5) The point established not beyond one inch to the left or right of the longitudinal center line of the pilot's seat. (See figure 1.)

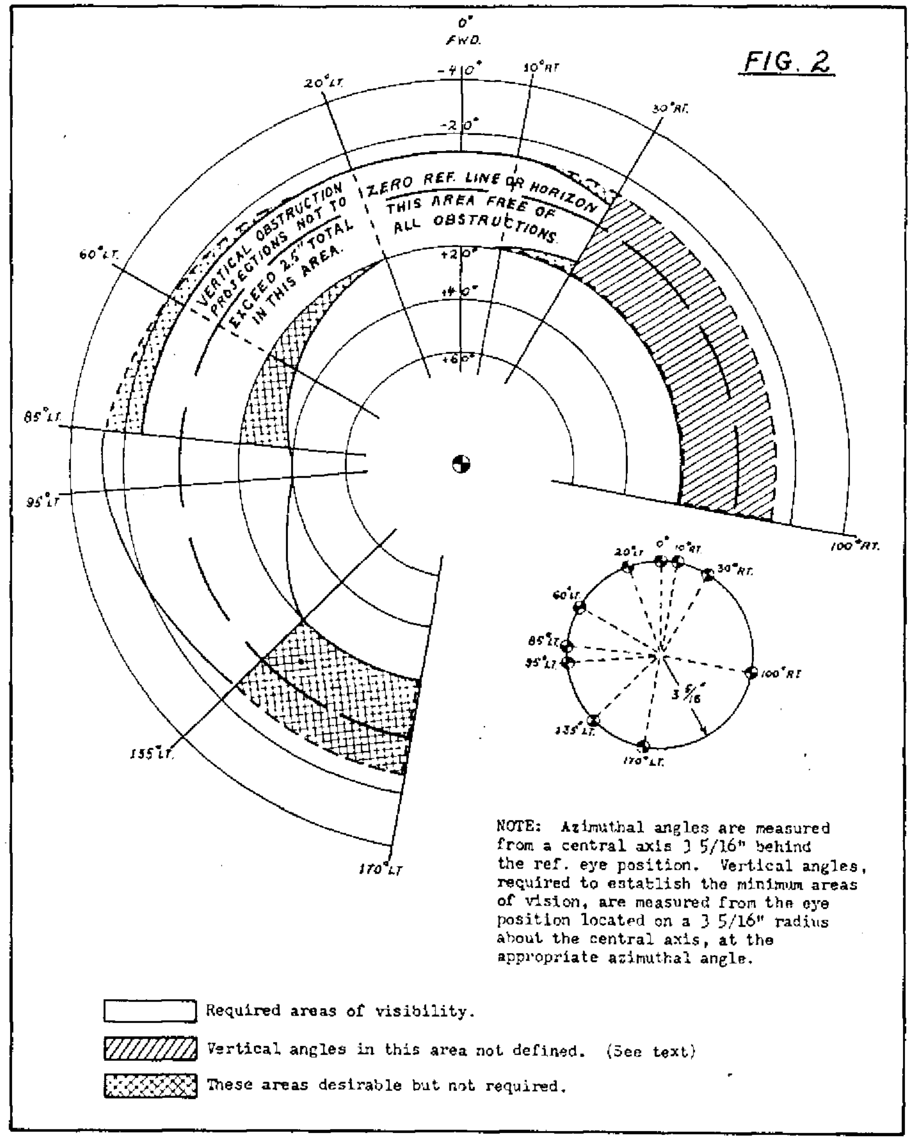
(6) All measurements made from a single point established in accordance with this paragraph.

(b) *Clear areas of vision.* (1) With the reference eye position located as indicated in paragraph (a) of this section,



and utilizing binocular vision and azimuthal movement of the head and eyes about a radius, the center of which is 3$\frac{5}{16}$ inches behind the reference eye position (this point to be known as the central axis), the pilot should have the following clear areas of vision measured from the appropriate eye position with the aircraft's longitudinal axis level. The areas defined are based on the cardinal points of reference listed below and indicated in figure 2. A dual lens camera as photo recorder should be used in measuring the angles specified in this paragraph. Other methods, including the use of a goniometer, are acceptable if they produce equivalent areas to those obtained with the dual lens camera. When not using a dual lens camera compensation should be made for ½ the distance which exists between the eyes, or 1¼ inches as indicated in figure 4.

(i) 20° forward and up from the horizon between 20° left and 10° right allowed to diminish to 15° up at 30° right (this area unbroken).



(ii) 15° forward and down from the horizon between 20° left and 10° right allowed to diminish to 10° down at 30° right (this area unbroken).

(iii) 40° above horizon between 85° and 95° left.

(iv) 30° below horizon between 85° and 95° left.

(v) 20° up and 15° down from horizon at 135° left.

(2) There should be no obstruction to vision in the area indicated in subparagraph (1) (i) and (ii) of this paragraph and in figure 2. Beyond 20° left the angles indicated in subparagraph (1) (i) and (ii) of this paragraph should remain constant, or increase progressively until they reach the reference angles in subparagraph (1) (iii) and (iv) of this paragraph at 85° and should not be less than indicated in these subdivisions up to the 95° position, at which time they may diminish gradually to the angles shown in subparagraph (1) (v) of this paragraph, and should be governed by the limitations of paragraph (d) (2) of this section. The area beyond 135°, if any, should be as large as possible since the human eye does not present any limitation when the use of perceptive rather than binocular vision is the criterion.

(3) It is possible that in the symmetrical type pilot compartment, there may be an area about the center line of the windshield where the requirements governing pilot and copilot vision areas do not overlap. In this area the angles above and below eye level may diminish due to the increased distance between the appropriate eye position and the windshield, but the windshield dimensions established at the 30° right position, above and below the horizontal plane of the pilot's eye should be retained. This area should also be governed by the limitations of paragraph (d) (1) and (2) of this section. No attempt is made to define the angles of vision for the pilot, to the right of 30°, since it is assumed that the required vision for the copilot will govern this area. This area not defined by exact limits is indicated by shading in figure 2.

(c) *Optical properties of windshield.* The windshield should exhibit equivalent optical properties to those covered in MIL-G-8602 dated June 29, 1953, for flat panels, and MIL-G-7767, dated Aug. 14, 1951, for curved panels or any applicable military specifications which may be published subsequent to these specifications. In addition, the optical properties of the windshield should not deteriorate under pressurization loads.

(d) *Impairments to vision.* (1) Any windshield post should not exceed 2.5 inches total obstruction in projected width on the pilot's eyes when located within a sector of 20° and 60° of azimuth to the left of the pilot's forward vision, when measured with head rotated so that the eyes are perpendicular to a vertical plane passing through the center line of the projected width as indicated in figure 3.

(2) The location of instruments, equipment, or structure should not impair any of the areas of vision established in this section. In addition, cockpit equipment should not obstruct a line of vision from a point two inches above

FIG. 3

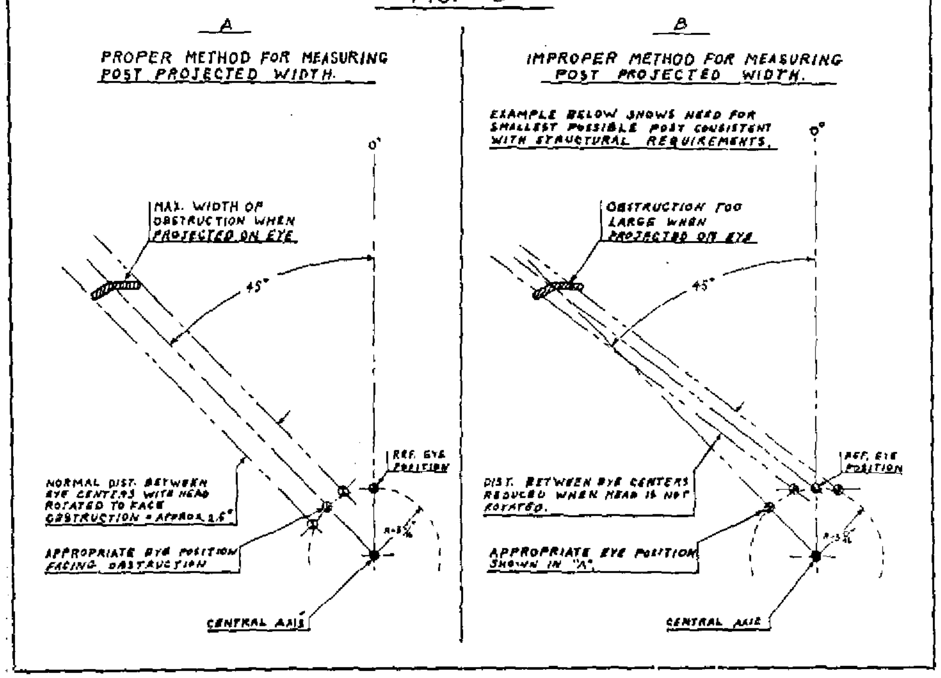
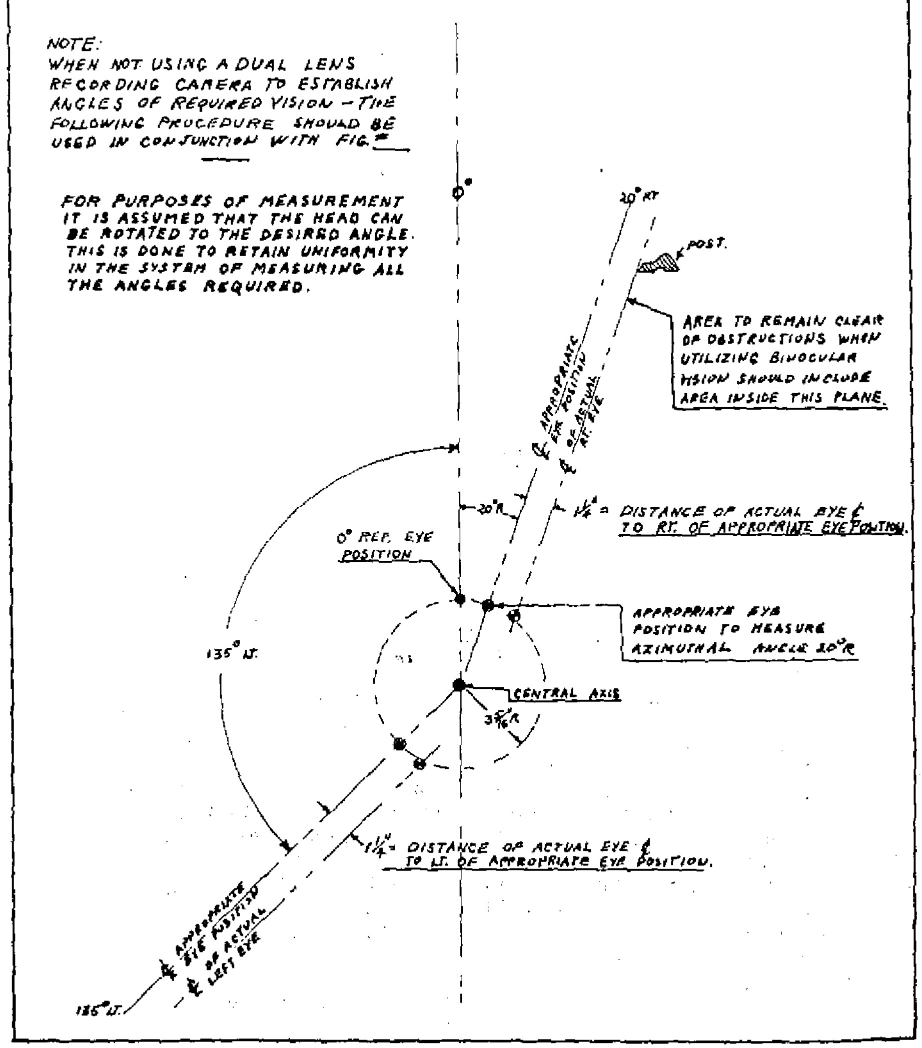


FIG ~~ 2

MEASUREMENT OF ANGLES



the reference eye position to any point along the upper limit of the forward windshield panels, and similarly, a line of vision from a point two inches below the reference eye position to the lower limit of the forward windshield panels.

[Supp. 35, 22 F. R. 7359, Sept. 14, 1957]

§ 4b.352 Windshields and windows.

(a) All internal glass panes shall be of a nonsplintering safety type.

(b) The windshield panes which the pilots will be directly behind in the normal conduct of their duties and the supporting structures for such panes shall have sufficient strength to withstand without penetration the impact of a four-pound bird when the velocity of the airplane relative to the bird along the airplane's flight path is equal to the value of V_c at sea level selected in accordance with § 4b.210(b)(4).

(c) Means shall be provided to minimize the danger to the pilots from flying windshield fragments due to bird impact unless it can be shown by analysis or test that the probability of occurrence of a critical fragmentation condition is of a low order. The provisions of this paragraph are intended to apply to all transparent panes in the cockpit section which appear in the front view of the aircraft, are inclined 15 degrees or more to the longitudinal axis of the aircraft, and have any portion located so that fragmentation thereof will constitute a hazard to the pilots.

(d) The design of windshields and windows in pressurized airplanes shall be based on factors peculiar to high altitude operation. (See also § 4b.373.) Strength shall be provided in the windshield and window panels to withstand the maximum cabin pressure differential loads (see § 4b.216(c)(1)) combined with critical aerodynamic pressure and temperature effects, after failure of a single load-carrying element of the windshield or window. It shall be acceptable to assume that after a single failure occurs, which is obvious to the flight crew, the cabin pressure differential will be reduced from the maximum in accordance with appropriate operating limitations enabling continued safe flight of the airplane with a cabin pressure altitude of not more than 15,000 feet. (See 4b.374(b).)

NOTE: Factors peculiar to high altitude operation as they may affect the design of windshields and windows include the effects of continuous and cyclic pressurization loadings, the inherent characteristics of the material used, the effects of temperatures and temperature differentials, etc.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 17 F.R. 1094, Feb. 5, 1952; Amdt. 4b–6, 22 F.R. 5564, July 16, 1957; Amdt. 4b–11, 24 F.R. 7069, Sept. 1, 1959; Amdt. 4b–12, 27 F.R. 2992, Mar. 30, 1962]

§ 4b.353 Controls.

(a) All cockpit controls shall be located to provide convenience in operation and in a manner tending to prevent confusion and inadvertent operation. (See also § 4b.737.)

(b) The direction of movement of controls shall be according to figures 4b–16 and 4b–17. Wherever practicable the sense of motion involved in the operation of other controls shall correspond with the sense of the effect of the operation upon the airplane or upon the part operated. All controls of a variable nature employing a rotary motion shall move clockwise from the off position, through an increasing range, to the full on position.

Controls	Movement and actuation
Powerplant	
Throttles	Forward to increase forward thrust and rearward to increase rearward thrust.
Propellers	Forward to increase rpm.
Mixture	Forward or upward for rich.
Carburetor air heat	Forward or upward for cold.
Supercharger	Forward or upward for low blower. In the case of turbo-superchargers, forward, upward, or clockwise to increase pressure.
Auxiliary	
Landing gear	Down to extend.

FIGURE 4b-17—POWERPLANT AND AUXILIARY CONTROLS

(c) The controls shall be so located and arranged with respect to the flight crew's seats that there exists full and unrestricted movement of each control without interference from either the cockpit structure or the flight crew's clothing when seated with the seat belt fastened. This shall be demonstrated for individuals ranging from 5′ 2″ to 6′ 0″ in height.

(d) Identical powerplant controls for each engine shall be located to prevent any misleading impression as to the engine to which they relate.

(e) The wing flap (or auxiliary lift device) and landing gear controls shall comply with the following:

(1) The wing flap control shall be located on top of the pedestal aft of the throttle(s), centrally or to the right of the pedestal centerline and shall be not less than 10 inches aft of the landing gear control.

(2) The landing gear control shall be located forward of the throttles and shall be operable by each of the pilots when seated with seat belts fastened.

(f) The control knobs shall be shaped in accordance with Figure 4b–22, and such knobs shall be of the same color, but of a color in contrast with that of not only the other control knobs but also the surrounding cockpit.

NOTE: Figure 4b–22 is not intended to indicate the exact size or proportion of the control knobs.

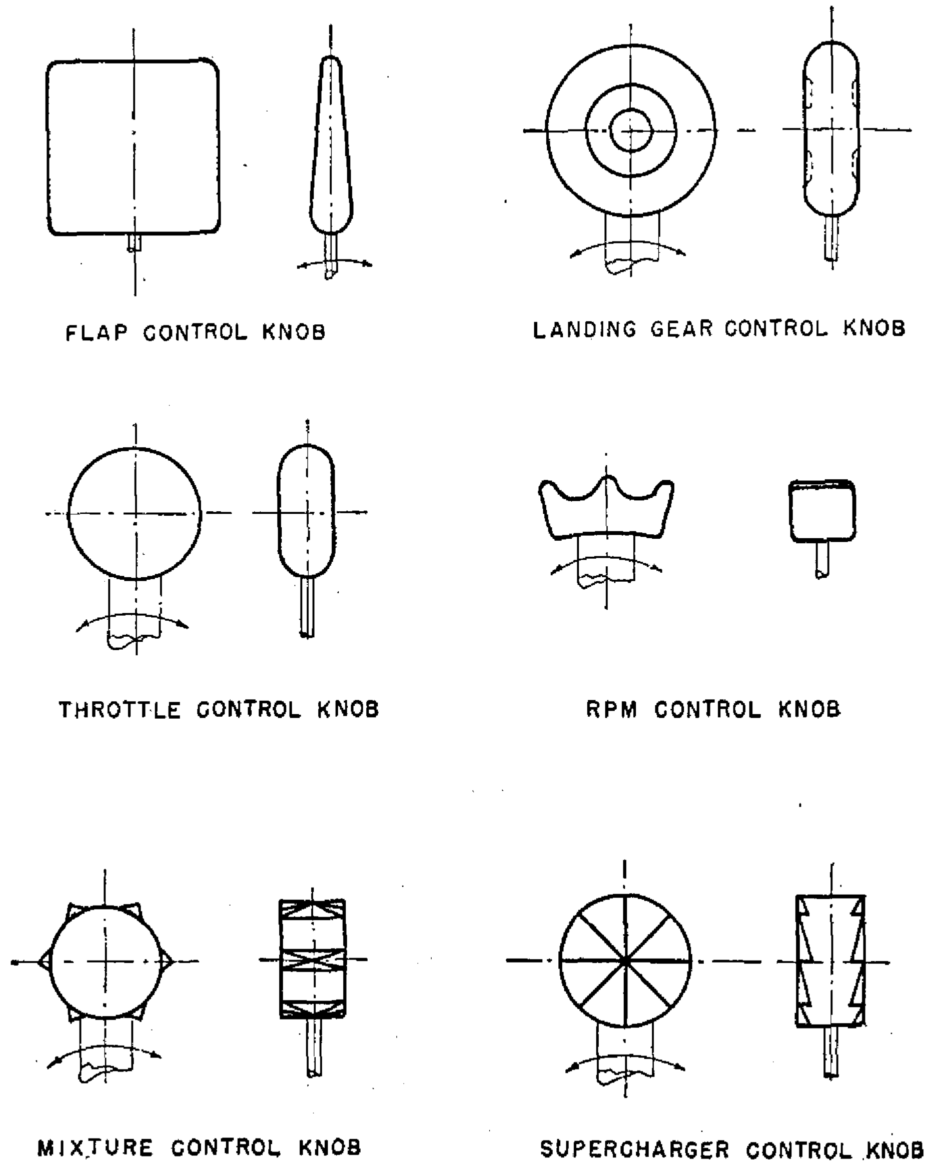


FIGURE 4b-22—Control knob shapes.

[Amdt. 4b–2, 15 F. R. 9185, Dec. 22, 1950]

(g) Where the work load on the flight crew is such as to require a flight engineer (see § 4b.720), a flight engineer station shall be provided. The station shall be so located and arranged that the flight crew members can perform their functions efficiently and without interfering with each other.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 17 F. R. 1094, Feb. 5, 1952; Amdt. 4b–8, 18 F. R. 2214, Apr. 18, 1953; Amdt. 4b–1, 19 F.R. 2250, Apr. 20, 1954; Amdt. 4b–6, 22 F.R. 5565, July 16, 1957]

§ 4b.353–1 Control tests (FAA policies which apply to § 4b.353).

Such tests as are deemed necessary to show compliance with the control movements and locations specified in § 4b.353 should be conducted.

[Supp. 24, 19 F. R. 4463, July 20, 1954]

§ 4b.354 Instrument arrangement.

(See § 4b.611.)

§ 4b.355 Instrument marking.

(The operational markings, instructions, and placards required for the instruments, controls, etc., are specified in §§ 4b.730 through 4b.738.)

§ 4b.356 Doors.

(a) Airplane cabins shall be provided with at least one easily accessible external door.

(b) Means shall be provided for locking each external door and for safeguarding against opening in flight either inadvertently by persons or as a result of mechanical failure. It shall be possible to open external doors from either the inside or the outside even though persons may be crowding against the door from the inside. The means of opening shall be simple and obvious and shall be so arranged and marked that it can be readily located and operated even in darkness.

NOTE: It is not the intent to prohibit the use of inward opening doors if sufficient measures are provided to prevent occupants from crowding against the door to an extent which would interfere with the opening of the door.

(c) Reasonable provisions shall be made to prevent the jamming of any external door as a result of fuselage deformation in a minor crash.

(d) External doors shall be so located that persons using them will not be endangered by the propellers when appropriate operating procedures are employed.

(e) Means shall be provided for a direct visual inspection of the locking mechanism by crew members to ascertain whether all external doors for which the initial opening movement is outward, including passenger, crew, service, and cargo doors, are fully locked (see also § 4b.362(e)(5) for emergency exits). In addition, visual means shall be provided to signal to appropriate crew members that all normally used external doors are closed and in the fully locked position.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–4, 16 F. R. 11759, Nov. 21, 1951; Amdt. 4b–2, 20 F.R. 5306, July 26, 1955; Amdt. 4b–6, 22 F.R. 5565, July 16, 1957]

§ 4b.356–1 External doors (FAA policies which apply to § 4b.356).

The provisions of § 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 § 4b.356 (e) and safeguarding against opening in flight as a result of mechanical failure.

[Supp. 25, 20 F.R. 2279, Apr. 8, 1955]

§ 4b.356–2 Auxiliary latching devices (FAA policies which apply to § 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 paragraph (b) of this section 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.

[Supp. 25, 20 F. R. 2279, Apr. 8, 1955]

§ 4b.356–3 Power operated external doors (FAA policies which apply to § 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.[10a]

[Supp. 25, 20 F. R. 2279, Apr. 8, 1955]

§ 4b.356–4 Means for safeguarding against inadvertent opening in flight (FAA policies which apply to § 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 § 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 § 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 be one which could be easily overridden such as a spring-loaded ball type latch.

(b) Flexible gates such as those made from webbing are not acceptable on the basis that persons may become entangled during an emergency egress. The use of a barrier to prevent persons from inadvertently opening the door in flight does not eliminate the need for a safety means to provide for possible malfunctioning of the primary locking mechanism; however, the auxiliary safetying means of § 4b.356–2 may eliminate the need for a restricted zone.

[Supp. 25, 20 F. R. 2279, Apr. 8, 1955]

§ 4b.356–5 Direct visual inspection (FAA policies which apply to § 4b.356(e)).

The means of complying with § 4b.356 (e) will depend upon the type of door and locking mechanism used. It should be determined in all cases that means are provided to ascertain that an unsatisfactory condition does not exist after closing the door. In some instances a central window for viewing the position of the mechanism may be sufficient while other cases may require one or more windows in the door frame to permit inspection of the bayonet location relative to that portion of the lock in the door frame. The need for and/or the number and location of inspection openings or windows will depend on the type of door and locking mechanism used.

[Supp. 25, 20 F. R. 2279, Apr. 8, 1955]

[10a] Since emergency landings, such as in 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.

§ 4b.356-6 Visual indicating system (FAA policies which apply to § 4b.356(e)).[10b]

(a) The visual indicating system may consist of an indicator for each individual door, or a system connecting all doors in series. If the latter system is used, it need not necessarily show which door is not fully locked.

(b) It is not necessary that more than one crew member be able to ascertain by a visual signal that all external doors, normally used by the crew in supplying the airplane, or in loading and unloading passengers and cargo, are fully closed and locked. The visual signal should be located so that it may easily be seen by the appropriate crew member from his station.

[Supp. 25, 20 F. R. 2279, Apr. 8, 1955]

§ 4b.358 Seats, berths, and safety belts.

(a) *General.* At all stations designated as occupiable during take-off and landing, the seats, berths, belts, harnesses, and adjacent parts of the airplane shall be such that a person making proper use of these facilities will not suffer serious injury in the emergency landing conditions as a result of inertia forces specified in § 4b.260. Seats and berths shall be of an approved type (see also § 4b.643 concerning safety belts).

(b) *Arrangement.* (1) Passengers and crew shall be afforded protection from head injuries by one of the following means:

(i) Safety belt and shoulder harness which will prevent the head from contacting any injurious object,

(ii) Safety belt and the elimination of all injurious objects within striking radius of the head,

(iii) Safety belt and a cushioned rest which will support the arms, shoulders, head, and spine.

(2) For arrangements which do not provide a firm hand hold on seat backs, hand grips or rails shall be provided along aisles to enable passengers or crew members to steady themselves while using the aisles in moderately rough air.

(3) All projecting objects which would cause injury to persons seated or moving about the airplane in normal flight shall be padded.

(4) Berths shall be so designed that the forward portion is provided with a padded end board, a canvas diaphragm, or other equivalent means, capable of withstanding the static load reaction of the occupant when subjected to the forward inertia force specified in § 4b.260. Berths shall be free from corners and protuberances likely to cause serious injury to a person occupying the berth during emergency conditions.

(5) Seats for all crew members at flight deck stations shall incorporate provisions for the use of a shoulder harness and the seats with such provisions shall comply with the strength requirements of paragraph (c) of this section.

(6) Seats for cabin attendants shall be disposed within the passenger compartment near approved floor level emergency exits. (See § 4b.362 (g).)

(c) *Strength.* All seats and berths and their supporting structure shall be designed for occupant weight of 170 pounds with due account taken of the maximum load factors, inertia forces, and reactions between occupant, seat, and safety belt or harness corresponding with all relevant flight and ground load conditions, including the emergency landing conditions prescribed in § 4b.260. In the case of berths, the forward inertia force shall be considered in accordance with paragraph (b) (4) of this section and need not be considered with respect to the safety belt. In addition, the following shall apply:

(1) Pilot seats shall be designed for the reactions resulting from the application of pilot forces to the flight controls as prescribed in § 4b.224.

(2) In determining the strength of the seat or berth attachments to the structure, and the safety belt or shoulder harness attachments to the seat, berth, or structure, the inertia forces specified in § 4b.260(a) shall be multiplied by a factor of 1.33 in lieu of the fitting factor prescribed in § 4b.307(c).

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 17 F. R. 1094, Feb. 5, 1952; Amdt. 4b-8, 18 F. R. 2215, Apr. 18, 1953; Amdt. 4b-3, 21 F.R. 993, Feb. 11, 1956; Amdt. 4b-6, 22 F.R. 5565, July 16, 1957; Amdt. 4b-8, 23 F.R. 2591, Apr. 19, 1958; Amdt. 4b-12, 27 F.R. 2992, Mar. 30, 1962]

[10b] The objective herein is to be able to ascertain by visual means that the door and/or locking means is sufficiently engaged to eliminate hazards emanating from an improperly closed door. Outward opening doors present a different problem from inward opening doors.

§ 4b.358-1 Application of loads (FAA policies which apply to § 4b.358).

The actual forces acting on seats, berths, and supporting structure in the various flight, ground and emergency landing conditions will consist of many possible combinations of forward, sideward, downward, upward, and aft loads. However, in order to simplify the structural analysis and testing of these structures, it will be permissible to assume that the critical load in each of these directions, as determined from the prescribed flight, ground, and emergency landing conditions, acts separately. If the applicant desires, selected combinations of loads may be used, provided the required strength in all specified directions is substantiated. (TSO C-25, Aircraft Seats and Berths, § 514.25 of this title, outlines acceptable methods for testing seats and berths).

[Supp. 22, 18 F. R. 5563, Sept. 17, 1953]

§ 4b.359 Cargo and baggage compartments.

(See also §§ 4b.382 to 4b.384.)

(a) Each cargo and baggage compartment shall be designed for the placarded maximum weight of contents and the critical load distributions at the appropriate maximum load factors corresponding with all specified flight and ground load conditions, excluding the emergency landing conditions of § 4b.260.

(b) Provisions shall be made to prevent the contents in the compartments from becoming a hazard by shifting under the loads specified in paragraph (a) of this section.

(c) Provisions shall be made to protect the passengers and crew from injury by the contents of any compartment, taking into account the emergency landing conditions of § 4b.260.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 17 F. R. 1094, Feb. 5, 1952]

Emergency Provisions

§ 4b.360 General.

The requirements of §§ 4b.361 and 4b.362 shall apply to the emergency provisions.

§ 4b.361 Ditching.

Compliance with this section is optional. The requirements of this section are intended to safeguard the occupants in the event of an emergency landing during overwater flight. When compliance is shown with the provisions of paragraphs (a) through (c) of this section and with the provisions of §§ 4b.362(d), 4b.645, and 4b.646, the type certificate shall include certification to that effect. When an airplane is certificated to include ditching provisions, the recommended ditching procedures established on the basis of these requirements shall be set forth in the Airplane Flight Manual (see § 4b.742(d)).

(a) All practicable design measures compatible with the general characteristics of the type airplane shall be taken to minimize the chance of any behavior of the airplane in an emergency landing on water which would be likely to cause immediate injury to the occupants or to make it impossible for them to escape from the airplane. The probable behavior of the airplane in a water landing shall be investigated by model tests or by comparison with airplanes of similar configuration for which the ditching characteristics are known. In this investigation account shall be taken of scoops, flaps, projections, and all other factors likely to affect the hydrodynamic characteristics of the actual airplane.

(b) It shall be shown that under reasonably probable water conditions the flotation time and trim of the airplane will permit all occupants to leave the airplane and to occupy the life rafts required by § 4b.645. If compliance with this provision is shown by buoyancy and trim computations, appropriate allowances shall be made for probable structural damage and leakage.

NOTE: In the case of fuel tanks which are equipped with fuel jettisoning provisions and which can be reasonably expected to withstand a ditching without leakage, the jettisonable volume of fuel may be considered as buoyancy volume.

(c) External doors and windows shall be designed to withstand the probable maximum local pressures, unless the effects of the collapse of such parts are taken into account in the investigation of the probable behavior of the airplane in a water landing as prescribed in paragraphs (a) and (b) of this section.

[Amdt. 4b-8, 18 F. R. 2215, Apr. 18, 1953]

§ 4b.362 Emergency evacuation.

Crew and passenger areas shall be provided with emergency evacuation means to permit rapid egress in the event of crash landings, whether with the landing gear extended or retracted, taking into account the possibility of the airplane being on fire. If the airplane is divided into separate compartments arranged so that the minimum unobstructed passageway between such compartments is not available as required by paragraph (g) of this section, requirements of this section shall be applied to each compartment independently. Passenger and crew entrances and service doors shall be considered as emergency exits if they meet the applicable requirements of this section.

(a) *Flight crew emergency exits.* Flight crew emergency exits shall be located in the flight crew area, one on each side of the airplane, or, alternatively, a top hatch shall be provided. Such exits shall be of sufficient size and shall be so located as to permit rapid evacuation by the crew. Such exits shall not be required in airplanes having a passenger capacity of 20 or less if the Administrator finds that the proximity of passenger emergency exits to the flight crew area offers a convenient and readily accessible means of evacuation for the flight crew.

(b) *Passenger emergency exits; type and location.* All required exits shall be in such specific locations as will afford the most effective means of passenger evacuation. The type of exits and their general location shall be as follows:

(1) Type I: A rectangular opening of not less than 24 inches wide by 48 inches high, with corner radii not greater than ⅓ the width of the exit. The first Type I exit on each side of the fuselage shall be located in the aft portion of the passenger compartment unless the configuration of the airplane is such that some other location would afford a more effective means of passenger evacuation. All Type I exits shall be floor level exits.

(2) *Type II:* A rectangular opening of not less than 20 inches wide by 44 inches high, with corner radii not greater than ⅓ the width of the exit. Unless Type I exits are required, one Type II exit on each side of the fuselage shall be located in the aft portion of the passenger compartment except where the configuration of the airplane is such that some other location would afford a more effective means of passenger evacuation. Type II exits shall be floor level exits unless located over the wing in which case they shall have a step-up inside the airplane of not more than 10 inches and a step-down outside the airplane of not more than 17 inches.

(3) *Type III:* A rectangular opening of not less than 20 inches wide by 36 inches high, with corner radii not greater than ⅓ the width of the exit, located over the wing with a step-up inside the airplane of not more than 20 inches and a step-down outside the airplane of not more than 27 inches.

(4) Type IV: *A rectangular opening of* not less than 19 inches wide by 26 inches high, with corner radii not greater than ⅓ the width of the exit, located over the wing with a step-up inside the airplane of not more than 29 inches and a step-down outside the airplane of not more than 36 inches.

NOTE: Larger openings than those specified in paragraph (b) of this section shall be acceptable, whether or not of rectangular shape, provided that the specified rectangular openings can be inscribed therein, and provided further that the base of the inscribed rectangular opening meets the specified step-up and step-down heights.

(c) *Passenger emergency exits; number required.* Emergency exits of the type and location prescribed in paragraph (b) of this section shall be accessible to the passengers and shall be provided in accordance with subparagraphs (1) through (5) of this paragraph.

(1) The relation between the passenger seating capacity and the type and number of exits provided on each side of the airplane shall be as follows:

Passenger seating capacity	Emergency exits required on each side of the fuselage			
	Type I	Type II	Type III	Type IV
1–10 inclusive	------	------	------	1
11–19 inclusive	------	------	1	------
20–39 inclusive	------	1	------	1
40–59 inclusive	1	------	------	1
60–79 inclusive	1	------	1	------
80–109 inclusive	1	------	1	1
110–139 inclusive	2	------	1	------
140–179 inclusive	2	------	2	------
180–219 inclusive	2	2	------	------

NOTE: Although similar exits and their locations are prescribed for each side of the fuselage, it is not the intent of this regulation to require that the exits necessarily be at locations diametrically opposite each other.

(2) Additional exits shall be provided on airplanes having 220 or more passengers. The additional exits shall provide an effective means of passenger evacuation consistent with the minima provided in the table in subparagraph (1) of this paragraph.

(3) In applying subparagraph (1) of this paragraph, it shall be acceptable to install 2 Type IV exits in lieu of each required Type III exit.

(4) If the Administrator finds that there exist compensating factors in the emergency evacuation means provided, it shall be permissible to increase the passenger seating capacity beyond that shown in subparagraph (1) of this paragraph, except that such increase in seating capacity shall in no case exceed 10 passengers.

(5) On airplanes where the vertical location of the wing does not permit the installation of over-wing exits, an exit the dimensions of which are not less than those prescribed in paragraph (b) (3) of this section shall be installed for each Type III and each Type IV exit required by subparagraph (1) of this paragraph.

(d) *Ditching emergency exits.* Except as otherwise provided in this paragraph, at least 2 exits, one on each side of the airplane, meeting the minimum dimensions of the exits specified in paragraph (b) (3) of this section and located above the water level, shall be provided. On airplanes with a passenger seating capacity of 10 or less, the minimum dimensions of the exit specified in paragraph (b) (4) of this section shall be acceptable. In addition, it shall be shown that there is not less than one emergency exit located above the water level for every 35 passengers. It shall be permissible to substitute 2 type IV exits for each required type III exit. When the configuration of the airplane is such that it will not permit the location of side exits above the water level, the required number of side exits shall be replaced by an equal number of overhead hatches of not less than the dimensions of exits specified in paragraph (b) (3) of this section, except that on airplanes having a passenger capacity of 35 or less only one such overhead hatch need be provided.

(e) *Emergency exit arrangement.* (1) Emergency exits shall consist of movable doors or hatches in the external walls of the fuselage and shall provide an unobstructed opening to the outside.

(2) All emergency exits shall be openable from the inside and from the outside except that the sliding window emergency exit in the flight crew area need not be openable from the outside if the Administrator finds that the proximity of other approved exits makes them convenient and readily accessible to the flight crew area.

(3) The means of opening emergency exits shall be simple and obvious and shall not require exceptional effort of a person opening them.

(4) Means shall be provided for locking each emergency exit and for safeguarding against opening in flight either inadvertently by persons or as a result of mechanical failure.

(5) Means shall be provided for a direct visual inspection of the locking mechanism by crew members to ascertain whether all emergency exits for which the initial opening movement is outward are fully locked.

(6) Provision shall be made to minimize the possibility of jamming of emergency exits as a result of fuselage deformation in a minor crash landing.

(7) For all landplane emergency exits other than exits located over the wing which are more than 6 feet from the ground with the airplane on the ground and the landing gear extended, approved means shall be provided to assist the occupants in descending to the ground.

(8) The proper functioning of emergency exit installations shall be demonstrated by test.

(f) *Emergency exit marking.* (1) All passenger emergency exits, their means of access, and their means of opening shall be marked conspicuously. The identity and location of emergency exits shall be recognizable from a distance equal to the width of the cabin. The location of the emergency exit operating handle and the instructions for opening shall be marked on or adjacent to the emergency exit and shall be readable from a distance of 30 inches.

(2) A source or sources of light, with an energy supply independent of the main lighting system, shall be installed to illuminate all emergency passenger exit markings. Such lights shall be designed to function automatically in a crash landing and shall also be operable manually.

(3) All emergency exits which are required to be openable from the outside, and their means of opening shall be marked on the outside of the airplane for guidance of rescue personnel.

(g) *Emergency exit access.* Passageways between individual compartments of the passenger area and passageways leading to Type I and Type II emergency exits (see paragraph (b) of this section) shall be unobstructed and shall be not less than 20 inches wide. Adjacent to emergency exits where assisting means are required by paragraph (e) (7) of this section, there shall be sufficient additional space to allow a crew member to assist in the evacuation of passengers without reduction in the unobstructed width of the passageway to such exit. Access shall be provided from the main aisle to all Type III and Type IV exits and such access shall not be obstructed by seats, berths, or other protrusions to an extent which would reduce the effectiveness of the exit, except that minor obstructions shall be permissible if the Administrator finds that compensating factors are present to maintain the effectiveness of the exit. If it is necessary to pass through a doorway to reach any required emergency exit from any seat in the passenger cabin, the door shall be provided with a means to latch it in the open position. A suitable placard stating that the door is to be latched in the open position during takeoff and landing shall be installed.

(h) *Width of main aisle.* The main passenger aisle width at any point between seats shall not be less than the values in the following table:

Passenger seating capacity	Minimum main passenger aisle width	
	Less than 25 inches from floor	25 inches and more from floor
	Inches	*Inches*
10 or less	12	18
11 to 19	12	20
20 or more	15	20

[Amdt. 4b-4, 16 F. R. 11761, Nov. 21, 1951, as amended by Amdt. 4b-1, 19 F. R. 2250, Apr. 20, 1954; Amdt. 4b-5, 22 F.R. 1546, Mar. 9, 1957; 22 F.R. 1931, Mar. 22, 1957; Amdt. 4b-6, 22 F.R. 5565, July 16, 1957; Amdt. 4b-8, 23 F.R. 2591, Apr. 19, 1958; Amdt. 4b-11, 24 F.R. 7070, Sept. 9, 1959; Amdt. 4b-12, 27 F.R. 2992, Mar. 30, 1962]

§ 4b.362-1 Flight crew emergency exits (FAA policies which apply to § 4b.362(a)).

(a) A flight crew area emergency exit should be a minimum of 19″ x 20″ unobstructed rectangular opening; however, other size and shape minimums will also be acceptable providing a demonstration of exit utility, using typical flight crew personnel, is satisfactorily demonstrated to the Administrator.

(b) The provisions of § 4b.362 (e) (2) through (8) and (f) are also applicable to flight crew emergency exits. When the internal exit "opening means" involve sequence operations, operation of two handles or latches, release of safety catches, etc., such means will be acceptable for flight crew exits when it can be reasonably established that the means will be "simple and obvious" to crew members trained in their use.

[Supp. 37, 23 F. R. 2789, Apr. 26, 1958]

§ 4b.362-2 Step-down distance (FAA interpretation which applies to § 4b.362(b)).

The step-down distances specified in § 4b.362(b) (2), (3), and (4) mean the actual distances between the bottom of the required openings and a useable foothold which extends out from the fuselage and is large enough to be effective without searching visually or by feel.

[Supp. 37, 23 F. R. 2789, Apr. 26, 1958]

§ 4b.362-3 Number of passengers (FAA policies which apply to § 4b.362(c)).

(a) Cabin attendants are considered part of the crew and are not included in the passenger seating capacity, § 4b.362(c)(1).

(b) The following compensatory factor in emergency evacuation means will be acceptable for an increase in the passenger seating capacity beyond the limits specified in § 4b.362 (c) (1).

(1) The installation of an approved inflatable slide at each floor level exit, other than over the wing exits, is acceptable for:

(i) An increase of no more than 5 passengers on airplanes having at least 2 such exits; or

(ii) An increase of no more than 10 passengers on airplanes having at least 4 such exits.

[Supp. 37, 23 F. R. 2789, Apr. 26, 1958]

§ 4b.362-4 Emergency exit design descent means[1] (FAA policies which apply to § 4b.362(e)(7)).

(a) The assist device required for crew exits may be a rope or any other device demonstrated to be suitable for the purpose. If a rope is provided, it should be attached to the fuselage structure at or above the upper limit of the exit opening. The rope and attachment should be capable of withstanding a 400 lb. static load.

(b) When required by § 4b.362 (e) (7) at floor level passenger exits, the approved means may be an inflatable slide, a non-inflatable slide, or any other device approved by FAA as suitable for the purpose. Ropes or ladders will not be approved as descent means for use at floor level passenger exits.

[Supp. 37, 23 F. R. 2789, Apr. 26, 1958]

§ 4b.362-5 Emergency exit marking (FAA policies which apply to § 4b.362(f)).

(a) Exits in excess of the number required by the table in § 4b.362 (c) (1), need not be marked as emergency exits, but if so marked, such exits must meet all requirements of § 4b.362 for the particular type.

(b) Emergency exits used solely for emergency evacuation of the aircraft should be marked "Emergency Exit." Emergency exits customarily used in entering or leaving the airplane need only be marked with the word "Exit." In either case, the marking should be in red or in another color which provides adequate contrast where red might be ineffective against the cabin color scheme.

(c) Opening instructions when not on the exit should be immediately beside the exit and no special effort should be required by a person having 20/20 vision to read these instructions. Readability should be evaluated under representative day and emergency night lighting conditions.

[Supp. 37, 23 F. R. 2790, Apr. 26, 1958]

[1] Consideration should be given to such factors affecting the utility of Type III and Type IV exits as weight, ease of handling, provision of hand holds, stowage space, adequacy of instructions, etc. A side hinged or external opening exit would not be as critical from the weight standpoint as one removed inwardly which must be moved an appreciable distance to clear the exit approach.

§ 4b.362-6 Emergency exit access (FAA policies which apply to § 4b.362(g)).

(a) Attendant seating facilities[2] should not normally result in any reduction in required aisle widths, passageways between compartments, or the minimum 20″ passageway leading to Types I and II exits. Attendant seating facilities provided with any acceptable means of clearing the passageway immediately is not considered as being an obstruction to these passageways. An acceptable means of demonstrating compliance would be a spring loaded attendant seat which provides automatic retraction when the seat is vacated. Unless the seat is aft facing, the seat should also be equipped with a shoulder harness.

(b) When it is required that there be an area adjacent to an exit to permit a crew member to assist passengers in the use of escape devices, a 12″ x 20″ area with the long dimension parallel to and clear of the required 20″ exit approach passageway or equivalent facility should be provided. The area should be adequate to permit an attendant to stand erect and to perform needed assist services in the evacuation of passengers.

(c) Projection of the seat backs into the minimum required exit opening may be permitted only if the seat back can be pushed forward or aft to clear the opening with the seat occupied. The force required to push the seat back away from the opening should be as low as practicable and should not exceed a maximum of 35 pounds with the seat unoccupied. The action should not require operation of any mechanical release. A clear opening should permit the required minimum exit shape to be projected inward past the seat bottom and back cushion. Minor protrusion of the seat upholstery is acceptable if it does not interfere with exit removal and if it would be compressed without special effort by the person(s) using the exit.

(d) Arm rests, curtains, or other protuberances should not restrict the required minimum opening unless they are removed simultaneously with opening of the exit.

[2] Under such seating arrangements, particular attention should be directed to compliance with § 4b.260 (c) to protect the attendant from incapacitation by aircraft or galley equipment.

(e) Berth installations, whether or not made up, should not decrease the accessibility and utility of emergency exits.

[Supp. 37, 23 F. R. 2790, Apr. 26, 1958]

§ 4b.362–7 Width of main aisle (FAA policies which apply to § 4b.362(h)).

In determining compliance with aisle width requirements in an airplane so arranged that passengers face the aisle, the minimum aisle should be considered to begin at a point 12″ forward of the leading edge of each seat.

[Supp. 37, 23 F. R. 2790, Apr. 26, 1958]

VENTILATION, HEATING, AND PRESSURIZATION

§ 4b.370 General.

The requirements of §§ 4b.371 through 4b.376 shall apply to the ventilation, heating, and pressurization of the aircraft.

§ 4b.371 Ventilation.

(a) All crew compartments shall be ventilated by providing a sufficient amount of fresh air to enable the crew members to perform their duties without undue discomfort or fatigue.

NOTE: An outside air supply of approximately 10 cubic feet per minute is considered a minimum for each crew member.

(b) Ventilating air in crew and passenger compartments shall be free of harmful or hazardous concentrations of gases or vapors.

NOTE: Carbon monoxide concentrations in excess of one part in 20,000 parts of air are considered hazardous. Carbon dioxide in excess of 3 percent by volume (sea level equivalent) is considered hazardous in the case of crew members. Higher concentrations of carbon dioxide may not necessarily be hazardous in crew compartments if appropriate protective breathing equipment is available.

(c) Provision shall be made to insure the conditions prescribed in paragraph (b) of this section in the event of reasonably probable failures or malfunctioning of the ventilating, heating, pressurization, or other systems and equipment. If accumulation of hazardous quantities of smoke in the cockpit area is reasonably probable, smoke evacuation shall be readily accomplished starting with full pressurization and without depressurizing beyond safe limits (see § 4b.374(b)).

NOTE: Examples of acceptable provisions include secondary isolation, integral protective devices, and crew warning and shutoff for equipment the malfunctioning of which could introduce harmful or hazardous quantities of smoke or gases.

(d) [Reserved]

(e) Means shall be provided to enable the crew to control the temperature and quantity of ventilating air supplied to the crew compartment independently of the temperature and quantity of ventilating air supplied to other compartments.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 17 F. R. 1094, Feb. 5, 1952; Amdt. 4b–8, 18 F.R. 2215, Apr. 18, 1953; Amdt. 4b–6, 22 F.R. 5565, July 16, 1957; Amdt. 4b–12, 27 F.R. 2992, Mar. 30, 1962]

§ 4b.371–1 Carbon monoxide detection (FAA policies which apply to § 4b.371).

Policies outlined in § 4b.467–1 will apply.

[Supp. 24, 19 F.R. 4463, July 20, 1954]

§ 4b.372 Heating systems.

Combustion heaters shall be of an approved type and shall comply with the fire protection requirements of § 4b.386. Engine exhaust heaters shall comply with the provisions of § 4b.467 (c) and (d).

[Amdt. 4b–6, 17 F. R. 1094, Feb. 5, 1952]

§ 4b.372–1 Combustion heaters equipped with carbon dioxide fire extinguishers (FAA policies which apply to § 4b.372).

The policies outlined in § 4b.484–1 apply.

[Supp. 24, 19 F. R. 4463, July 20, 1954]

§ 4b.373 Pressurized cabins; general.

The design of pressurized cabins shall comply with the requirements of §§ 4b.374 through 4b.376. (See also §§ 4b.216 (c) and 4b.352, and the oxygen requirements of the appropriate operating parts of the Civil Air Regulations.)

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–2, 20 F. R. 5306, July 26, 1955]

§ 4b.374 Pressure equipment and supply.

(See § 4b.477(c).

(a) Occupied cabins or compartments of airplanes shall be equipped to provide a cabin pressure altitude of not more than 8,000 feet at the maximum operating altitude of the airplane under normal operating conditions.

(b) Airplanes certificated for operation at altitudes over 25,000 feet shall be capable of maintaining a cabin pressure altitude of not more than 15,000 feet in the event of any reasonably probable failure or malfunction in the pressurization system.

[Amdt. 4b–6, 22 F. R. 5565, July 16, 1957]

§ 4b.375 Pressure control.

Pressurized cabins shall be provided with at least the following valves, controls, and indicators for controlling cabin pressure.

(a) Two pressure relief valves, at least one of which is the normal regulating valve, shall be installed to limit automatically the positive pressure differential to a predetermined value at the maximum rate of flow delivered by the pressure source. The combined capacity of the relief valves shall be such that the failure of any one valve would not cause an appreciable rise in the pressure differential. The pressure differential shall be considered positive when the internal pressure is greater than the external.

(b) Two reverse pressure differential relief valves (or equivalent) shall be installed to prevent automatically a negative pressure differential which would damage the structure, except that one such valve shall be considered sufficient if it is of a design which reasonably precludes its malfunctioning.

(c) Means shall be provided by which the pressure differential can be rapidly equalized.

(d) An automatic or manual regulator for controlling the intake and/or exhaust air flow shall be installed so that the required internal pressures and air flow rates can be maintained.

(e) Instruments shall be provided at the pilot or flight engineer station showing the pressure differential, the absolute pressure in the cabin, and the rate of change of the absolute pressure.

(f) Warning indication shall be provided at the pilot or flight engineer station to indicate when the safe or preset limits on pressure differential and on absolute cabin pressure are exceeded.

(g) If the structure is not designed for pressure differentials up to the maximum relief valve setting in combination with landing loads (see § 4b.216 (c)), a warning placard shall be placed at the pilot or flight engineer station.

§ 4b.375–1 Warning indication (FAA policies which apply to § 4b.375(f)).

(a) *Cabin pressure differential warning.* Because of the protection provided by the required duplication of pressure relief valves, appropriate warning markings on the cabin pressure differential indicator will meet the requirement for a warning indication to the pilot or flight engineer when the safe or preset cabin pressure differential limits are exceeded.

(b) *Cabin absolute pressure warning.* An aural or visual signal in addition to cabin altitude indicating means will meet the requirements for a warning indication to the pilot or flight engineer when the cabin absolute pressure is reduced below that equivalent to 10,000 feet.

[Supp. 37, 23 F. R. 2790, Apr. 26, 1958]

§ 4b.376 Tests.

(a) *Strength test.* The complete pressurized cabin, including doors, windows, and all valves, shall be tested as a pressure vessel for the pressure differential specified in § 4b.216(c)(3).

(b) *Functional tests.* The following functional tests shall be performed.

(1) To simulate the condition of regulator valves closed, the functioning and the capacity shall be tested of the positive and negative pressure differential valves and of the emergency release valve.

(2) All parts of the pressurization system shall be tested to show proper functioning under all possible conditions of pressure, temperature, and moisture up to the maximum altitude selected for certification.

(3) Flight tests shall be conducted to demonstrate the performance of the pressure supply, pressure and flow regulators, indicators, and warning signals in steady and stepped climbs and descents at rates corresponding with the maximum attainable without exceeding the operating limitations of the airplane up to the maximum altitude selected for certification.

(4) All doors and emergency exits shall be tested to ascertain that they operate properly after being subjected to the flight tests prescribed in subparagraph (3) of this paragraph.

FIRE PROTECTION

§ 4b.380 General.

Compliance shall be shown with the fire protection requirements of §§ 4b.381 through 4b.386. (See also §§ 4b.480 through 4b.490.) In addition, the following shall apply.

(a) *Hand fire extinguishers.* Hand fire extinguishers shall be of an approved type. The types and quantities of extinguishing agents shall be appropriate for the types of fires likely to occur in the compartments where the extinguishers are intended for use. Extinguishers intended for use in personnel compartments shall be such as to minimize the hazard of toxic gas concentrations.

(b) *Built-in fire extinguishers.* Where a built-in fire extinguishing system is required, its capacity in relation to the compartment volume and ventilation rate shall be sufficient to combat any fire likely to occur in the compartment. All built-in fire extinguishing systems shall be so installed that any extinguisher agent likely to enter personnel compartments will not be hazardous to the occupants and that discharge of the extinguisher cannot result in structural damage. (See also § 4b.371.)

(c) *Protective breathing equipment.* If the airplane contains Class A, B, or E cargo compartments (see § 4b.383), protective breathing equipment shall be installed for the use of appropriate crew members. (See § 4b.651 (h).)

[Amdt. 4b–6, 17 F.R. 1094, Feb. 5, 1952, as amended by Amdt. 4b–7, 17 F.R. 11631, Dec. 20, 1952; Amdt. 4b–10, 24 F.R. 3153, Apr. 23, 1959]

§ 4b.380–1 Protective breathing equipment (FAA policies which apply to § 4b.380(c)).

The policies outlined in § 4b.651–2 apply.

[Supp. 24, 19 F.R. 4463, July 20, 1954]

§ 4b.380–2 Approved hand fire extinguishers (FAA policies which apply to § 4b.380(a)).

(a) *Standards for approval.* An approved type fire extinguisher includes those approved by the Underwriters Laboratories, Inc., Factory Mutual Laboratories, Underwriters' Laboratories of Canada, or any other agency deemed qualified by the Administrator, or approved by the Administrator in accordance with the provisions of § 4b.18.

(b) *General.* When selecting a hand fire extinguisher for use in aircraft, consideration should be given to the most appropriate extinguishing agent for the type and location of fires[1] likely to be encountered. Consideration should also be given to the agent's ratio of extinguishing ability to quantity required, toxicity,[2] corrosive properties, freezing point, and to the unit's gross weight, ease of operation, and maintenance requirements. Aircraft hand fire extinguishers using agents having a rating in toxicity Group 4 or under should not be installed in airplanes for which an application for a type certificate was made on or after March 5, 1952.[3]

(c) *Types of extinguishers*—(1) *Carbon dioxide extinguishers.*[4] Carbon dioxide extinguishers are acceptable when the principal hazard is a Class B or Class C fire. Carbon dioxide portable installations should not exceed five pounds of agent per unit to insure extinguisher portability and to minimize crew compartment CO_2 concentrations.

(2) *Water extinguishers.*[5] Water extinguishers are acceptable when the principal hazard is a Class A fire and where a fire might smolder if attacked solely by such agents as carbon dioxide or dry chemical.

[1] Class A fires: Fires in ordinary combustible materials where the quenching and cooling effects of quantities of water, or solutions containing large percentages of water, are of first importance.

Class B fires: Fires in flammable liquids, greases, etc., where a blanketing effect is essential.

Class C fires: Fires in electrical equipment, where the use of a nonconducting extinguishing agent is of first importance.

[2] The toxicity ratings listed by the Underwriters' Laboratories for some of the commonly known fire extinguisher chemicals are as follows:

Bromochloromethane—Group 3.
Bromotrifluoromethane—Group 6.
Carbon dioxide—Group 5.
Carbon tetrachloride—Group 3.
Dibromodifluoromethane—Group 4.
Methyl bromide—Group 2.

[3] Many transport type airplanes, due to their type certification basis, are not required to comply with § 4b.380. For such airplanes, it is recommended that hand fire extinguishers employing agents in toxicity Group 4 or higher be installed when renewing or replacing hand fire extinguishers employing toxic agents.

[4] Carbon dioxide is noncorrosive and will not injure food or fabric. Extinguishers must be winterized if they are to operate at temperatures below −40° F. Approved unit capacity ranges upwards from two pounds. These extinguishers have only limited value for the extinguishment of Class A fires, the action of the agent being to blanket the fire by excluding oxygen.

[5] Certain antifreeze agents may be corrosive. Approved extinguishers are either protected against freezing to −40° F. or must be handled as any other unprotected water on the airplane. Technical Standard Order C19a (14 CFR 514.19a) covers a minimum 1⅜ quart capacity approved water extinguisher. Water extinguishers of the kinds currently on the market are not acceptable for flammable liquid or electrical fires.

(3) *Vaporizing liquid extinguishers.*[6] Vaporizing liquid type fire extinguishers are acceptable when the principal hazard is a Class B or Class C fire.

(4) *Dry chemical extinguishers.*[7] Dry chemical extinguishers are acceptable where the principal hazard is a Class B or Class C fire. The extinguisher should not be used in crew compartments because of interference with visibility during discharge and because of the possibility of the nonconductive powders' being discharged on electrical contacts not otherwise involved.

[Supp. 30, 21 F. R. 5735, Aug. 7, 1956]

§ 4b.381 Cabin interiors.

All compartments occupied or used by the crew or passengers shall comply with the following provisions:

(a) The materials in no case shall be less than flash-resistant.

(b) The wall and ceiling linings, the covering of all upholstering, floors, and furnishings shall be flame-resistant.

(c) Compartments where smoking is to be permitted shall be equipped with ash trays of the self-contained type which are completely removable. All other compartments shall be placarded against smoking.

(d) All receptacles for used towels, papers, and waste shall be of fire-resistant material, and shall incorporate covers or other provisions for containing possible fires.

(e) At least one hand fire extinguisher shall be provided for use by the flight crew.

(f) In addition to the requirements of paragraph (e) of this section at least the following number of hand fire extinguishers conveniently located for use in passenger compartments shall be provided according to the passenger capacity of the airplane:

Passenger capacity:	*Minimum number of fire extinguishers*
6 or less	0
7 through 30	1
31 through 60	2
61 or more	3

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 17 F. R. 1094, Feb. 5, 1952]

§ 4b.381–1 Hand fire extinguishers for cabin interiors (FAA policies which apply to § 4b.381 (e) and (f)).

(a) *Crew compartment.* At least one hand fire extinguisher suitable for Class B and C fires should be installed in the crew compartment. Additional extinguishers may be required as dictated by potential fire hazards, extinguisher accessibility, and agent capacity.

(1) The extinguisher(s) should be readily accessible to crew members and mounted so as to facilitate quick removal from its mounting bracket.

(b) *Passenger compartments.* Fire extinguisher type and capacity should be based on the hazard, e. g., if a unit must protect large accessible baggage compartments, galleys, or electrical equipment racks, portables larger than minimum size should be provided. The size of the extinguisher should not, however, preclude ready portability by a flight attendant or even a passenger.

(1) Each fire extinguisher should be located adjacent to the most prominent hazard such as a baggage compartment, galley, etc.

(i) Where no such obvious hazard exists, or when only one unit is required, the extinguisher should be located at the flight attendant's station or at the entrance door on aircraft with no flight attendant.

(ii) Where two or more extinguishers are required and location is not dictated by special hazards, the units should be located at opposite ends of the passenger cabin.

(2) An extinguisher should be installed in each separate cabin, lounge, or smoking compartment unless the extinguisher in the adjacent compartment is in close proximity and easily accessible.

(3) All extinguishers should be easily accessible and clearly visible to the crew

[6] These agents are not normally corrosive to aircraft structure and approved units will be satisfactorily protected against freezing to at least −40° F. Up to the effective date of this policy, no vaporizing liquid extinguisher with Underwriters' Laboratories toxicity rating higher than Group 4 is commercially available. Approved units have a minimum capacity of one quart. They are of only limited value for the extinguishment of Class A fires, having a cooling effect of about one-tenth that of water.

[7] The powder is nontoxic and noncorrosive and approved units are protected against freezing to at least −40° F. Minimum capacity of approved units is two pounds.

and passengers; however, if they cannot be clearly visible, their location should be indicated by a clearly legible placard or sign visible to the crew and passengers.[6]

[Supp. 30, 21 F. R. 5735, Aug. 1, 1956]

§ 4b.382 Cargo and baggage compartments.

(a) Cargo and baggage compartments shall include no controls, wiring, lines, equipment, or accessories the damage or failure of which would affect the safe operation of the airplane, unless such items are shielded, isolated, or otherwise protected so that they cannot be damaged by movement of cargo in the compartment, and so that any breakage or failure of such item will not create a fire hazard.

(b) Provision shall be made to prevent cargo or baggage from interfering with the functioning of the fire-protective features of the compartment.

(c) All materials used in the construction of cargo or baggage compartments, including tie-down equipment, shall be flame-resistant.

(d) Sources of heat within the compartment shall be shielded and insulated to prevent igniting the cargo.

NOTE: Sources of heat likely to ignite cargo include light bulbs, combustion heaters, heater ducts, electrical appliances, etc.

[15 F.R. 3543, June 8, 1950, as amended by Amdt. 4b-10, 24 F.R. 3153, Apr. 23, 1959]

§ 4b.383 Cargo compartment classification.

All cargo and baggage compartments shall include provisions for safeguarding against fires according to the following classification.

(a) *Class A.* Cargo and baggage compartments shall be classified as "A" if the presence of a possible fire therein would be easily discernible to a member of the crew while at his station, and if all parts of the compartment are easily accessible in flight. A hand fire extinguisher shall be available for each compartment. (See § 4b.380 (c) for protective breathing requirements.)

(b) *Class B.* Cargo and baggage compartments shall be classified as "B" if sufficient access is provided while in flight to enable a member of the crew to reach effectively all parts of the compartment and its contents with a hand fire extinguisher. Compliance shall be shown with the following:

(1) The design of the compartment shall be such that, when the access provisions are being used, no hazardous quantity of smoke, flames, or extinguishing agent will enter any compartment occupied by the crew or passengers. (See § 4b.380 (c) for protective breathing requirements.)

(2) Each compartment shall be equipped with a separate system of an approved type smoke detector or fire detector to give warning at the pilot or flight engineer station.

(3) Hand fire extinguishers shall be readily available for use in each compartment.

(4) The compartment shall be completely lined with fire-resistant material.

(c) *Class C.* Cargo and baggage compartments shall be classified as "C" if they do not conform to the prerequisites for the "A" or "B" classifications. Compliance shall be shown with the following.

(1) Each compartment shall be equipped with:

(i) A separate system of an approved type smoke detector or fire detector to give warning at the pilot or flight engineer station, and

(ii) An approved built-in fire-extinguishing system controlled from the pilot or flight engineer station.

(2) Means shall be provided to exclude hazardous quantities of smoke, flames, or extinguishing agent from entering into any compartment occupied by the crew or passengers.

(3) Ventilation and drafts shall be controlled within each compartment so that the extinguishing agent provided can control any fire which may start within the compartment.

(4) The compartment shall be completely lined with fire-resistant material.

(d) *Class D.* Cargo and baggage compartments shall be classified as "D" if they are so designed and constructed that a fire occurring therein will be completely confined without endangering the safety of the airplane or the occupants. Compliance shall be shown with the following:

(1) Means shall be provided to exclude hazardous quantities of smoke, flames, or other noxious gases from entering into any compartment occupied by the crew or passengers.

(2) Ventilation and drafts shall be controlled within each compartment so that any fire likely to occur in the compartment will not progress beyond safe limits.

NOTE: For compartments having a volume not in excess of 500 cu. ft. an airflow of not more than 1,500 cu. ft. per hour is considered acceptable. For larger compartments lesser airflow may be applicable.

(3) The compartment shall be completely lined with fire-resistant material.

(4) Consideration shall be given to the effect of heat within the compartment on adjacent critical parts of the airplane.

(e) *Class E.* On airplanes used for the carriage of cargo only it shall be acceptable to classify the cabin area as a Class "E" compartment. Compliance shall be shown with the following:

(1) The compartment shall be completely lined with fire-resistant material.

(2) The compartment shall be equipped with a separate system of an approved type smoke or fire detector to give warning at the pilot or flight engineer station.

(3) Means shall be provided to shut off the ventilating airflow to or within the compartment. Controls for such means shall be accessible to the flight crew in the crew compartment.

(4) Means shall be provided to exclude hazardous quantities of smoke, flames, or noxious gases from entering the flight crew compartment. (See § 4b.380(c) for protective breathing equipment.)

(5) Required crew emergency exits shall remain accessible under all cargo loading conditions.

[15 F.R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 17 F.R. 1094, Feb. 5, 1952; Amdt. 4b-8, 18 F.R. 2215, Apr. 18, 1953; Amdt. 4b-2, 20 F.R. 5306, July 26, 1955; Amdt. 4b-10, 24 F.R. 3153, Apr. 23, 1959]

§ 4b.384 Proof of compliance.

(a) Compliance with those provisions of § 4b.383 which refer to compartment accessibility, to the entry of hazardous quantities of smoke or extinguishing agent into compartments occupied by the crew or passengers, and to the dissipation of the extinguishing agent in class C compartments shall be demonstrated by tests in flight.

(b) It shall also be demonstrated during the tests prescribed in paragraph (a) of this section that no inadvertent operation of smoke or fire detectors in adjacent or other compartments within the airplane would occur as a result of fire contained in any one compartment, either during or after extinguishment, unless the extinguishing system floods such compartments simultaneously.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 17 F. R. 1095, Feb. 5, 1952]

§ 4b.384-1 Cargo and baggage compartments equipped with carbon dioxide fire extinguishers (FAA policies which apply to § 4b.384).

The policies outlined in § 4b.484-1 apply.

[Supp. 24, 19 F. R. 4463, July 20, 1954]

§ 4b.385 Flammable fluid fire protection.

In areas of the airplane where flammable fluids or vapors might be liberated by leakage or failure in fluid systems, design precautions shall be made to safeguard against the ignition of such fluids or vapors due to the operation of other equipment, or to control any fire resulting from such ignition.

[Amdt. 4b-6, 17 F. R. 1095, Feb. 5, 1952]

§ 4b.386 Combustion heater fire protection.

(a) *Combustion heater fire zones.* The following shall be considered as combustion heater fire zones and shall be protected against fire in accordance with applicable provisions of §§ 4b.480 through 4b.486 and § 4b.489.

(1) Region surrounding the heater, if such region contains any flammable fluid system components other than the heater fuel system which might be damaged by heater malfunctioning or which, in case of leakage or failure, might permit flammable fluids or vapors to reach the heaters.

(2) Region surrounding the heater, if the heater fuel system incorporates fittings the leakage of which would permit fuel or vapors to enter this region.

(3) That portion of the ventilating air passage which surrounds the combustion chamber except that no fire extinguishment need be provided in cabin ventilating air passages.

[6] It is recommended that signs indicating location of extinguishers have letters at least ⅜ inch in height mounted on a contrasting background.

(b) *Ventilating air ducts.* (1) Ventilating air ducts which pass through fire zones shall be of fireproof construction.

(2) Unless isolation is provided by the use of fireproof valves or other equivalently effective means, the ventilating air duct downstream of the heater shall be of fireproof construction for a sufficient distance to assure that any fire originating from within the heater can be contained within the duct.

(3) Portions of ventilating ducts passing through regions in the airplane where flammable fluid systems are located shall be so constructed or isolated from such systems that failure or malfunctioning of the flammable fluid system components cannot introduce flammable fluids or vapors into the ventilating airstream.

(c) *Combustion air ducts.* (1) Combustion air ducts shall be of fireproof construction for a distance sufficient to prevent damage from backfiring or reverse flame propagation.

(2) Combustion air ducts shall not communicate with the ventilating airstream unless it is demonstrated that flames from backfires or reverse burning cannot enter the ventilating airstream under any conditions of ground or flight operation including conditions of reverse flow or malfunctioning of the heater or its associated components.

(3) Combustion air ducts shall not restrict prompt relief of backfires which can cause heater failure due to pressures generated within the heater.

(d) *Heater controls; general.* Provision shall be made to prevent hazardous accumulations of water or ice on or within any heater control components, control system tubing, or safety controls.

(e) *Heater safety controls.* (1) In addition to the components provided for normal continuous control of air temperature, air flow, and fuel flow, means independent of such components shall be provided with respect to each heater to shut off automatically that heater's ignition and fuel supply at a point remote from the heater when the heat exchanger temperature or ventilating air temperature exceed safe limits or when either the combustion air flow or the ventilating air flow becomes inadequate for safe operation. The means provided for this purpose for any individual heater shall be independent of all components serving other heaters the heat output of which is essential to the safe operation of the airplane.

(2) Warning means shall be provided to indicate to the crew when a heater, the heat output of which is essential to the safe operation of the airplane, has been shut off by the operation of the automatic means prescribed in subparagraph (1) of this paragraph.

(f) *Air intakes.* Combustion and ventilating air intakes shall be so located that no flammable fluids or vapors can enter the heater system under any conditions of ground or flight operation either during normal operation or as a result of malfunctioning, failure, or improper operation of other airplane components.

(g) *Heater exhaust.* Heater exhaust systems shall comply with the provisions of § 4b.467 (a) and (b). In addition, provisions shall be made in the design of the heater exhaust system so that the products of combustion will be safely conveyed overboard to prevent the occurrence of the following:

(1) Fuel leakage from the exhaust to surrounding compartments;

(2) Exhaust gas impingement on surrounding equipment or structure;

(3) Ignition of flammable fluids by the exhaust, when the exhaust is located in a compartment containing flammable fluid lines;

(4) Restriction by the exhaust of the prompt relief of backfires which can cause heater failure due to pressure generated within the heater.

(h) *Heater fuel systems.* Heater fuel systems shall comply with all portions of the powerplant fuel system requirements which affect safe heater operations. In addition, heater fuel system components within the ventilating airstream shall be protected by shrouds so that leakage from such components cannot enter the ventilating airstream.

(i) *Drains.* Means shall be provided for safe drainage of fuel accumulations which might occur within the combustion chamber or the heat exchanger. Portions of such drains which operate at high temperatures shall be protected in the same manner as heater exhausts (see paragraph (g) of this section). Drains shall be protected against hazardous ice accumulations in flight and during ground operation.

[Amdt. 4b-6, 17 F. R. 1095, Feb. 5, 1952, as amended by Amdt. 4b-8, 18 F. R. 2215, Apr. 18, 1953; Amdt. 4b-2, 20 F. R. 5306, July 26, 1955; Amdt. 4b-3, 21 F. R. 993, Feb. 11, 1956]

MISCELLANEOUS

§ 4b.390 Reinforcement near propellers.

Portions of the airplane near propeller tips shall have sufficient strength and stiffness to withstand the effects of the induced vibration and of ice thrown from the propeller. Windows shall not be located in such regions unless shown capable of withstanding the most severe ice impact likely to occur.

§ 4b.391 Leveling marks.

Reference marks shall be provided for use in leveling the airplane to facilitate weight and balance determinations on the ground.

Subpart E—Powerplant Installation

INSTALLATION

§ 4b.400 General.

The powerplant installation shall be considered to include all components of the airplane which are necessary for its propulsion. It shall also be considered to include all components which affect the control of the major propulsive units or which affect their safety of operation between normal inspections or overhaul periods. (See §§ 4b.604 and 4b.613 for instrument installation and marking.)

(a) *Scope.* Reciprocating engine installations shall comply with the provisions of this subpart. Turbine engine installations shall comply with such of the provisions of this subpart as are found applicable to the specific type of installation.

(b) *Functioning.* All components of the powerplant installation shall be constructed, arranged, and installed in a manner which will assure their continued safe operation between normal inspections or overhaul periods.

(c) *Accessibility.* Accessibility shall be provided to permit such inspection and maintenance as is necessary to assure continued airworthiness.

(d) *Electrical bonding.* Electrical interconnections shall be provided to prevent the existence of differences of potential between major components of the powerplant installation and other portions of the airplane.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 17 F. R. 1095, Feb. 5, 1952]

§ 4b.400–1 Engine and propeller operation (FAA policies which apply to § 4b.400).

The engines and propellers should be observed during the flight test program to determine satisfactory operation of these systems and their associated components.

[Supp. 24, 19 F. R. 4463, July 20, 1954]

§ 4b.400–2 Powerplant installation components (FAA interpretations which apply to § 4b.400).

The term "all components" includes engines and propellers and their parts, appurtenances, and accessories which are furnished by the engine or propeller manufacturer and all other components of the powerplant installation which are furnished by the airplane manufacturer. For example: Fuel pumps, lines, valves, and other components of the fuel system which are integral parts of the type certificated engine are also components of the airplane powerplant installation.

[Supp. 40, 23 F. R. 9018, Nov. 20, 1958]

§ 4b.401 Engines.

(a) *Type certification.* All engines shall be type certificated in accordance with the provisions of Part 13 of this subchapter.

(b) *Engine isolation.* The powerplants shall be arranged and isolated each from the other to permit operation in at least one configuration in a manner such that the failure or malfunctioning of any engine, or of any system of the airplane the failure of which can affect an engine, will not prevent the continued safe operation of the remaining engine(s) or require immediate action by a crew member for continued safe operation.

(c) *Control of engine rotation.* Means shall be provided for individually stopping and restarting the rotation of any engine in flight, except that for turbine engine installations means for stopping the rotation need be provided only if such rotation could jeopardize the safety of the airplane. All components provided for this purpose which are located on the engine side of the fire wall and which might be exposed to fire shall be of fire-resistant construction. If hydraulic propeller feathering systems are used for this purpose, the feathering lines on all airplanes manufactured after June 30, 1954, shall be fire-resistant under the operating conditions which may be expected to exist when feathering is being accomplished. (See also § 4b.449.)

(d) *Rotor blade protection.* Turbine powerplant installations shall include a means of protection such that the occurrence of rotor blade failure in any engine will not affect the operation of remaining engines nor jeopardize the continued safe operation of the airplane, unless the engine type certificate specifies that the engine rotor cases have been substantiated as capable of containing the damage resulting from rotor blade failure.

(e) *Engine turbine rotor.* Design precautions shall be taken to minimize the probability of jeopardizing the safety of the airplane in the event of engine turbine rotor failure, unless the engine type certificate specifies that the turbine rotors have been demonstrated to provide sufficient strength to withstand damage inducing factors such as those which might result from abnormal rotor speeds, temperature, or vibration and the design and functioning of the powerplant systems associated with engine control devices, systems, and instrumentation are such as to give reasonable assurance that those engine operating limitations which adversely affect turbine rotor structural integrity will not be exceeded in service.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 17 F. R. 1095, Feb. 5, 1952; Amdt. 4b-8, 18 F. R. 2215, Apr. 18, 1953; Amdt. 4b-2, 20 F.R. 5306, July 26, 1955; Amdt. 4b-6, 22 F.R. 5565, July 16, 1957]

§ 4b.401-1 Approval of automatic propeller feathering system (FAA policies which apply to § 4b.401(c)).

All parts of the feathering device which are integral with the propeller or attached to it in a manner that may affect propeller airworthiness should be considered from the standpoint of the applicable provisions of Part 14 of this subchapter. The determination of the continuing eligibility of the propeller under the existing type certificate, when the device is installed or attached, will be made on the following basis:

(a) The automatic propeller feathering system should not adversely affect normal propeller operation and should function properly under all temperature, altitude, airspeed, vibration, acceleration, and other conditions to be expected in normal ground and flight operation.

(b) The automatic device should be demonstrated to be free from malfunctioning which may cause feathering under any conditions other than those under which it is intended to operate. For example, it should not cause feathering during:

(1) Momentary loss of power,

(2) Approaches with reduced throttle settings.

(c) The automatic propeller feathering system should be capable of operating in its intended manner whenever the throttle control is in the normal position to provide take-off power. No special operations at the time of engine failure should be necessary on the part of the crew in order to make the automatic feathering system operative.

(d) The automatic propeller feathering installation should be such that not more than one engine will be feathered automatically even if more than one engine fails simultaneously.

(e) The automatic propeller feathering installation should be such that normal operation may be regained after the propeller has begun to feather automatically.

(f) The automatic propeller feathering installation should incorporate a switch or equivalent means by which to make the system inoperative. (See also § 4b. 10-2.)

[Supp. 23, 19 F. R. 1818, Apr. 2, 1954]

§ 4b.401-2 Propeller feathering system operational tests (FAA policies which apply to § 4b.401(c)).

(a) Tests should be conducted to determine the time required for the propeller to change from windmilling (with the propeller controls set for take-off) to the feathered position at the take-off safety speed, V_1.

(b) (1) The propeller feathering system should be tested to demonstrate nonrotation up to 1.2 times the maximum level flight speed with one engine inoperative or the speed employed in emergency descents whichever is higher with:

Critical engine—Inoperative.
Wing flaps—Retracted.
Landing gear—Retracted.
Cowl flaps—Closed.

(2) A sufficient speed range should be covered to assure that the propeller feathering angle established on the basis of the high speed requirement does not permit rotation in reverse at the lower speeds. In addition, the propeller should not inadvertently unfeather during these tests.

(c) In order to demonstrate that the feathering system operates satisfactorily, the propeller should be feathered and unfeathered at the maximum operating altitude established in accordance with § 4b.722. The following data should be recorded:

Time to feather propeller at the one-engine-inoperative cruising speed.
Time to unfeather propeller to 1,000 r. p. m. at maximum operating altitude and one-engine-inoperative cruising speed.
Altitude of propeller feathering tests.
Ambient air temperature of propeller feathering tests.

[Supp. 24, 19 F. R. 4463, July 20, 1954]

§ 4b.401-3 Continued rotation of turbine engines (FAA policies which apply to § 4b.401(c)).

(a) If means are not provided to completely stop the rotation of turbine engines it should be shown that continued rotation, either windmilling or controlled, of a shutdown turbine engine will not cause:

(1) Powerplant (including engine and accessories) structural damage which will adversely affect other engines or the aircraft structure,

(2) Flammable fluid to be pumped into a fire or onto an ignition source, or

(3) A vibration mode which will adversely affect the aerodynamic or structural integrity of the airplane.

(b) Feathered propellers, brakes, doors or other means used to control turbine engine rotation need not produce a complete stop of engine rotation [1] unless the continued rotation will cause any of the conditions set forth in paragraph (a) of this section.

(c) If engine induction air duct doors, or shaft, or other types of brakes [2] are provided to control turbine engine rotation, no single fault or failure of the system controlling engine rotation should cause the inadvertent travel of the doors toward the closed position, or the inadvertent energizing of braking means, unless compensating features are provided to assure that engine failure or a critical operating condition will not occur.

[Supp. 32, 22 F. R. 5793, July 20, 1957]

§ 4b.401-4 Engine operation with automatic propeller control system installed (FAA policies which apply to § 4b.401(b)).

(a) When an automatic control system for simultaneous r.p.m. control of all propellers is installed, it should be shown that no single failure or malfunction in this system or in an engine controlling this system will:

(1) Cause the tolerable engine overspeed for this condition [3] to be exceeded at any time, and

(2) Cause a loss of thrust which will cause the airplane to descend below the established takeoff path (§ 4b.116) if such system is certificated for use during takeoff and climb. This should be shown for all weights and altitudes for which certification is desired. A period of five seconds should be allowed from the time the malfunction occurs to the initial motion of the cockpit control for corrective action taken by the crew.

(b) Compliance with this policy may be shown by, (1) analysis, (2) flight demonstration, or (3) a combination of analysis and flight demonstration.

[Supp. 33, 22 F. R. 6883, Aug. 27, 1957]

§ 4b.402 Propellers.

Propellers shall be type certificated in accordance with the provisions of Part 14 of this subchapter. The maximum propeller shaft rotational speed and the engine power permissible for use in the airplane shall not exceed the corresponding limits for which the propeller has been certificated.

§ 4b.402-1 Reverse thrust propeller installations (FAA policies which apply to § 4b.402).

The Administrator may approve reverse thrust propeller installations which comply with the following:

(a) Exceptional pilot skill should not be required in taxying or any condition in which reverse thrust is to be used.

[1] It may be assumed that the conditions in paragraph (a) of this section will not occur at engine rotor speeds up to 400 r.p.m.

[2] The provision of doors or brakes is a protective feature to assure that the conditions of paragraph (a) of this section will not occur. Such provision, therefore, should be of a high order of reliability, and the probability should be remote that doors or brakes will not function normally on demand.

[3] 105 percent of takeoff r.p.m. will be considered tolerable for this condition for all engines, except that higher overspeeds may be acceptable if the engine manufacturer substantiates a higher value to the FAA.

(b) Necessary operating procedures, operating limitations and placards should be established.

(c) The airplane control characteristics should be satisfactory with regard to control forces encountered, and buffeting should not be likely to cause structural damage.

(d) The directional control should be adequate using normal piloting skill.

(e) It should be determined that no dangerous condition is encountered in the event of sudden failure of one engine in any likely operating condition.

(f) The operating procedures and airplane configuration should be such as to provide reasonable safeguards against serious structural damage to parts of the airplane due to the reverse airflow.

(g) It should be determined that the pilot's vision is not dangerously obscured under normal operating conditions on dusty or wet runways and where light snow is on the runway.

(h) It should be determined that the pilot's vision is not dangerously obscured by spray due to reverse airflow under normal water operating conditions with seaplanes.

(i) The procedure and mechanisms for reversing should provide a reverse idle setting such that without requiring exceptional piloting skill at least the following conditions are met:

(1) Sufficient power is maintained to keep the engine running at an adequate speed to prevent engine stalling during and after the propeller reversing operation.

(2) The propeller does not overspeed during and after the propeller reversing operation.

(3) This idle setting does not exceed 25 percent of the maximum continuous rating.

(j) The engine cooling characteristics should be satisfactory in any likely operating condition.

(k) The use of reverse thrust will be permitted, in combination with the brakes installed, in establishing the accelerate-stop distance, if it is shown that such use provides a level of safety equivalent to that when wheel brakes alone are used, taking into consideration pilot skill required and the likelihood of attaining the necessary performance under conditions of simulated engine failure. Either of the following conditions and limitations should be used:

(1) Symmetrical reverse thrust on (n–2) engines with power not to exceed the maximum continuous rating, where n is equal to the number of engines.

(2) Asymmetrical reverse thrust on (n–1) engines in reverse idle setting. This operation should be permitted only where it can be shown that with use of this asymmetrical reverse thrust the airplane can be satisfactorily controlled on a wet runway.

(l) On four engine aircraft the use of reverse thrust will be permitted in combination with the brakes installed in establishing the landing distance if it is shown that such use provides a level of safety equivalent to that when wheel brakes alone are used taking into consideration pilot skill required and the likelihood of attaining the necessary performance under conditions of simulated engine failure. Determination of landing distance should be conducted in accordance with §§ 4b.122 and 4b.123 with the following additional provisions:

(1) A steady gliding approach should be made on an ILS flight path corresponding to the average value of 2½ degrees, except that this prescribed approach will not be required if the application of reverse thrust credit is limited to operations on dry and ice free runways under VFR conditions.

(2) The two most critical symmetrical engines may be placed in the reverse idle position not sooner than four seconds after the aircraft is firmly on the ground.

(3) An accelerated service test should be conducted in accordance with § 4b.16 (b) to establish reliability of the installation which should include not less than 25 landings, covering a range of power settings during the approach and a range of altitudes for which approval is desired.

[Supp. 25, 20 F. R. 2279, Apr. 8, 1955]

§ 4b.403 Propeller vibration.

The magnitude of the propeller blade vibration stresses under all normal conditions of operation shall be determined by actual measurement or by comparison with similar installations for which such measurements have been made. The vibration stresses thus determined shall not exceed values which have been demonstrated to be safe for continuous operation.

§ 4b.404 Propeller pitch and speed limitations.

(a) The propeller pitch and speed shall be limited to values which will assure safe operation under all normal conditions and which will assure compliance with the performance requirements specified in §§ 4b.110 through 4b.125.

(b) A propeller speed limiting means shall be provided at the governor. Such means shall be set to limit the maximum possible governed engine speed to a value not exceeding the maximum permissible r. p. m.

(c) The low pitch blade stop in the propeller, or other means used to limit the low pitch position, shall be set so that the engine speed does not exceed 103 percent of the maximum permissible engine r. p. m. under the following conditions:

(1) Propeller blades at the low pitch limit and governor inoperative, and

(2) Engine operating at take-off manifold pressure with the airplane stationary under standard atmospheric conditions.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–2, 20 F. R. 5306, July 26, 1955]

§ 4b.405 Propeller clearance.

With the airplane loaded to the maximum weight and at the most adverse center of gravity position and the propellers in the most adverse pitch position, the propeller clearances shall not be less than the following, unless smaller clearances are substantiated for the particular design involved.

(a) *Ground.* Seven inches of ground clearance for airplanes equipped with nose-wheel type landing gears, or nine inches of ground clearance for airplanes equipped with tail-wheel type landing gears shall be provided with the landing gear statically deflected and the airplane in the level take-off or in the taxiing attitude, whichever is most critical. In addition, there shall be positive clearance between the propeller and the ground when, with the airplane in the level take-off attitude, the critical tire is completely deflated and the corresponding landing gear strut is completely bottomed.

(b) *Water.* A water clearance of 18 inches shall be provided unless compliance with § 4b.182 (a) is demonstrated with less clearance.

(c) *Structure.* (1) One inch radial clearance shall be provided between the blade tips and the airplane structure, or whatever additional radial clearance is necessary to preclude harmful vibration of the propeller or airplane.

(2) One-half inch longitudinal clearance shall be provided between the propeller blades or cuffs and all stationary portions of the airplane.

(3) Positive clearance shall be provided between other rotating portions of the propeller or spinner and all stationary portions of the airplane.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–7, 17 F. R. 11631, Dec. 20, 1952]

§ 4b.406 Propeller de-icing provisions.

(a) Airplanes intended for operation under atmospheric conditions conducive to the formation of ice on propellers or on accessories where ice accumulation would jeopardize engine performance shall be provided with means for the prevention or removal of hazardous ice accumulations.

(b) If combustible fluid is used for propeller de-icing, the provisions of §§ 4b.480 through 4b.483, inclusive, shall be complied with.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 17 F. R. 1095, Feb. 5, 1952]

§ 4b.406–1 Fluid type propeller de-icing test (FAA policies which apply to § 4b.406).

If the propellers are equipped with fluid type de-icers, the flow test should be conducted starting with a full tank of fluid and operated at maximum flow for a 15 minute timed period. The operation should be checked at all engine speeds and powers. The tank should be refilled to determine the amount of fluid used after the airplane is landed.

[Supp. 24, 19 F. R. 4463, July 20, 1954]

§ 4b.407 Reversing systems.

(a) Reversing systems intended for ground operation only shall be such that no single failure or malfunctioning of the system under all anticipated conditions of airplane operation will result in unwanted reverse thrust. Failure of structural elements need not be considered if occurrence of such failure is expected to be extremely remote.

(b) Turbo-jet reversing systems intended for inflight use shall be such that no unsafe condition will result during normal operations of the system, or from any failure or reasonably likely combination of failures of the reversing system, under all anticipated conditions of operation of the airplane. Failure of structural elements need not be considered if occurrence of such failure is expected to be extremely remote.

[Amdt. 4b-11, 24 F.R. 7070, Sept. 1, 1959]

§ 4b.407-1 Investigation of propeller systems which produce negative thrust (FAA policies which apply to § 4b.407).

(a) Compliance with § 4b.407 may be demonstrated by failure analysis, testing, or a combination of both for propeller systems that allow propeller blades to move from the flight low-pitch position to a position[1] that is substantially less than that at the normal flight low-pitch stop position.

(b) The analysis should disclose, for all components involved in the reversing system, the types of failure or malfunction likely to occur, how such failures or malfunctions affect propeller pitch, and the design feature that prevents unwanted travel of the propeller blades to a position substantially below the normal flight low-pitch stop. The analysis may include, or be supported by, the analysis made to demonstrate compliance with the requirements of § 14.103 of this subchapter for the propeller and associated installation components supplied with it.

(c) When necessary, testing should be conducted to verify assumptions made in the analysis of how the propeller will function with a failed system component and that the design feature provided does in fact prevent unwanted travel of the propeller blades.

[Supp. 33, 22 F. R. 6885, Aug. 27, 1957]

§ 4b.408 Turbo-propeller-drag limiting systems.

For turbo-propeller-powered airplanes, propeller-drag limiting systems shall be such that no single failure or malfunction of any of the systems during normal or emergency operation will result in propeller drag in excess of that for which the airplane was designed in compliance with § 4b.216 (d). Failure of structural elements of the drag limiting systems need not be considered if occurrence of such failure is expected to be extremely remote. (See also § 4b.310.)

[Amdt. 4b-6, 22 F. R. 5565, July 16, 1957]

§ 4b.409 Turbine powerplant operating characteristics.

Turbine powerplant operating characteristics shall be investigated in flight to determine that no adverse characteristics, such as stall, surge, or flameout, are present to a hazardous degree during normal and emergency operation of the airplane within the range of operating limitations of the airplane and of the engine.

[Amdt. 4b-8, 23 F.R. 2591, Apr. 19, 1958]

FUEL SYSTEM OPERATION AND ARRANGEMENT

§ 4b.410 General.

(a) The fuel system shall be constructed and arranged in such a manner as to assure a flow of fuel at a rate and pressure which have been established for proper engine functioning under all likely operating conditions, including all maneuvers for which the airplane is intended. (For fuel system instruments see § 4b.604.)

(b) The fuel system shall be so arranged that no one fuel pump can draw fuel from more than one tank at a time unless means are provided to prevent introducing air into the system.

[15 F.R. 3543, June 8, 1950, as amended by Amdt. 4b-11, 24 F.R. 7070, Sept. 1, 1959]

§ 4b.411 Fuel system independence.

The design of the fuel system shall comply with the requirements of § 4b.401(b). Unless other provisions are made in compliance with this requirement, the fuel system shall be arranged to permit the supply of fuel to each engine through a system independent of any portion of a system supplying fuel to any other engine.

[Amdt. 4b-6, 17 F. R. 1095, Feb. 5, 1952]

§ 4b.413 Fuel flow.

(a) The fuel system shall provide not less than 100 percent of the fuel flow required by the engines when the airplane is operated under all intended operating conditions and maneuvers.

(b) In determining compliance with the provisions of paragraph (a) of this section, the provisions of subparagraphs (1) through (4) of this paragraph shall apply.

(1) Fuel shall be delivered to the engine at a pressure within the limits specified in the engine type certificate.

(2) The quantity of fuel in the tank being considered shall not exceed the sum of the amount established as the unusable fuel supply for that tank, as determined in accordance with the provisions of § 4b.416, and whatever minimum quantity of fuel it may be necessary to add for the purpose of determining compliance.

(3) Such main pumps shall be used as are necessary for each operating condition and airplane attitude for which compliance is determined, and, in addition, for each main pump so used, the appropriate emergency pump shall be substituted. (See § 4b.430(b).)

(4) If a fuel flowmeter is provided, operation of the meter shall be blocked in determining compliance with this section and the fuel shall flow through the meter or its bypass.

(c) If an engine can be supplied with fuel from more than one tank, it shall be possible to regain the full fuel pressure of that engine in not more than 20 seconds after switching to any fuel tank when engine malfunctioning becomes apparent due to the depletion of the fuel supply in any tank from which the engine can be fed.

[Amdt. 4b-12, 27 F.R. 2992, Mar. 30, 1962]

§ 4b.416 Unusable fuel supply.

The unusable fuel supply shall be selected by the applicant and shall be established for each tank as not less than the quantity at which the first evidence of malfunctioning occurs under the most adverse condition from the standpoint of fuel feed during all intended operations and flight maneuvers involving use of that tank.

[Amdt. 4b-12, 27 F.R. 2992, Mar. 30, 1962]

§ 4b.417 Fuel system hot weather operation.

(a) To prove satisfactory hot weather operation the airplane shall be climbed from the altitude of the airport chosen by the applicant to the altitude corresponding with that at which the one-engine-inoperative best rate of climb is not greater than the en route climb with the configuration and at the weight specified in § 4b.120(c). There shall be no evidence of vapor lock or other malfunctioning. The climb test shall be conducted under the following conditions.

(1) For reciprocating-engine-powered airplanes, all engines shall operate at maximum continuous power, except that take-off power shall be used for the altitude range extending from 1,000 feet below the critical altitude through the critical altitude. The time interval during which take-off power is used shall not be less than the take-off time limitation. For turbine-engine-powered airplanes, all engines shall operate at take-off power for the time interval selected by the applicant in demonstrating the take-off flight path and thereafter shall operate at maximum continuous power for the duration of the climb.

(2) The weight shall be with full fuel tanks, minimum crew, and such ballast as is required to maintain the center of gravity within allowable limits.

(3) The speed of climb shall not exceed that which will permit compliance with the minimum climb requirement specified in § 4b.119 (a).

(4) The fuel temperature shall be not less than 110° F.

(b) The test prescribed in paragraph (a) of this section shall be performed either in flight or on the ground closely simulating flight conditions. If a flight test is performed in weather sufficiently cold to interfere with the proper conduct of the test, the fuel tank surfaces, fuel lines, and other fuel system parts subjected to cooling action from cold air shall be insulated to simulate, in so far as practicable, flight in hot weather.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-2, 20 F. R. 5306, July 26, 1955]

§ 4b.417-1 Hot weather fuel system tests (FAA policies which apply to § 4b.417).

(a) *General.* Hot weather fuel system tests should be conducted with fuel in the tanks normally used for take-off and landing, and with the maximum number of engines drawing fuel from the tank as would normally occur in flight. In the case of symmetrical fuel tank systems, the tests may be confined to one of each such system. Unweathered fuel should be used during these demonstrations. The fuel temperature should be 110° F. just prior to take-off. If the fuel must be heated to this temperature caution should be taken to prevent overheating during the process. The auxiliary fuel pumps should be turned "off" or "on" during the tests depending upon the normal

[1] Where the blade position is intended to provide increased drag during the landing run (ground fine pitch) or a reversed propeller blade position.

operating procedure established for the airplane. If the auxiliary pumps are being considered for use as emergency pumps they should be inoperative to at least 6,000 feet. A fuel pressure failure is considered to occur when the fuel pressure decreases below the minimum prescribed by the engine manufacturer.

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

Weight—Corresponding to operation with full fuel tanks, minimum crew and ballast required to maintain airplane within center of gravity limits.
C. G. position—Optional, within allowable limits.
Wing flaps—Most favorable position.
Landing gear—Retracted.
Cowl flaps—In a position that provides adequate cooling in the hot day condition.
Engines—See paragraph (c) of this section.

(c) *Test procedure and required data*. The take-off and climb should be made as soon as possible after the fuel in the tank has been heated to 110° F. The air speed during the climb should not exceed that speed used in demonstrating the requirements specified in § 4b.119(a). If the engines are normally operated with the auxiliary pumps "off," they should be turned "on" when a fuel pressure failure occurs. Restoration of fuel pressure should be noted and the climb continued to the maximum operating altitude selected by the applicant for certification. The following data should be recorded at reasonable time intervals:

Fuel temperature at start of test.
Fuel pressure at start of test and continuously during climb noting any pressure failures.
Auxiliary fuel pump operation.
Pressure altitude.
Ambient air temperature.
Air speed.
Engines, rpm and manifold pressure.
Comments on engine operation.

[Supp. 24, 19 F.R. 4463, July 20, 1954, as amended by Supp. 34, 22 F.R. 6963, Aug. 29, 1957]

§ 4b.418 Flow between interconnected tanks.

If it is possible to pump fuel from one tank to another in flight, the design of the fuel tank vents and the fuel transfer system shall be such that no structural damage to tanks will occur in the event of overfilling.

[Amdt. 4b-12, 27 F.R. 2992, Mar. 30, 1962]

Fuel System Construction and Installation

§ 4b.420 General.

(a) Fuel tanks shall be capable of withstanding without failure all vibration, inertia, fluid, and structural loads to which they may be subjected in operation.

(b) Flexible fuel tank liners shall be of an approved type or shall be shown to be suitable for the particular application.

(c) Integral type fuel tanks shall be provided with facilities for inspection and repair of the tank interior.

(d) [Reserved]

(e) Fuel tanks located within the fuselage contour shall be capable of resisting rupture and retaining the fuel under the inertia forces prescribed for the emergency landing conditions in § 4b.260. In addition, these tanks shall be located in a protected position so that exposure of the tanks to scraping action with the ground will be unlikely.

(f) The augmentation liquid tank capacity available for the use of each engine shall be sufficient to permit operation of the airplane in accordance with the procedures for the use of liquid augmented powers which are established and approved with respect to compliance with the related requirements of this part. The computation of liquid consumption shall be based on the maximum approved rate appropriate for the desired engine output and shall include the effect of temperature on engine performance as well as any other factors that might cause a variation in the amount of liquid required.

[15 F.R. 3543, June 8, 1950, as amended by Amdt. 4b-2, 20 F.R. 5306, July 26, 1955; Amdt. 4b-3, 21 F.R. 993, Feb. 11, 1956; Amdt. 4b-6, 22 F.R. 5565, July 16, 1957; Amdt. 4b-12, 27 F.R. 2993, Mar. 30, 1962]

§ 4b.420-1 Minimum quantity of antidetonant fluid required (FAA policies which apply to § 4b.420(e)).

(a) *Airplanes equipped with a common tank for two engines*. The usable capacity of the tank should be sufficient for operation of the engines served by that tank for a duration equal to that determined by Case A, B, or C, whichever is applicable and results in the greater value (see table 2). The capacity should be based on the flow rate approved during engine type certification.

(1) *Case A*. Case A is intended to provide for conditions with all engines operating and, therefore, the approach climb requirement is not involved.

(2) *Case B*. Case B is intended to provide for failure of one engine during the course of a flight between takeoff and landing and may, therefore, involve the approach climb requirement but not the landing climb requirement.

(3) *Case C*. Case C provides for failure of an engine during the course of a flight between takeoff and landing on a four-engine aircraft which has two tanks; each feeding a pair of engines on one side of the airplane. The tables show the quantities required to assure an adequate supply of fluid on the side of the airplane opposite to the side on which the failure occurs since this is the critical consideration for determining the tank quantity. Both tanks on the airplane should, of course, have this capacity. For the same reason as in Case B, the landing climb is not involved for Case C, but the approach climb requirement may be involved.

(b) *Airplanes equipped with a separate tank for each engine*. The capacity of the tank should be sufficient for operation of the engine for a duration equal to the greatest value specified for engine No. 1 in the three cases listed in table 2. However, in no case should the quantity be less than that required for three minutes of engine operation.

TABLE 2—ANTI-DETONANT TANK CAPACITY

(Total for tank equals sum of totals for both engines served by tank)

	Case A		Case B		Case C	
	Engine No. 1	Engine No. 2	Engine No. 1	Engine No. 2	Engine No. 1	Engine No. 2
Takeoff	X [1]	X	X	X	X	X
Approach [2]	----	----	X	----	X	X
Landing [3]	X/2 [4]	X/2 [4]	----	----	----	----
Reserve	X/2 [1,4]	X/2 [1,4]	X	----	X	X

[1] Whenever "X" appears in the table, it denotes a duration equal to the maximum time for which the use of wet takeoff power is used for determination of the takeoff flight path of the airplane. However, in no case should the value of either "X" or "X/2" be considered to be less than one minute.

[2] Applies as indicated by "X" only if wet takeoff power is used to demonstrate compliance with the approach climb requirement of § 4b.120 (d).

[3] Applies as indicated by "X" only if wet takeoff power is used to demonstrate compliance with the landing climb requirement of § 4b.119 (b).

[4] "X/2" is specified for the reserve in the all-engine operating case rather than "X" because this type of operation, s considered less critical than operation with one engine inoperative and the reserve need not therefore be as large.

[Supp. 25, 20 F. R. 2280, Apr. 8, 1955]

§ 4b.421 Fuel tank tests.

(a) Fuel tanks shall be demonstrated by test to be capable of withstanding the more critical of the pressures resulting from the conditions of subparagraphs (1) and (2) of this paragraph without failure or leakage as mounted in the airplane. In addition, tank surfaces subjected to more critical pressures resulting from the conditions of subparagraphs (3) and (4) of this paragraph shall be demonstrated by means of either analyses or tests to be capable of withstanding such pressures.

(1) Internal pressures of 3.5 psi;

(2) 125 percent of the maximum air pressure developed in the tank from ram effect;

(3) Fluid pressures developed during maximum limit accelerations and deflections of the airplane with a full tank;

(4) Fluid pressures developed during the most adverse combination of airplane roll and fuel load.

(b) Metallic tanks with large unsupported or unstiffened flat surfaces, the failure or deformation of which could cause fuel leakage, shall be capable of withstanding a vibration test in accordance with the conditions of subparagraphs (1) through (4) of this paragraph, or other equivalent test, without leakage, or excessive deformation of the tank walls.

(1) The complete tank assembly together with its supports shall be subjected to a vibration test when mounted in a manner simulating the actual installation.

(2) The tank assembly shall be vibrated for 25 hours while filled two-thirds full of water or any suitable test fluid. The amplitude of vibration shall

not be less than one thirty-second of an inch, unless otherwise substantiated.

(3) The frequency of vibration shall be 90 percent of the maximum continuous rated speed of the engine unless some other frequency within the normal operating range of speeds of the engine is more critical, in which case the latter speed shall be employed and the time of test shall be adjusted to accomplish the same number of vibration cycles.

(4) During the test, the tank assembly shall be rocked at the rate of 16 to 20 complete cycles per minute through an angle of 15° on either side of the horizontal (30° total) about the most critical axis for 25 hours. If motion about more than one axis is likely to be critical, the tank shall be rocked about each axis for 12½ hours.

(c) Nonmetallic tanks shall withstand the test specified in subparagraph (b) (4) of this section with fuel at a temperature of 110° F. except that this test shall not be required where satisfactory operating experience with a similar tank in a similar installation is shown. During the test a representative specimen of the tank shall be installed in supporting structure which simulates the installation in the airplane.

[15 F.R. 3543, June 8, 1950, as amended by Amdt. 4b-3, 21 F.R. 993, Feb. 11, 1956; Amdt. 4b-11, 24 F.R. 7070, Sept. 1, 1959]

§ 4b.422 Fuel tank installation.

(a) The method of support for fuel tanks shall not permit concentration of loads, resulting from the weight of the fuel in the tank, on unsupported tank surfaces. The following shall be applicable.

(1) Pads shall be provided to prevent chafing between the tank and its supports.

(2) Materials employed for padding shall be nonabsorbent or shall be treated to prevent the absorption of fluids.

(3) If flexible tank liners are employed they shall be so supported that the liner is not required to withstand fluid loads.

(4) Interior surfaces of tank compartments shall be smooth and free of projections which could cause wear of the liner, unless provisions are made for protection of the liner at such points or unless the construction of the liner itself provides such protection.

(b) Spaces adjacent to the surfaces of the tank shall be ventilated consistent with the size of the compartment to avoid fume accumulation in the case of minor leakage. If the tank is in a sealed compartment it shall be acceptable to limit the ventilation to that provided by drain holes of sufficient size to prevent excessive pressure resulting from altitude changes.

(c) Location of fuel tanks shall comply with the provisions of § 4b.481 (a).

(d) No portion of engine nacelle skin which lies immediately behind a major air egress opening from the engine compartment shall act as the wall of an integral tank.

(e) Fuel tanks shall be isolated from personnel compartments by means of fumeproof and fuelproof enclosures.

§ 4b.423 Fuel tank expansion space.

(a) Fuel tanks shall be provided with an expansion space of not less than 2 percent of the tank capacity.

(b) It shall not be possible to fill the fuel tank expansion space inadvertently when the airplane is in the normal ground attitude.

§ 4b.424 Fuel tank sump.

(a) Each fuel tank shall be provided with a sump having a capacity of not less than either 0.10 percent of the tank capacity or one-sixteenth of a gallon, whichever is the greater, except that a smaller capacity shall be acceptable if operating limitations are established to assure that in service the accumulation of water will not exceed the sump capacity.

(b) The fuel tank sump capacity specified in paragraph (a) of this section shall be effective with the airplane in the normal ground attitude. The fuel tank shall be constructed to permit drainage of any hazardous quantity of water from all portions of the tank to the sump when the airplane is in the ground attitude.

(c) Fuel tank sumps shall be provided with an accessible drain to permit complete drainage of the sump on the ground. The drain shall discharge clear of all portions of the airplane and shall be provided with means for positive locking of the drain in the closed position, either manually or automatically.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-3, 21 F. R. 993, Feb. 11, 1956]

§ 4b.425 Fuel tank filler connection.

(a) The design of fuel tank filler connections shall be such as to prevent the entrance of fuel into the fuel tank compartment or any other portion of the airplane other than the tank itself.

(b) Recessed fuel tank filler connections which retain any appreciable quantity of fuel shall incorporate a drain, and the drain shall discharge clear of all portions of the airplane.

(c) The fuel tank filler cap shall provide a fuel-tight seal.

(d) The fuel tank filler connections shall be marked as prescribed in § 4b.738 (b).

§ 4b.426 Fuel tank vents and carburetor vapor vents.

(a) Fuel tanks shall be vented from the top portion of the expansion space in such a manner that venting of the tank is effective under all normal flight conditions. The following shall be applicable.

(1) Vent outlets shall be located and constructed to prevent the possibility of being obstructed by ice or other foreign matter.

(2) The vent shall be constructed to preclude the possibility of siphoning fuel during normal operation.

(3) The vent shall be of sufficient size to prevent the existence of excessive differences of pressure between the interior and exterior of the tank during normal flight operation, during maximum rate of descent, and, if applicable, during refueling and defueling.

(4) Air spaces of tanks with interconnected outlets shall also be interconnected.

(5) There shall be no points in the vent line where moisture could accumulate with the airplane in either the ground or the level flight attitude unless drainage is provided.

(6) Vents and drainage shall not terminate at points where the discharge of fuel from the vent outlet would constitute a fire hazard or from which fumes could enter personnel compartments.

(b) Carburetors which are provided with vapor elimination connections shall be provided with a vent line to lead vapors back to one of the fuel tanks. The vents shall comply with the following.

(1) Provisions shall be incorporated in the vent system to avoid stoppage by ice.

(2) If more than one fuel tank is provided and it is necessary to use the tanks in a definite sequence, the vapor vent return line shall lead back to the fuel tank used for take-off and landing.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 17 F. R. 1095, Feb. 5, 1952]

§ 4b.427 Fuel tank outlet.

A fuel strainer of 8 to 16 meshes per inch shall be provided either for the fuel tank outlet or for the booster pump. Strainers shall comply with the following.

(a) The clear area of the fuel tank outlet strainer shall not be less than 5 times the area of the fuel tank outlet line.

(b) The diameter of the strainer shall not be less than the diameter of the fuel tank outlet.

(c) Finger strainers shall be accessible for inspection and cleaning.

§ 4b.428 Under-wing fueling provisions.

Under-wing fuel tank connections shall be provided with means to prevent the escape of hazardous quantities of fuel from the tank in the event of malfunctioning of the fuel entry valve while the cover plate is removed. In addition to the normal means provided in the airplane for limiting the tank content, a means shall be installed to prevent damage to the tank in case of failure of the normal means.

[Amdt. 4b-6, 17 F. R. 1096, Feb. 5, 1952]

Fuel System Components

§ 4b.430 Fuel pumps.

(a) *Main pumps.* (1) Any fuel pump that is required for proper engine operation or to meet the fuel system requirements of this subpart, except for the provisions of paragraph (b) of this section, shall be considered a main pump.

(2) Provision shall be made to permit the bypass of all positive displacement fuel pumps except fuel injection pumps approved as part of the engine.

(b) *Emergency pumps.* (1) Emergency pumps shall be provided and immediately available to permit supplying all engines with fuel in case of failure of any one main fuel pump except fuel injection pumps approved as part of the engine. This requirement is not intended to prohibit the use of another main pump as an emergency pump after failure of one main pump.

[Amdt. 4b-11, 24 F.R. 7070, Sept. 1, 1959]

§ 4b.430–1 Fuel injection pump (FAA interpretations which apply to § 4b.430).

The phrase "fuel injection pump" means a pump that supplies the proper flow and pressure conditions for fuel injection[1] when such injection is not accomplished in a carburetor.

[Supp. 39, 23 F. R. 7482, Sept. 26, 1958]

§ 4b.432 Fuel system lines and fittings.

(a) Fuel lines shall be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure and due to accelerated flight conditions.

(b) Fuel lines which are connected to components of the airplane between which relative motion could exist shall incorporate provisions for flexibility.

(c) Flexible connections in fuel lines which may be under pressure and subjected to axial loading shall employ flexible hose assemblies rather than hose clamp connections.

(d) Flexible hose shall be of an approved type or shall be shown to be suitable for the particular application.

(e) Flexible hoses which might be adversely affected by exposure to high temperatures shall not be employed in locations where excessive temperatures will exist during operation or after engine shut-down.

[15 F.R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 17 F.R. 1096, Feb. 5, 1952]

§ 4b.433 Fuel lines and fittings in designated fire zones.

Fuel lines and fittings in all designated fire zones (see § 4b.480) shall comply with the provisions of § 4b.483.

§ 4b.434 Fuel valves.

In addition to the requirements of § 4b.482 for shut-off means, all fuel valves shall be provided with positive stops or suitable index provisions in the "on" and "off" positions and shall be supported so that loads resulting from their operation or from accelerated flight conditions are not transmitted to the lines attached to the valve.

[1] Fuel injection is a special form of carburetion: the charging of air or gas with volatile carbon compounds. It is either an intermittent charging of air by discrete, metered quantities of fuel such as occurs on a Diesel cylinder or it is a continuous charging of air by fuel, the fuel flow being proportioned to the airflow through the engine. Examples of continuous injection are injections into the supercharger section of a reciprocating engine or into the combustion chambers of a turbine engine.

§ 4b.435 Fuel strainer or filter.

A fuel strainer or filter shall be provided between the fuel tank outlet and the fuel metering device of the engine. The following provisions of this section shall be complied with:

(a) If an engine-driven fuel pump is provided, the strainer or filter shall be located between the tank outlet and the engine-driven pump inlet.

(b) The fuel strainer or filter shall be accessible for drainage and cleaning, and the strainer screen shall be easily removable.

(c) The strainer of filter shall be mounted in a manner not to cause its weight to be supported by the connecting lines or by the inlet or outlet connections of the strainer itself.

(d) Provision shall be made to maintain automatically the fuel flow when ice-clogging of the filter occurs, unless means are incorporated in the fuel system to prevent the accumulation of ice particles on the filter.

(e) The fuel strainer or filter shall be of adequate capacity, commensurate with operating limitations established to insure proper service and of appropriate mesh to insure proper engine operation with the fuel contaminated to a degree, with respect to particle size and density, which can be reasonably expected to occur in service. The degree of fuel filtering shall be not less than that established for the engine in accordance with Part 13 of this subchapter.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-3, 21 F.R. 993, Feb. 11, 1956; Amdt. 4b-6, 22 F.R. 5565, July 16, 1957; Amdt. 4b-8, 23 F.R. 2591, Apr. 19, 1958; Amdt. 4b-12, 27 F.R. 2993, Mar. 30, 1962]

§ 4b.436 Fuel system drains.

Drainage of the fuel system shall be accomplished by fuel strainer drains and other drains as provided in § 4b.424. The drains shall discharge clear of all portions of the airplane and shall incorporate means for positive locking of the drain in the closed position, either manually or automatically.

[Amdt. 4b-12, 27 F.R. 2993, Mar. 30 1962]

§ 4b.437 Fuel jettisoning system.

If the maximum take-off weight for which the airplane is certificated exceeds 105 percent of the certificated maximum landing weight, provision shall be made for the jettisoning of fuel from the maximum take-off to the maximum landing weight.

(a) The average rate of fuel jettisoning shall be 1 percent of the maximum take-off weight per minute, except that the time required to jettison the fuel need not be less than 10 minutes. Compliance with these provisions shall be shown at maximum take-off weight, with flaps and landing gear up, and in the following flight conditions:

(1) Power-off glide at a speed of 1.4 V_{s_1}.

(2) Climb at the one-engine-inoperative best rate-of-climb speed with the critical engine inoperative, the remaining engine(s) at maximum continuous power.

(3) Level flight at a speed of 1.4 V_{s_1}, if the results of tests in conditions specified in subparagraphs (1) and (2) of this paragraph indicate that this condition could be critical.

(b) During the flight tests prescribed in paragraph (a) of this section it shall be demonstrated that the fuel jettisoning system complies with the following provisions.

(1) The fuel jettisoning system and its operation shall be free of fire hazard.

(2) The fuel shall discharge clear of all portions of the airplane.

(3) Fuel or fumes shall not enter any portion of the airplane.

(4) The jettisoning operation shall not affect adversely the controllability of the airplane.

(c) The design of the jettisoning system shall be such that it would not be possible to jettison fuel in the tanks used for take-off and landing below the level providing 45 minutes flight at 75 percent maximum continuous power, except that it shall be permissible to jettison all fuel where an auxiliary control is provided independent of the main jettisoning control. For turbine-powered airplanes, the design of the jettisoning system shall be such that it would not be possible to jettison fuel in the tanks used for take-off and landing below the level providing climb from sea level to 10,000 feet and thereafter providing 45 minutes cruise at a speed for maximum range.

(d) The fuel jettisoning valve shall permit the flight personnel to close the valve during any portion of the jettisoning operation. (See § 4b.475 for fuel jettisoning system controls.)

(e) Unless it is demonstrated that lowering of the flaps does not adversely affect fuel jettisoning, a placard shall be provided adjacent to the jettisoning control to warn flight personnel against jettisoning fuel while the flaps are lowered. A notation to this effect shall also be included in the Airplane Flight Manual. (See § 4b.740.)

(f) The design of the fuel jettisoning system shall be such that any reasonably probable single malfunction in the system will not result in a hazardous condition due to unsymmetrical jettisoning or inability to jettison fuel.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 17 F. R. 1096, Feb. 5, 1952; Amdt. 4b-3, 21 F.R. 994, Feb. 11, 1956; Amdt. 4b-6, 22 F.R. 5565, July 16, 1957]

§ 4b.437-1 Test procedure for fuel jettisoning (FAA policies which apply to § 4b.437).

(a) *Preliminary tests.* In the case where the maximum take-off weight exceeds 105 percent of the maximum landing weight, provisions should be available for jettisoning fuel from the maximum takeoff weight to the maximum landing weight at the corresponding altitude range of airports for which certification is sought. If the applicant has made sufficient jettisoning tests[10] to prove the safety of the jettisoning system, the tests 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 impinge 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.

[10] The basic purpose of these tests is to determine that the required amount of fuel may be safely jettisoned under reasonably anticipated operating conditions within the prescribed time limit without danger from fire, explosion, or adverse effects on the flying qualities.

(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 for 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 § 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 take-off.
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.
Air speed—1.4 V_{s_1}.

(2) *Climb.*

Weight—Maximum take-off.
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.
Air speed—One engine inoperative best rate of climb speed.

(3) *Level flight.*

Weight—Maximum take-off.
C. G. position—Optional.
Wing flaps—Retracted or in a position desired for approval.
Landing gear—Retracted or extended.
Engines—Power required for air speed 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 paragraph (b) (1) and (2) of this section, the jettisoning valves should be opened and allowed to remain open until all jettisoning liquid has been disposed. If the configuration of paragraph (b) (3) of this section is critical, tests should also be conducted for this 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.
Ambient air temperature.
Indicated air speed.
Engines, rpm and manifold pressure.
Carburetor air temperature.

[Supp. 24, 19 F. R. 4464, July 20, 1954]

OIL SYSTEM

§ 4b.440 General.

(a) Each engine shall be provided with an independent oil system capable of supplying the engine with an appropriate quantity of oil at a temperature not exceeding the maximum which has been established as safe for continuous operation. (For oil system instruments see §§ 4b.604 and 4b.735.)

(b) The oil tank capacity available for the use of the engine shall not be less than the product of the endurance of the airplane under critical operating conditions times the approved maximum permissible oil consumption rate of the engine under the same conditions, plus a suitable margin to assure system circulation. In lieu of a rational analysis of airplane range for reciprocating engines, a fuel-oil ratio of 30:1 by volume shall be acceptable for airplanes not provided with a reserve or transfer system.

(c) If either an oil transfer system or a reserve oil system is provided for reciprocating engines, the total oil capacity need not exceed one gallon for each 40 gallons of fuel capacity.

(d) Oil-fuel ratios lower than those prescribed in paragraphs (b) and (c) of this section shall be acceptable if substantiated by data on the actual oil consumption of the engine.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 17 F. R. 1096, Feb. 5, 1952; 17 F.R. 1334, Feb. 12, 1952; Amdt. 4b-6, 22 F.R. 5565, July 16, 1957; Amdt. 4b-12, 27 F.R. 2993, Mar. 30, 1962]

§ 4b.441 Oil tank construction.

The following requirements shall apply to the construction of the oil tank.

(a) *Oil tank expansion space.* (1) Oil tanks shall have an expansion space of not less than either 10 percent of the tank capacity or 0.5 gallon, whichever is the greater.

(2) Reserve oil tanks which have no direct connection to any engine shall have an expansion space which is not less than 2 percent of the tank capacity.

(3) It shall not be possible to fill the oil tank expansion space inadvertently when the airplane is in the normal ground attitude.

(b) *Oil tank filler connection.* (1) Recessed oil tank filler connections which retain any appreciable quantity of oil shall incorporate a drain, and the drain shall discharge clear of all portions of the airplane.

(2) The oil tank filler cap shall provide an oil-tight seal.

(3) Oil tank filler connections shall be marked as prescribed in § 4b.738 (b).

(c) *Oil tank vent.* (1) Oil tanks shall be vented from the top portion of the expansion space in such a manner that venting of the tank is effective under all normal flight conditions.

(2) Oil tank vents shall be arranged so that condensation of water vapor which might freeze and obstruct the line cannot accumulate at any point. (See also § 4b.483 (c).)

(d) *Oil tank outlet.* Provision shall be made either to prevent entrance into the tank itself or into the tank outlet of any foreign object which might obstruct the flow of oil through the system. The oil tank outlet shall not be enclosed by any screen or guard which would reduce the flow of oil below a safe value at any operating temperature condition.

(e) *Flexible oil tank liners.* Flexible oil tank liners shall be of an approved type or shall be shown to be suitable for the particular application.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 17 F. R. 1096, Feb. 5, 1952]

§ 4b.442 Oil tank tests.

(a) Oil tanks shall be capable of withstanding without failure all vibration, inertia, and fluid loads to which they would be subjected in operation.

(b) The provisions of § 4b.421 shall be applicable to oil tanks, except as follows.

(1) The test pressure specified in § 4b.421 (a) shall be 5 p. s. i.

(2) The test fluid specified in § 4b.421 (c) shall be oil at a temperature of 250° F.

§ 4b.443 Oil tank installation.

The oil tank installation shall comply with the provisions of § 4b.422, except that the location of an engine oil tank in a designated fire zone shall be acceptable if the tank and its supports are of fireproof construction to the extent that damage by fire to any nonfireproof parts would not result in leakage or spillage of oil.

[Amdt. 4b-6, 17 F. R. 1096, Feb. 5, 1952]

§ 4b.444 Oil lines and fittings.

(a) *General.* The provisions of § 4b.432 shall be applicable to oil lines.

(b) *Lines and fittings in designated fire zones.* Oil lines and fittings in all designated fire zones (see § 4b.480) shall comply with the provisions of § 4b.483.

(c) *Engine breather lines.* (1) Engine breather lines shall be arranged so that condensation of water vapor which might freeze and obstruct the line cannot accumulate at any point.

(2) Breathers shall discharge in a location which will not constitute a fire hazard in case foaming occurs and in a manner so that the emitted oil will not impinge upon the pilot windshield.

(3) The breather shall not discharge into the engine air induction system. (See also § 4b.483 (c).)

§ 4b.445 Oil valves.

(a) The requirements of § 4b.432 for shut-off means shall be complied with. Closing of oil shut-off means shall not prevent feathering the propeller.

(b) All oil valves shall be provided with positive stops or suitable index provisions in the "on" and "off" positions, and they shall be supported so that loads resulting from their operation or from accelerated flight conditions are not transmitted to the lines attached to the valve.

heat-rise provisions shall be demonstrated in air free of visible moisture at a temperature of 30° F.

(1) Airplanes equipped with altitude engines employing conventional venturi carburetors shall have a preheater capable of providing a heat rise of 120° F. when the engine is operating at 60 percent of its maximum continuous power.

(2) Airplanes equipped with altitude engines employing carburetors which embody features tending to reduce the possibility of ice formation shall have a preheater capable of providing a heat rise of 100° F. when the engine is operating at 60 percent of its maximum continuous power.

(c) *Turbine powerplants.* Turbine-powered airplanes shall be capable of operation throughout the flight power range without accumulation of ice in the air induction system such as to adversely affect engine operation or cause a serious loss of power and/or thrust in the continuous maximum and intermittent maximum icing conditions as defined in § 4b.1 (b) (7) and (8). Means to indicate the functioning of the powerplant ice protection system shall be provided.

[15 F.R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 22 F.R. 5565, July 16, 1957; Amdt. 4b-11, 24 F.R. 7070, Sept. 1, 1959]

§ 4b.461-1 Procedure for demonstrating carburetor air heat rise (FAA policies which apply to § 4b.461(b)).

(a) *Conditions for tests.* The carburetor air temperature should be measured by a minimum of three thermocouples so arranged as to give an average air temperature. This indicator should be calibrated prior to the test. The tests should be conducted at an altitude where the free air temperature is 30° F. or at two altitudes of different temperatures, one of which is near 30° F.

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

Weight—Optional.
C. G. position—Optional.
Wing flaps—Optional.
Landing gear—Optional.
Engines—60 percent maximum continuous power.
Cowl flaps—Appropriate for flight condition.
Mixture setting—Normal cruising position.

(c) *Test procedure and required data.* (1) After all temperatures have been stabilized (i. e., when the rate of temperature change is less than 2° F. per minute) and with the airplane in level flight and full cold carburetor at 60 percent maximum continuous power, the following data should be recorded:

Pressure altitude.
Ambient air temperature.
Indicated air speed.
Carburetor air temperature.
Engines, rpm and manifold pressure.
Torque pressure.
Mixture setting.
Cowl flap setting.

(2) Preheat should then be applied slowly (power may be restored to 60 percent maximum continuous at the applicant's option) and the above data recorded again after the carburetor air temperature has stabilized. The carburetor heat rise should be determined from the results of the data.

[Supp. 24, 19 F.R. 4465, July 20, 1954, as amended by Supp. 34, 22 F.R. 6963, Aug. 29, 1957]

§ 4b.462 Carburetor air preheater design.

Carburetor air preheaters shall incorporate the following provisions.

(a) Means shall be provided to assure ventilation of the preheater when the engine is being operated with cold air.

(b) The preheater shall be constructed to permit inspection of exhaust manifold parts which it surrounds and also to permit inspection of critical portions of the preheater itself.

§ 4b.463 Induction system ducts.

Induction system ducts shall incorporate the following provisions.

(a) Induction system ducts ahead of the first stage of the supercharger shall be provided with drains to prevent hazardous accumulations of fuel and moisture in the ground attitude. The drains shall not discharge in locations which might cause a fire hazard.

(b) Sufficient strength shall be incorporated in the ducts to prevent induction system failures resulting from normal backfire conditions.

(c) Ducts which are connected to components of the airplane between which relative motion could exist shall incorporate provisions for flexibility.

(d) Induction system ducts within any fire zone for which a fire-extinguishing system is required shall be of fire-resistant construction.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 17 F. R. 1096, Feb. 5, 1952]

§ 4b.464 Induction system screens.

If induction system screens are employed, they shall comply with the following provisions:

(a) Screens shall be located upstream from the carburetor.

(b) Screens shall not be located in portions of the induction system which constitute the only passage through which air can reach the engine, unless the screen is so located that it can be de-iced by heated air.

(c) De-icing of induction system screens by means of alcohol alone shall not be acceptable.

(d) It shall not be possible for fuel to impinge upon the screens.

§ 4b.466 Inter-coolers and after-coolers.

Inter-coolers and after-coolers shall be capable of withstanding without failure all vibration, inertia, and air pressure loads to which they would be subjected in operation.

§ 4b.467 Exhaust system and installation components.

(a) *General.* (1) The exhaust system shall be constructed and arranged to assure the safe disposal of exhaust gases without the existence of a fire hazard or carbon monoxide contamination of air in personnel compartments.

(2) Unless appropriate precautions are taken, exhaust system parts shall not be located in hazardous proximity to portions of any system carrying flammable fluids or vapors nor shall they be located under portions of such systems where the latter could be subject to leakage.

(3) All airplane components upon which hot exhaust gases might impinge, or which could be subjected to high temperatures due to proximity to exhaust system parts, shall be constructed of fireproof material. All exhaust system components shall be separated by means of fireproof shields from adjacent portions of the airplane which are outside the engine compartment.

(4) Exhaust gases shall not discharge in a manner to cause a fire hazard with respect to any flammable fluid vent or drain.

(5) Exhaust gases shall not discharge at a location which will cause a glare seriously affecting pilot visibility at night.

(6) All exhaust system components shall be ventilated to prevent the existence of points of excessively high temperature.

(7) Exhaust shrouds shall be ventilated or insulated to avoid during normal operation a temperature sufficiently high to ignite any flammable fluids or vapors external to the shrouds.

(b) *Exhaust piping.* (1) Exhaust piping shall be constructed of material resistant to heat and corrosion, and shall incorporate provisions to prevent failure due to expansion when heated to operating temperatures.

(2) Exhaust pipe shall be supported to withstand all vibration and inertia loads to which they would be subjected in operation.

(3) Portions of the exhaust piping which are connected to components between which relative motion could exist shall incorporate provisions for flexibility.

(c) *Exhaust heat exchangers.* (1) Exhaust heat exchangers shall be constructed and installed to assure their ability to withstand without failure all vibration, inertia, and other loads to which they would be subjected in operation.

(2) Heat exchangers shall be constructed of materials which are suitable for continued operation at high temperatures and which are resistant to corrosion due to elements contained in exhaust gases.

(3) Provision shall be made for the inspection of all critical portions of exhaust heat exchangers.

(4) Heat exchangers shall incorporate cooling provisions wherever they are subject to contact with exhaust gases.

(5) Heat exchangers or muffs shall incorporate no stagnant areas or liquid traps which would increase the possibility of ignition of flammable fluids or vapors which might be present in case of failure or malfunctioning of components carrying flammable fluids.

(d) *Exhaust heating of ventilating air.* If an exhaust heat exchanger is used for heating ventilating air, a secondary heat exchanger shall be provided between the primary exhaust gas heat exchanger and the ventilating air system, unless it is demonstrated that other means used preclude harmful contamination of the ventilating air.

(e) *Exhaust driven turbo-superchargers.* (1) Exhaust driven turbines shall be of an approved type or shall be shown to be suitable for the particular application. They shall be installed and supported to assure their safe operation between normal inspection and overhaul periods.

(2) Provision for expansion and flexibility shall be made between exhaust conduits and the turbine.

(3) Provision shall be made for lubrication of the turbine and for cooling of those turbine parts where the temperatures are critical.

(4) Means shall be provided so that, in the event of malfunctioning of the normal turbo-supercharger control system, the turbine speed will not be greater than its maximum allowable value. The components provided for this purpose shall be independent of the normal turbo-supercharger controls with the exception of the waste gate operating components themselves.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 17 F. R. 1096, Feb. 5, 1952]

§ 4b.467-1 Carbon monoxide detection (FAA policies which apply to § 4b.467(a)(1)(d)).

(a) *Conditions for tests.* Any acceptable carbon monoxide detection method may be used in demonstrating compliance with § 4b.467(a) (1) and (d), and with the ventilating requirements of § 4b.371. The tests should be conducted with the airplane's heater system in operation if there is any possibility of a system containing carbon monoxide. In aircraft employing thermal de-icing, tests should be conducted with the system operating at full capacity.

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

(1) *Power on level flight.*

Weight—Optional.
C. G. position—Optional.
Wing flaps—Retracted.
Landing gear—Retracted.
Engines—Maximum continuous power.
Cowl flaps—Appropriate for flight condition.

(2) *Power off glide.*

Wing flaps—Retracted.
Landing gear—Retracted.
Engines—Idling.
Cowl flaps—Appropriate for flight condition.

(3) *Power approach.*

Wing flaps—Approach position.
Landing gear—Extended.
Engines—Power for level flight.
Cowl flaps—Appropriate for flight condition.
Air speed—Any speed from 1.4 V_{s_1} to 1.6 V_{s_1}.

(c) *Test procedure and required data.* The air should be sampled with a carbon monoxide indicator in front of cabin heater opening(s) with heat on and at representative passenger and crew locations. If the airplane does not have pressurization equipment installed, the air should be sampled at the above locations with the windows closed and also partially opened. If the airplane is equipped for pressurization, carbon monoxide indications should be taken when the cabin is pressurized and also unpressurized.

[Supp. 24, 19 F. R. 4465, July 20, 1954]

§ 4b.467-2 Determination of exhaust gas interference with visibility (FAA policies which apply to § 4b.467(a)(5)).

The effects of exhaust gas interference with visibility should be observed during tests to demonstrate other night flying requirements.

[Supp. 24, 19 F. R. 4466, July 20, 1954]

POWERPLANT CONTROLS AND ACCESSORIES

§ 4b.470 Powerplant controls; general.

The provisions of § 4b.353 shall be applicable to all powerplant controls with respect to location, grouping, and direction of motion, and the provisions of § 4b.737 shall be applicable to all powerplant controls with respect to marking. In addition all powerplant controls shall comply with the following.

(a) Controls shall be so located that they cannot be inadvertently operated by personnel entering, leaving, or making normal movements in the cockpit.

(b) Controls shall maintain any set position without constant attention by flight personnel. They shall not tend to creep due to control loads or vibration.

(c) Flexible controls shall be of an approved type or shall be shown to be suitable for the particular application.

(d) Controls shall have strength and rigidity to withstand operating loads without failure and without excessive deflection.

§ 4b.471 Throttle and A.D.I. system controls.

(a) A separate throttle control shall be provided for each engine. Throttle controls shall be grouped and arranged to permit separate control of each engine and also simultaneous control of all engines.

(b) Throttle controls shall afford a positive and immediately responsive means of controlling the engines.

(c) If an antidetonant injection system is provided, the flow of ADI fluid shall be automatically controlled in relation to the amount of power produced by the engine. In addition to the automatic control, a separate control shall be provided for the ADI pumps.

[Amdt. 4b-2, 15 F. R. 9185, Dec. 22, 1950, as amended by Amdt. 4b-8, 18 F. R. 2215, Apr. 18, 1953]

§ 4b.472 Ignition switches.

(a) Ignition switches shall provide control for each ignition circuit on each engine.

(b) Means shall be provided for quickly shutting off all ignition by the grouping of switches or by providing a master ignition control.

(c) If a master ignition control is provided, a guard shall be incorporated to prevent inadvertent operation of the control.

§ 4b.473 Mixture controls.

(a) If mixture controls are provided, a separate control shall be provided for each engine. The mixture controls shall be grouped and arranged to permit separate control of each engine and also simultaneous control of all engines.

(b) Any intermediate position of the mixture control which corresponds with a normal operating setting shall be provided with a sensory and a visual identification.

(c) The mixture controls shall be placed in a location accessible to both pilots, except where a separate flight engineer station with a control panel is provided, in which case the mixture controls shall be accessible to the flight engineer.

[Amdt. 4b-2, 15 F. R. 9185, Dec. 22, 1950, as amended by Amdt. 4b-8, 18 F. R. 2215, Apr. 18, 1953]

§ 4b.474 Propeller controls.

(a) *Propeller speed and pitch controls.* (1) A separate propeller speed and pitch control shall be provided for each propeller. The propeller speed and pitch controls shall be grouped and arranged to permit separate control of each propeller and also simultaneous control of all propellers.

(2) The propeller speed and pitch controls shall provide for synchronization of all propellers. (See also § 4b.404.)

(3) Propeller speed and pitch control(s) shall be placed to the right of the pilot's throttle and shall be at least 1 inch lower than the throttle controls.

(b) *Propeller feathering controls.* (1) A separate propeller feathering control shall be provided for each propeller.

(2) Propeller feathering controls shall be provided with means to prevent inadvertent operation.

(3) If feathering is accomplished by movement of the propeller pitch or speed control lever, provision shall be made to prevent the movement of this control to the feathering position during normal operation.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 17 F. R. 1096, Feb. 5, 1952; Amdt. 4b-8, 18 F.R. 2215, Apr. 18, 1953; Amdt. 4b-6, 22 F.R. 5565, July 16, 1957]

§ 4b.474-1 [1] Propeller feathering pump motors, intermittent duty type (FAA policies which apply to § 4b.474(b)).

(a) An intermittent duty type motor [2] in the propeller feathering control system should automatically stop or be made to stop upon the completion of the feathering operation by any of the following means:

(1) Installation of a pressure cutout switch in the feathering button holding coil circuit.

(2) Installation of a timer switch in the feathering button holding coil circuit.

(3) Manually interrupting the feathering pump circuit by pulling out the feathering button. In this arrangement a warning light should be installed in the pump circuit to illuminate while the pump motor is operating. The light may be either in the feathering button or adjacent to it.

(b) Timer switches of either the mechanical or the thermal types are acceptable.

[Supp. 33, 22 F. R. 6885, Aug. 27, 1957]

§ 4b.474a Reverse thrust controls.

(a) Propeller reverse thrust controls shall incorporate a means to prevent their inadvertent movement to a reverse thrust position. The means provided shall incorporate a positive lock or stop at the flight idle position and shall require a separate and distinct operation

[1] Appears as § 4.474-1 at 22 F. R. 6885.
[2] Intermittent duty type motors may fail if operated continuously for more than two minutes.

by the crew in order to displace the control from the flight regime.

(b) Turbojet reverse thrust controls shall incorporate a means to prevent their inadvertent movement to a reverse thrust position. The means provided shall incorporate a positive lock or stop at the flight idle position and shall require a separate and distinct operation by the crew in order to displace the control from the forward thrust regime.

[Amdt. 4b–6, 22 F. R. 5565, July 16, 1957]

§ 4b.475 Fuel system controls.

(See also § 4b.434.)

(a) Fuel jettisoning system controls shall be provided with guards to prevent their inadvertent operation.

(b) Fuel jettisoning system controls shall not be located in close proximity to fire extinguisher controls nor to any other controls intended to combat fire.

§ 4b.476 Carburetor air preheat controls.

Separate carburetor air preheat controls shall be provided to regulate the temperature of the carburetor air for each engine.

§ 4b.476a Supercharger controls.

Supercharger controls shall be accessible to the pilots, except where a separate flight engineer station with a control panel is provided, in which case they shall be accessible to the flight engineer.

[Amdt. 4b–8, 18 F. R. 2215, Apr. 18, 1953]

§ 4b.477 Powerplant accessories.

(a) Engine mounted accessories shall be of a type approved for installation on the engine involved and shall utilize the provisions made on the engine for mounting.

(b) Items of electrical equipment subject to arcing or sparking shall be installed to minimize the possibility of their contact with any flammable fluids or vapors which might be present in a free state.

(c) If continued rotation of an engine-driven cabin supercharger or any remote accessory driven by the engine will constitute a hazard in case malfunctioning occurs, means shall be provided to prevent hazardous rotation of such accessory without interfering with the continued operation of the engine. (See also § 4b.371 (c).)

NOTE: Hazardous rotation may involve consideration of mechanical damage or sustained air flows which may be dangerous under certain conditions.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 17 F. R. 1096, Feb. 5, 1952]

§ 4b.478 Engine ignition systems.

(a) Battery ignition systems shall be supplemented with a generator which is automatically made available as an alternate source of electrical energy to permit continued engine operation in the event of the depletion of any battery.

(b) The capacity of batteries and generators shall be sufficient to meet the simultaneous demands of the engine ignition system and the greatest demands of any airplane electrical system components which would draw electrical energy from the same source.

(1) The design of the engine ignition system shall take into consideration the condition of an inoperative generator and the condition of a completely depleted battery when the generator is running at its normal operating speed.

(2) If only one battery is provided the design of the engine ignition system shall take into consideration the condition in which the battery is completely depleted and the generator is operating at idling speed.

(3) Portions of magneto ground wires for separate ignition circuits which lie on the engine side of the fire wall shall be installed, located, or protected so as to minimize the possibility of simultaneous failure of two or more wires as a result of mechanical damage, electrical faults, etc.

(4) Ground wires for any engine shall not be routed through fire zones, except those associated with the engine which the wires serve, unless those portions of the wires which are located in such fire zones are fireproof or are protected against the possibility of damage by fire in a manner to render them fireproof. (See § 4b.472 for ignition switches.)

(5) Ignition circuits shall be electrically independent of all other electrical circuits except circuits used for analyzing the operation of the ignition system.

(c) Means shall be provided to warn flight personnel if malfunctioning of any part of the electrical system is causing the continuous discharging of a battery which is necessary for engine ignition. (See § 4b.472 for ignition switches.)

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 17 F. R. 1096, Feb. 5, 1952]

Powerplant Fire Protection

§ 4b.480 Designated fire zones.

(a) Designated fire zones shall comprise the following regions:

(1) Engine power section,

(2) Engine accessory section,

(3) Complete powerplant compartments in which no isolation is provided between the engine power section and the engine accessory section,

(4) Auxiliary power unit compartments,

(5) Fuel-burning heaters and other combustion equipment installations as defined by § 4b.386.

NOTE: See also § 4b.385.

(6) Compressor and accessory sections of turbine engines.

(7) Combustor, turbine, and tail pipe sections of turbine engine installations which contain lines or components carrying flammable fluids or gases, except that the fire-extinguisher system specified in § 4b.484 need not be provided for such sections if it is demonstrated that any fire occurring therein can be otherwise controlled.

(b) Designated fire zones shall be protected from fire by compliance with §§ 4b.481 through 4b.490.

(c) The nacelle area immediately behind the fire wall shall comply with the provisions of §§ 4b.385, 4b.463 (d), 4b.478 (b) (4), 4b.481 (c), 4b.482 through 4b.485 and 4b.489. If a retractable landing gear is located in this area, compliance with this paragraph is required only with the landing gear retracted.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 17 F. R. 1097, Feb. 5, 1952; Amdt. 4b–7, 17 F. R. 11631, Dec. 20, 1952; Amdt. 4b–2, 20 F.R. 5306, July 26, 1955; Amdt. 4b–6, 22 F.R. 5565, July 16, 1957]

§ 4b.481 Flammable fluids.

(a) No tanks or reservoirs which are a part of a system containing flammable fluids or gases shall be located in designated fire zones except where the fluid contained, the design of the system, the materials used in the tank, the shut-off means, all connections, lines, and controls are such as to provide an equally high degree of safety.

(b) Not less than one-half inch of clear air space shall be provided between any tank or reservoir and a fire wall or shroud isolating a designated fire zone.

(c) If absorbent materials are located in proximity to flammable fluid system components which might be subject to leakage, such materials shall be covered or treated to prevent the absorption of hazardous quantities of fluids.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–2, 20 F. R. 5306, July 26, 1955]

§ 4b.482 Shut-off means.

(a) Means for each individual engine and for each individual fire zone specified in § 4b.480(a) (4) and (5) shall be provided for shutting off or otherwise preventing hazardous quantities of fuel, oil, de-icer, and other flammable fluids from flowing into, within, or through any designated fire zone, except that means need not be provided to shut off flow in lines forming an integral part of an engine. Closing the fuel shutoff valve for any engine shall not make any of the fuel supply unavailable to the remaining engines.

(b) Operation of the shutoff means shall not interfere with the subsequent emergency operation of other equipment, such as feathering the propeller.

(c) The shut-off means shall be located outside of designated fire zones, unless an equally high degree of safety is otherwise provided (see § 4b.481). It shall be shown that no hazardous quantity of flammable fluid could drain into any designated fire zone after shutting-off has been accomplished.

(d) Provisions shall be made to guard against inadvertent operation of the shutoff means and to make it possible for the crew to reopen the shutoff means in flight after it has once been closed.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 17 F. R. 1097, Feb. 5, 1952]

§ 4b.483 Lines and fittings.

(a) All lines and fittings carrying flammable fluids in designated fire zones shall be fire-resistant, except as otherwise provided in this section. If flexible hose is used, the assembly of hose and end fittings shall be of an approved type. The provisions of this paragraph need not apply to those lines and fittings which form an integral part of the engine.

(b) Vent and drain lines and their fittings shall be subject to the provisions of paragraph (a) of this section unless a failure of such line or fitting will not result in, or add to, a fire hazard.

[Amdt. 4b–11, 24 F.R. 7071, Sept. 1, 1959]

§ 4b.484 Fire extinguisher systems.

(a) *General.* (1) Fire extinguisher systems shall be provided to serve all designated fire zones. This requirement shall be effective with respect to applications for type certificates in accordance with the provisions of § 4b.11(a). In addition, all other airplanes manufactured after June 30, 1954, shall comply with this requirement, unless the engine power section is completely isolated from the engine accessory section by a fireproof diaphragm and unless the cowling and nacelle skin comply with the provisions of § 4b.487, in which case fire extinguisher systems need not be provided in the engine power section.

NOTE: Induction systems for reciprocating engines are considered to be located in a designated fire zone, and therefore subject to the fire extinguisher protection provisions unless tests or experience with the particular type of induction and carburetion systems shows that fuel burning in the induction system passages is not likely to occur.

(2) The fire extinguishing system, the quantity of extinguishing agent, and the rate of discharge shall be such as to provide two adequate discharges. It shall be possible to direct both discharges to any main engine installation. Individual "one-shot" systems shall be acceptable in the case of auxiliary power units, fuel-burning heaters, and other combustion equipment.

(3) The fire-extinguishing system for a nacelle shall be capable of protecting simultaneously all zones of the nacelle for which protection is provided.

(b) *Fire extinguishing agents.* (1) Extinguishing agents employed shall be methyl bromide, carbon dioxide, or any other agent which has been shown to provide equivalent extinguishing action.

(2) If methyl bromide, carbon dioxide, or any other toxic extinguishing agent is employed, provision shall be made to prevent the entrance of harmful concentration of fluid or fluid vapors into any personnel compartments either due to leakage during normal operation of the airplane or as a result of discharging the fire extinguisher on the ground or in flight even though a defect may exist in the extinguishing system. Compliance with this requirement shall be demonstrated by appropriate tests.

(3) If a methyl bromide system is provided, the containers shall be charged with a dry agent and shall be sealed by the fire extinguisher manufacturer or by any other party employing appropriate recharging equipment.

(c) *Extinguishing agent container pressure relief.* Extinguisher agent containers shall be provided with a pressure relief to prevent bursting of the container due to excessive internal pressures. The following provisions shall apply.

(1) The discharge line from the relief connection shall terminate outside the airplane in a location convenient for inspection on the ground.

(2) An indicator shall be provided at the discharge end of the line to provide a visual indication when the container has discharged.

(d) *Extinguishing agent container compartment temperature.* Under all conditions in which the airplane is intended for operation, the temperature range of the extinguishing agent containers shall be maintained to assure that the pressure in the containers can neither fall below the minimum necessary to provide an adequate rate of extinguisher agent discharge nor rise above a safe limit so that the system will not be prematurely discharged.

(e) *Fire-extinguishing system materials.* Materials in the fire extinguishing system shall not react chemically with the extinguishing agent so as to constitute a hazard. All components of the fire extinguishing systems located in designated fire zones shall be constructed of fireproof materials.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 17 F. R. 1097, Feb. 5, 1952; Amdt. 4b–8, 18 F. R. 2215, Apr. 18, 1953; Amdt. 4b–2, 20 F.R. 5308, July 26, 1955; Amdt. 4b–6, 22 F.R. 5566, July 16, 1957; Amdt. 4b–12, 27 F.R. 2993, Mar. 30, 1962]

§ 4b.484–1 Determination of carbon dioxide concentration in flight crew compartments (FAA policies which apply to § 4b.484(b)).

(a) Carbon dioxide has been found to adversely affect flight crew personnel in the performance of their duties. Therefore, in aircraft equipped with built-in carbon dioxide fuselage compartment fire extinguishing systems, the carbon dioxide concentration occurring at the flight crew stations as a result of discharging the fire extinguishers should be determined in accordance with paragraphs (b) and (c) of this section, except that such determination is not considered necessary if:

(1) Five pounds or less of carbon dioxide will be discharged into any one such fuselage compartment in accordance with established fire control procedures, or

(2) Protective breathing equipment is provided for each flight crew member on flight deck duty.

(b) The carbon dioxide concentrations at 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 maximum operating limit 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 paragraph (b) of this section, 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) of this section 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.

[Supp. 11, 15 F.R. 8904, Dec. 15, 1950, as amended by Amdt. 4b–12, 27 F.R. 2993, Mar. 30, 1962]

§ 4b.485 Fire-detector systems.

Quick-acting fire or overheat detectors of an approved type shall be provided in all designated fire zones and in the combustion, turbine, and tailpipe sections of turbine-engine installations, and they shall be sufficient in number and location to assure prompt detection of fire in such zones and sections. Fire detectors shall comply with the following provisions:

(a) Fire detectors shall be constructed and installed to assure their ability to resist without failure all vibration, inertia, and other loads to which they would be subjected in operation.

(b) Fire detectors shall be unaffected by the exposure to oil, water, or other fluids or fumes which might be present.

(c) Means shall be provided to permit the crew to check in flight the functioning of the electric circuit associated with the fire-detection system.

(d) Wiring and other components of detector systems which are located in fire zones shall be of fire-resistant construction.

(e) Detector system components for any fire zone shall not pass through other fire zones, unless they are protected against the possibility of false warnings resulting from fires in zones through which they pass. This requirement shall not be applicable with respect to zones which are simultaneously protected by the same detector and extinguisher systems.

[15 F.R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 17 F.R. 1097, Feb. 5, 1952; Amdt. 4b–6, 22 F.R. 5566, July 16, 1957]

§ 4b.485–1 Fire detector test circuit (FAA policies which apply to § 4b.485(c)).

(a) The checking means should serve to assure the crew that a fire within the zone of coverage will produce a fire warning if all fire-responsive (detector) elements are operative. The means need not be designed to disclose whether fire detector sensor elements themselves would respond properly to a fire.[4]

(b) The check should reveal any probable malfunction or failure in the fire-detection system, external to the detector elements, which could interfere with, or prevent, fire warning. Open and short circuits in wiring, and inoperative lights, bells, switches, or relays are examples of malfunctions which should be revealed by such a check.

[Supp. 33, 22 F.R. 6885, Aug. 27, 1957]

§ 4b.486 Fire walls.

All engines, auxiliary power units, fuel-burning heaters, and other combustion equipment which are intended for operation in flight as well as the combustion, turbine, and tail pipe sections of turbine engines shall be isolated from the remainder of the airplane by means of fire walls, shrouds, or other

---

[4] This is normally a separate ground maintenance operation.

equivalent means. The following shall apply:

(a) Fire walls and shrouds shall be constructed in such a manner that no hazardous quantity of air, fluids, or flame can pass from the compartment to other portions of the airplane.

(b) All openings in the fire wall or shroud shall be sealed with close-fitting fireproof grommets, bushings, or firewall fittings.

(c) Fire walls and shrouds shall be constructed of fireproof material and shall be protected against corrosion.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–3, 18 F. R. 2216, Apr. 18, 1953; Amdt. 4b–2, 20 F. R. 5308, July 26, 1955]

§ 4b.487 Cowling and nacelle skin.

(a) Cowling shall be constructed and supported so as to make it capable of resisting all vibration, inertia, and air loads to which it would be subjected in operation.

(b) Cowling shall have drainage and ventilation provisions as prescribed in § 4b.489.

(c) On airplanes equipped with a diaphragm to isolate the engine power section from the engine accessory section, the parts of the accessory section cowling which might be subjected to flame in the event of a fire in the engine power section of the nacelle shall be constructed of fireproof material and shall comply with the provisions of § 4b.486.

(d) Those portions of the cowling which would be subjected to high temperatures due to their proximity to exhaust system parts or exhaust gas impingement shall be constructed of fireproof material.

(e) The airplane shall be so designed and constructed that, in the event of fire originating in the engine power or accessory sections, the probability is extremely remote for fire to enter either through openings or by burning through external skin into any other zone of the nacelle where such fire could create additional hazards. If the airplane is provided with a retractable landing gear, this provision shall apply with the landing gear retracted. Fireproof materials shall be used for all nacelle skin areas which might be subjected to flame in the event of a fire originating in the engine power or accessory sections.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 17 F. R. 1097, Feb. 5, 1952; Amdt. 4b–8, 18 F. R. 2216, Apr. 18, 1953; Amdt. 4b–2, 20 F.R. 5308, July 26, 1955; Amdt. 4b–12, 27 F.R. 2993, Mar. 30, 1962]

§ 4b.489 Drainage and ventilation of fire zones.

(a) Complete drainage of all portions of designated fire zones shall be provided to minimize the hazards resulting from failure or malfunctioning of components containing flammable fluids. The drainage provisions shall be effective under conditions expected to prevail when drainage is needed and shall be so arranged that the discharged fluid will not cause an additional fire hazard.

(b) All designated fire zones shall be ventilated to prevent the accumulation of flammable vapors. Ventilation openings shall not be placed in locations which would permit the entrance of flammable fluids, vapors, or flame from other zones. The ventilation provisions shall be so arranged that the discharged vapors will not cause an additional fire hazard.

(c) Except with respect to the engine power section of the nacelle and the combustion heater ventilating air ducts, provision shall be made to permit the crew to shut off sources of forced ventilation in any fire zone, unless the extinguishing agent capacity and rate of discharge are based on maximum air flow through the zone.

[Amdt. 4b–6, 17 F. R. 1097, Feb. 5, 1952, as amended by Amdt. 4b–2, 20 F. R. 5308, July 26, 1955]

§ 4b.490 Protection of other airplane components against fire.

(a) All airplane surfaces aft of the nacelles, in the region of one nacelle diameter on both sides of the nacelle center line, shall be constructed of fire-resistant material. This provision need not be applied to tail surfaces lying behind nacelles, unless the dimensional configuration of the aircraft is such that the tail surfaces could be affected readily by heat, flames, or sparks emanating from a designated fire zone or engine compartment of any nacelle.

(b) Consideration shall be given to the effect on adjacent parts of the airplane of heat within designated fire zones and within the combustion, turbine, and tail pipe sections of turbine engines.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 17 F. R. 1097, Feb. 5, 1952; Amdt. Amdt. 4b–2, 20 F. R. 5308, July 26, 1955]

Subpart F—Equipment

GENERAL

§ 4b.600 Scope.

The required basic equipment as prescribed in this subpart is the minimum which shall be installed in the airplane for certification. Such additional equipment as is necessary for a specific type of operation is prescribed in the operating rules of this subchapter.

§ 4b.601 Functional and installational requirements.

Each item of equipment shall be:

(a) Of a type and design appropriate to perform its intended function,

(b) Labeled as to its identification, function, or operational limitations, or any combination of these, whichever is applicable,

(c) Installed in accordance with specified limitations of the equipment,

(d) Demonstrated to function properly in the airplane.

§ 4b.602 Required basic equipment.

The equipment listed in §§ 4b.603 through 4b.605 shall be the required basic equipment. (See § 4b.600.)

§ 4b.603 Flight and navigational instruments.

(See § 4b.612 for installation requirements.)

(a) Air-speed indicating system. If the air-speed limitations vary with altitude, the air-speed indicator shall incorporate a maximum allowable air-speed indication showing the variation of V_{MO}/M_{MO} with altitude including compressibility limitations. (See § 4b.732.)

(b) Altimeter (sensitive or precision type),

(c) Rate-of-climb indicator (vertical speed),

(d) Free air temperature indicator,

(e) Clock (sweep-second pointer type),

(f) Rate-of-turn indicator (gyroscopic type with integral bank or slip indicator),

(g) Bank and pitch indicator (gyroscopically stabilized),

(h) Direction indicator (gyroscopically stabilized magnetic and/or nonmagnetic type),

(i) Direction indicator (nonstabilized type magnetic compass),

(j) Machmeter for airplanes having compressibility limitations not otherwise indicated to the pilot in accordance with § 4b.732.

(k) Speed warning device for all turbine-powered airplanes and for all other airplanes for which V_{MO}/M_{MO} is greater than 0.8 V_{DF}/M_{DF} or 0.8 V_D/M_D. The device shall provide effective aural warning to the pilots which is distinctively different from aural warnings used for other purposes, whenever the speed exceeds V_{MO} plus 6 knots or $M_{MO}+0.01$. The upper limit of the production tolerance permitted for the warning device shall be at a speed not greater than the prescribed warning speed.

[Amdt. 4b–11, 24 F.R. 7071, Sept. 1, 1959, as amended by Amdt. 4b–12, 27 F.R. 2993, Mar. 30, 1962]

§ 4b.604 Powerplant instruments.

(See § 4b.613 for installation requirements.)

(a) Carburetor air temperature indicator for each reciprocating engine.

(b) Cylinder head temperature indicator for each air-cooled reciprocating engine.

(c) Gas temperature indicator for each turbine engine.

(d) Manifold pressure indicator for each reciprocating engine.

(e) Fuel pressure indicator for each reciprocating engine to indicate the pressure under which the fuel is being supplied.

(f) Fuel pressure warning means for each engine or a master warning means for all engines with provision for isolating the individual warning means from the master warning means.

(g) Fuel flowmeter indicator for each turbine engine. For reciprocating engines, a fuel flowmeter or fuel mixture indicator for each engine not equipped with an automatic altitude mixture control.

(h) Fuel quantity indicator for each fuel tank.

(i) Augmentation liquid quantity indicator for each tank which is appropriate to the manner in which the liquid is to be used in operations.

(j) Oil quantity indicator for each oil tank. (See § 4b.613 (d).)

(k) Oil pressure indicator for each independent pressure oil system of each engine.

(l) Oil pressure warning means for each engine or a master warning means for all engines with provision for isolating the individual warning means from the master warning means.

(m) Oil temperature indication for each engine.

(n) Tachometer for each reciprocating engine.

(o) Tachometer for each turbine engine to indicate the speed of the rotors for which limiting speeds have been established.

(p) Fire-warning indicators. (See § 4b.485.)

(q) An indicator for each turbojet engine to indicate a change in thrust, resulting from any deficiency in the engine or an indicator to indicate a gas stream pressure which can be related to thrust.

(r) A torque indicator for each turbine-propeller engine. A device for each reciprocating engine capable of indicating to the flight crew during flight any change in the power output if the engine is equipped with an automatic propeller feathering system, the operation of which is initiated by a power output measuring system, or if the total engine cylinder displacement is 2,000 cubic inches or more.

(s) Position indicating means for each propeller on a turbine engine to indicate to the flight crew when the propeller blade angle is below the flight low pitch position (see § 4b.613). For reciprocating engines, a means for each reversing propeller to indicate to the pilot when the propeller is in reverse pitch.

(t) Position indicating means for each turbine engine utilizing a thrust reversing device to indicate to the flight crew when the device is in the reverse thrust position.

[Amdt. 4b-6, 22 F.R. 5566, July 16, 1957, as amended by Amdt. 4b-12, 27 F.R. 2994, Mar. 30, 1962]

§ 4b.605 Miscellaneous equipment.

(a) Approved seats for all occupants (see § 4b.358).

(b) Approved safety belts for all occupants (see § 4b.643).

(c) [Reserved]

(d) Source(s) of electrical energy (see § 4b.620).

(e) Electrical protective devices (see § 4b.624).

(f) Radio communication system (two-way).

(g) Radio navigation system.

(h) Windshield wiper or equivalent for each pilot.

(i) Ignition switch for each and all engines (see § 4b.472).

(j) Approved portable fire extinguisher (see § 4b.641).

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-7, 17 F.R. 11631, Dec. 20, 1952; Amdt. 4b-6, 22 F.R. 5566, July 16, 1957]

§ 4b.606 Equipment, systems, and installations.

(a) *Functioning and reliability.* All equipment, systems, and installations the functioning of which is necessary in showing compliance with the regulations in this subchapter shall be designed and installed to insure that they will perform their intended functions reliably under all reasonably foreseeable operating conditions.

(b) *Hazards.* All equipment, systems, and installations shall be designed to safeguard against hazards to the airplane in the event of their malfunctioning or failure.

(c) *Power supply.* Where an installation the functioning of which is necessary in showing compliance with the regulations of this subchapter requires a power supply, such installation shall be considered an essential load on the power supply, and the power sources and the system shall be capable of supplying the following power loads in probable operating combinations and for probable durations:

(1) All loads connected to the system with the system functioning normally;

(2) All essential loads after failure of any one prime mover, power converter, or energy storage device;

(3) All essential loads after failure of any one engine on two- or three-engine airplanes, or after failure of any two engines on four-or-more-engine airplanes;

(4) In determining the probable operating combinations and durations of essential loads for the partial power failure conditions prescribed in subparagraphs (2) and (3) of this paragraph, it shall be permissible to assume that the power loads are reduced in accordance with a monitoring procedure which is consistent with safety in the types of operations authorized. If a particular load is not required to maintain controlled flight it need not be considered for the two-engine-inoperative condition on airplanes with four or more engines as prescribed in subparagraph (3) of this paragraph.

[Amdt. 4b-6, 17 F. R. 1097, Feb. 5, 1952, as amended by Amdt. 4b-1, 19 F. R. 2250, Apr. 20, 1954]

§ 4b.606-1 Safety criteria[1] for electric utilization system; (FAA policies which apply to § 4b.606 (a) and (b)).

Electric utilization systems[2] 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,[3] 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 § 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 fight 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.

[Supp. 29, 21 F. R. 2747, Apr. 28, 1956]

§ 4b.606-2 Installation of flight recorders (FAA policies which apply to § 4b.606).

Flight recorders required under Parts 40, 41, and 42 of this subchapter as amended should be installed in the airplane in conformance with the following:

(a) *Location of flight recorder.* The recorder should be located in accordance with the applicable type in the following:

Type I—Unrestricted location.

Type II—Restricted to any location more than one-half of the wing root chord from the main wing structure through the fuselage and from any fuel tanks.

Type III—Unrestricted location.

(b) *Vertical acceleration sensing.* (1) The vertical acceleration forces should be sensed at a location within or adjacent to the fuselage, and within or

[1] 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, trimtab 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.

[2] 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.

[3] 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.

as close to the center of gravity range of the airplane as practicable.

(2) The vertical acceleration sensor, or the unit in which it is contained, should be attached to a rigid structural member of the airplane so that vertical acceleration forces present in that area can be sensed with a minimum of error.

(3) Sensing of only the in-flight vertical acceleration forces is necessary; impact forces need not be sensed.

(c) *Connection to sources of data.* The air speed, altitude, and heading data should be obtained from either[2] a required duplicate instrument, or from a source independent of required flight and navigation instrument systems, or a combination thereof. No connection should be made within the case itself of the required altimeter indicators. If data are obtained from an independent source, such source should provide data which has an accuracy equivalent to corresponding data furnished by required flight and navigation instrument systems. Provisions need not be made to disconnect or isolate the recorder in flight from sources of data which are independent of required flight and navigation instruments.

(d) *Connection to electrical power.* The flight recorder should be connected to a bus of maximum reliability when such connection does not jeopardize service to essential or emergency loads. If service to such loads is affected, the recorder should be connected to a bus of the next lower reliability.

[Supp. 39, 23 F. R. 7482, Sept. 26, 1958]

INSTRUMENTS; INSTALLATION

§ 4b.610 General.

The provisions of §§ 4b.611 through 4b.613 shall apply to the installation of instruments.

NOTE: It may be necessary to duplicate certain instruments at two or more crew stations to meet the instrument visibility requirements prescribed in § 4b.611, or when required by the operating rules of the Civil Air Regulations for reliability or cross-check purposes in particular types of operations. In the latter case, independent operating systems would be required in accordance with the provisions of § 4b.612 (f).

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–2, 20 F. R. 5308, July 26, 1955]

[2] See § 4b.612 (f) for requirements concerning the connection of additional instruments to required duplicate and duplicated instrument systems.

§ 4b.611 Arrangement and visibility of instrument installations.

(a) Flight, navigation, and powerplant instruments for use by each pilot shall be plainly visible to him from his station with the minimum practicable deviation from his normal position and line of vision when he is looking out and forward along the flight path.

(b) Flight instruments required by § 4b.603 shall be grouped on the instrument panel and centered as nearly as practicable about the vertical plane of the pilot's forward vision. The four basic instruments specified in subparagraphs (1) through (4) of this paragraph shall be located on the flight instrument panel as follows:

(1) The top center position on the panel shall contain that instrument which, of all instruments on the panel, most effectively indicates attitude.

(2) The position adjacent to and directly to the left of the top center position shall contain that instrument which, of all instruments on the panel, most effectively indicates air speed.

(3) The position adjacent to and directly to the right of the top center position shall contain that instrument which, of all instruments on the panel, most effectively indicates altitude.

(4) The position adjacent to and directly below the top center position shall contain that instrument which, of all instruments on the panel, most effectively indicates direction of flight.

(c) All the required powerplant instruments shall be closely grouped on the instrument panel.

(d) Identical powerplant instruments for the several engines shall be located to prevent any misleading impression as to the engines to which they relate.

(e) Powerplant instruments vital to the safe operation of the airplane shall be plainly visible to the appropriate crew members.

(f) The vibration characteristics of the instrument panel shall be such as not to impair seriously the accuracy of the instruments or to damage them.

[15 F.R. 3543, June 8, 1950, as amended by Amdt. 4b–8, 18 F.R. 2216, Apr. 18, 1953; Amdt. 4b–7, 22 F.R. 7462, Sept. 19, 1957]

§ 4b.611–1 Procedure for checking arrangement and visibility of instrument installations (FAA policies which apply to § 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.

[Supp. 24, 19 F.R. 4466, July 20, 1954]

§ 4b.612 Flight and navigational instruments.

(a) *Air-speed indicating systems.* (1) Air-speed indicating instruments shall be of an approved type and shall be calibrated to indicate true air speed at sea level in the standard atmosphere with a minimum practicable instrument calibration error when the corresponding pilot and static pressures are applied to the instrument.

(2) The air-speed indicating system shall be calibrated to determine the system error, i. e., the relation between IAS and CAS, in flight and during the accelerated take-off ground run. The ground run calibration shall be obtained from 0.8 of the minimum value of V_1 to the maximum value of V_1, taking into account the approved altitude and weight range for the airplane. In the ground run calibration, the flap and power settings shall correspond with the values determined in the establishment of the take-off path under the provisions of § 4b.116, assuming the critical engine to fail at the minimum approved value of V_1.

(3) The air-speed error of the installation, excluding the air-speed indicator instrument calibration error, shall not exceed 3 percent or 5 mph, whichever is the greater, throughout the speed range from V_{MO} to 1.3 V_{s_1} with flaps retracted, and from 1.3 V_{s_0} to V_{FE} with flaps in the landing position.

(4) The air-speed indicating system shall be arranged in so far as practicable to preclude malfunctioning or serious error due to the entry of moisture, dirt, or other substances.

(5) The air-speed indicating system shall be provided with a heated pitot tube or equivalent means of preventing malfunctioning due to icing.

(6) Where duplicate air-speed indicators are required, their respective pitot tubes shall be spaced apart to avoid damage to both tubes in the event of a collision with a bird.

(b) *Static air vent and pressure altimeter systems.* (1) All instruments provided with static air case connections shall be vented to the outside atmosphere through an appropriate piping system.

(2) The vent(s) shall be so located on the airplane that its orifices will be least affected by air flow variation, moisture, or other foreign matter.

(3) The installation shall be such that the system will be air-tight, except for the vent into the atmosphere.

(4) Pressure altimeters shall be of an approved type and shall be calibrated to indicate pressure altitude in standard atmosphere with a minimum practicable instrument calibration error when the corresponding static pressures are applied to the instrument.

(5) The design and installation of the altimeter system shall be such that the error in indicated pressure altitude at sea level in standard atmosphere, excluding instrument calibration error, does not result in a value more than the ±30 feet per 100 knots in speed for the appropriate configuration in the speed range between 1.3 V_{s_0} (flaps extended) and 1.8 V_{s_1} (flaps retracted), except that the error need not be less than ±30 feet.

(c) *Magnetic direction indicator.* (1) The magnetic direction indicator shall be installed so that its accuracy will not be excessively affected by the airplane's vibration or magnetic fields of a permanent or transient nature.

(2) After the magnetic direction indicator has been compensated, the calibration shall be such that the deviation in level flight does not exceed ±10° on any heading.

(3) A calibration placard shall be provided as specified in § 4b.733.

(d) *Automatic pilot system.* If an automatic pilot system is installed, it shall be of an approved type, and the following shall be applicable:

(1) The system shall be so designed that the automatic pilot can be quickly and positively disengaged by the human pilots to prevent it from interfering with their control of the airplane.

(2) A means shall be provided to indicate readily to the pilot the alignment of the actuating device in relation to the control system which it operates, except when automatic synchronization is provided.

(3) The manually operated control(s) for the system's normal operation shall be readily accessible to the pilots. The quick release (emergency) controls shall be installed on both the pilots' control wheels, on the side of the wheel opposite from the throttles. Attitude controls shall operate in the same plane and sense of motion as specified for the cockpit

controls in § 4b.353 (b) and Figure 4b-16. The direction of motion shall be plainly indicated on or adjacent to each control.

(4) The automatic pilot system shall be of such design and so adjusted that, within the range of adjustment available to the human pilot, it cannot produce hazardous loads on the airplane or create hazardous deviations in the flight path under any conditions of flight appropriate to its use either during normal operation or in the event of malfunctioning, assuming that corrective action is initiated within a reasonable period of time.

(5) When the automatic pilot integrates signals from auxiliary controls or furnishes signals for operation of other equipment, positive interlocks and sequencing of engagement shall be provided to preclude improper operation. Protection against adverse interaction of integrated components resulting from a malfunction shall be provided.

(e) *Instruments utilizing a power supply.* The following shall apply to each instrument required in § 4b.603 (f), (g), and (h) which utilizes a power supply:

(1) Each instrument shall have a visual type of power failure indicating means, integral with or located adjacent to the instrument, to indicate when adequate power is not being supplied to the instrument (see note) to sustain proper instrument performance. The power shall be sensed at or near the point where power enters the instrument. For electric instruments power shall be deemed adequate when voltage is between approved limits.

(2) Each instrument shall be provided with two independent sources of power and a means of selecting either power source. When duplicate independent instruments are installed, power source selection need not be provided if each instrument has an independent power source.

(3) The installation and power supply system shall be such that failure of one instrument, or the energy supply from one source, or a fault in any part of the power distribution system, will not interfere with the proper supply of energy from the other source. (See also §§ 4b.606(c) and 4b.623.)

NOTE: The word "instrument" as used herein includes those devices which are physically contained in one unit and those devices which are composed of two or more physically separate units or components connected together; such as a remote indicating gyroscopic direction indicator which includes a magnetic sensing element, a gyroscopic unit, an amplifier, and an indicator connected together.

(f) *Duplicate instrument systems.* If duplicate flight instruments are required by the operating parts of the Civil Air Regulations (see note under § 4b.610), the provisions of subparagraphs (1) through (3) of this paragraph shall apply.

(1) The operating system for flight instruments used by the first pilot, which are required to be duplicated at other flight crew stations, shall be completely independent of the operating system provided for other flight crew stations.

(2) Only the required flight instruments and duplicates of required instruments provided for use of the first pilot shall be connected to the operating system provided for the first pilot.

(3) When other than required instruments and duplicates are connected to other than the first pilot's operating system, provision shall be made to disconnect or isolate in flight such other instruments.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-6, 17 F. R. 1098, Feb. 5, 1952; Amdt. 4b-8, 18 F. R. 2216, Apr. 18, 1953; Amdt. 4b-2, 20 F.R. 5308, July 26, 1955; Amdt. 4b-6, 22 F.R. 5566, July 16, 1957; Amdt. 4b-8, 23 F.R. 2591, Apr. 19, 1958; Amdt. 4b-11, 24 F.R. 7071, Sept. 1, 1959; Amdt. 4b-12, 27 F.R. 2994, Mar. 30, 1962]

§ 4b.612-1 Air-speed indicating system calibration (FAA policies which apply to § 4b.612(a)).

(a) *Methods.* 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 paragraph (c) of this section are for the purpose of showing compliance with § 4b.612(a) and not intended to cover the speed range of the flight tests. If an alternate air-speed indicating system is provided, it should also be calibrated. The air-speed indicating system should be calibrated in accordance with the following methods:

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

(2) A reference air-speed system should consist of either of the following:

(i) An air-speed 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 air-speed calibration method, for example, the altimeter method of air-speed calibration. However, when using the altimeter method care should be exercised to measure the airplane's altitude accurately—especially at speeds below 125 mph.

(3) When establishing the airplane's true air speed by means of the ground speed course, flight between the two reference points should be made at constant air speed 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.

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

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

Weight—Between maximum take-off and maximum landing.
C. G. position—Optional.
Wing flaps and landing gear retracted.
Wing flaps in landing position and landing gear extended.
Engines—Optional power.
Mixture setting—Optional.
Cowl flaps—Optional.

(c) *Test procedure and required data.* Any one or any desired combination of the procedures in subparagraphs (1) through (3) of this paragraph may be used for calibrating the air-speed instrument. The air-speed 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 mph from 1.3 V_{s_1} to 1.6 V_{s_1} or placard speed, and 30 mph from 1.6 V_{s_1} to V_{NO}.

(1) *Speed course.* The air-speed and altitude should be stabilized before entering the speed course. Constant air speed 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.
Air speed at several intervals during run.
Wing flap position.
Landing gear position.
Course distance.

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

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

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

[Supp. 24, 19 F. R. 4466, July 20, 1954, as amended by Supp. 25, 20 F. R. 2280, Apr. 8, 1955; Supp. 26, 20 F. R. 6677, Sept. 10, 1955]

§ 4b.612-2 Static air vent system (FAA policies which apply to § 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 air-speed indicators are vented to the same static systems, the altimeter calibration may be made in conjunction with the air-speed calibrations.

(b) The theoretical relationship between air-speed error and altimeter error is given in Figure 4 so that an altimeter calibration may be derived from the air-speed 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. (Note: See Figure 4, *infra*).

[Supp. 24, 19 F.R. 4466, July 20, 1954, as amended by Supp. 32, 22 F.R. 5793, July 20, 1957]

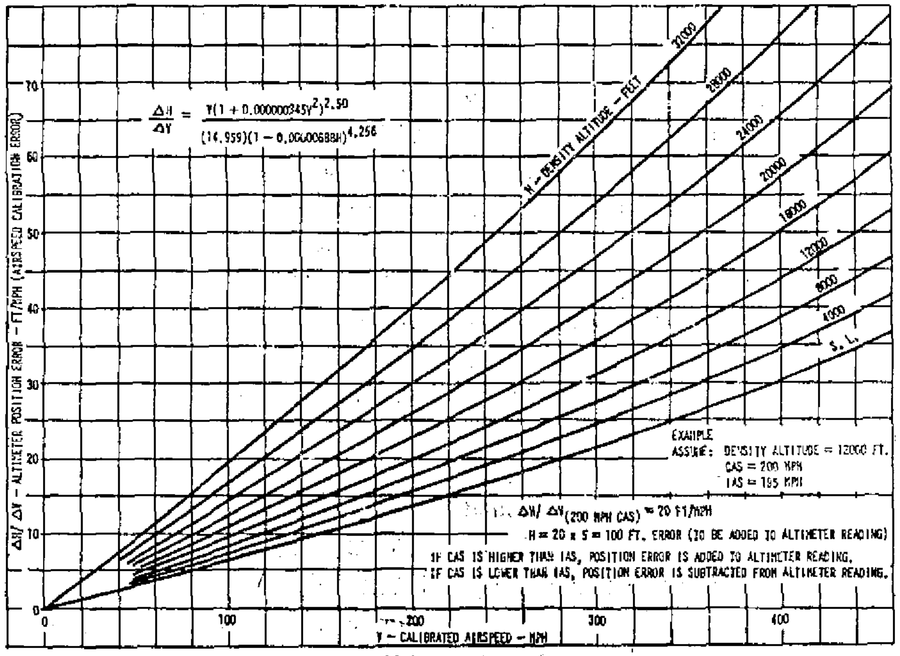


FIGURE 4—Altimeter Position Error.

§ 4b.612–3 Calibration of magnetic direction indicator (FAA policies which apply to § 4b.612(c)).

It is recommended that the magnetic direction indicator be calibrated while the airplane is on the ground with its engines and electrical equipment operating. The calibration data should be included in Form ACA 283–4b.

[Supp. 24, 19 F. R. 4466, July 20, 1954]

§ 4b.612–4 Automatic pilot systems (FAA policies which apply to § 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,[1] cruise, and descent regimes. When corrective action is taken 3 seconds after the airplane response[2] 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_{FC} (or M_{FC} 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] The configuration for normal climb will be that for operational all-engine climb with 75 percent maximum continuous power and flaps retracted.

[2] 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.

(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 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 1 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 3° 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 §§ 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 paragraph (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.

[Supp. 27, 21 F.R. 2124, Apr. 3, 1956, as amended by Amdt. 4b–12, 27 F.R. 2994, Mar. 30, 1962]

§ 4b.612–5 Connection of additional instruments to duplicate instrument system (FAA policies which apply to § 4b.612(f)).

Neither the accuracy nor the performance of any required duplicate instrument should be reduced below the minimum required by the pertinent Civil Air Regulations when an additional instrument is connected to or is subsequently disconnected from the system.

[Supp. 39, 23 F. R. 7482, Sept. 26, 1958]

§ 4b.613 Powerplant instruments.

(a) *Instrument lines.* (1) Powerplant instrument lines carrying flammable fluids or gases under pressure shall be provided with restricted orifices or equivalent safety devices at the source of the pressure to prevent the escape of excessive fluid or gas in case of line failure.

(2) The provisions of §§ 4b.432 and 4b.433 shall be made applicable to powerplant instrument lines.

(b) *Fuel quantity indicator.* Means shall be provided to indicate to the flight crew the quantity in gallons or equivalent units of usable fuel in each tank during flight. The following shall apply.

(1) Tanks, the outlets and air spaces of which are interconnected, shall be considered as one tank for the purpose of providing separate indicators.

(2) Exposed sight gauges shall be protected against damage.

(3) Fuel quantity indicators shall be calibrated to read zero during level flight when the quantity of fuel remaining in the tank is equal to the unusable fuel supply as defined by § 4b.416 (see § 4b.736).

(c) *Fuel flowmeter system.* When a flowmeter system is installed, the metering component shall include a means for by-passing the fuel supply in the event that malfunctioning of the metering component results in a severe restriction to fuel flow.

(d) *Oil quantity indicator.* (1) A stick gauge or other equivalent means shall be provided to indicate the quantity of oil in each tank. (See § 4b.735.)

(2) If an oil transfer system or a reserve oil supply system is installed, means shall be provided to indicate to the crew during flight the quantity of oil in each tank.

(e) *Turbine-propeller blade position indicating means.* The indicating means required for turbine propellers by § 4b.604 (s) shall initiate indication before the propeller blade has moved more than eight degrees below the flight low pitch stop. The source of the indication shall sense blade position directly.

(f) *Fuel pressure indication.* (1) Provisions shall be made to measure the fuel pressure, in all systems supplying reciprocating engines, at a point downstream of all fuel pumps except fuel injection pumps. (For instrument requirements see § 4b.604(e).)

(2) When necessary for the maintenance of the proper fuel delivery pressure, a connection shall be provided to transmit the carburetor air intake static pressure to the proper fuel pump relief valve connection. In such cases, to avoid erroneous fuel pressure reading, the gauge balance lines shall be independently connected to the carburetor inlet pressure.

[15 F.R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 17 F.R. 1098, Feb. 5, 1952; Amdt. 4b–6, 22 F.R. 5566, July 16, 1957; Amdt. 4b–11, 24 F.R. 7071, Sept. 1, 1959]

Electrical Systems and Equipment

§ 4b.620 General.

The provisions of §§ 4b.621 through 4b.627 shall apply to all electrical systems and equipment. (See also § 4b.606.)

[Amdt. 4b–6, 17 F. R. 1098, Feb. 5, 1952]

§ 4b.621 Electrical system capacity.

The required generating capacity and the number and type of power sources shall be determined by an electrical load analysis and shall comply with § 4b.606 (c).

[Amdt. 4b–6, 17 F. R. 1098, Feb. 5, 1952]

§ 4b.622 Generating system.

(a) The generating system shall be considered to include electrical power sources, main power busses, transmission cables, and associated control, regulation, and protective devices.

(b) The generating system shall be designed so that:

(1) The power sources function properly when independent and when connected in combination;

(2) The failure or malfunctioning of any power source cannot create a hazard or impair the ability of the remaining sources to supply essential loads;

(3) The system voltage and frequency (as applicable) at the terminals of all essential load equipment can be maintained within the limits for which the equipment is designed, during any probable operating condition; and

(4) System transients initiated by switching, fault clearing, or other causes, do not render essential loads inoperative, and do not introduce a smoke or fire hazard.

(c) Means accessible in flight to appropriate crew members shall be provided for the independent disconnection of each electrical power source from the system. Controls for this purpose shall be grouped to permit expeditious disconnection of electrical power sources.

(d) Means shall be provided to indicate to appropriate crew members those generating system quantities which are essential for the safe operation of the system.

NOTE: The voltage and current supplied by each generator are quantities considered essential.

[Amdt. 4b–6, 17 F.R. 1098, Feb. 5, 1952, as amended by Amdt. 4b–6, 22 F.R. 5566, July 16, 1957; Amdt. 4b–12, 27 F.R. 2994, Mar. 30, 1962]

§ 4b.622–1 Generating system reliability (FAA policies which apply to § 4b.622(b)).

Generating systems should be analyzed, inspected or tested to assure conformance to the following reliability criteria:

(a) *Failure of propulsion engines or other prime movers.* The generating system performance (after failure of one or more propulsion engines or other prime movers) should be that specified in § 4b.606 (c).

(b) *Generating system malfunctions.* No probable malfunction [5] in the generating system, or in the generator drive system,[6] should result in the permanent loss of service to electric utilization systems [7] which are necessary to maintain controlled flight and to effect a safe landing,[8] unless the aircraft is equipped with an independent source of electric power capable of supplying continuous emergency service to these utilization systems.

(c) *Corrective action.* Where corrective action is necessary to comply with paragraphs (a) and (b) of this section,

(1) Adequate warning should be provided for any malfunction or failure requiring such corrective action.

---

[5] A probable malfunction is any single electrical or mechanical malfunction or failure 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.

[6] The generator drive system includes the prime movers (propulsion engines or other) and coupling devices such as gear-boxes or constant-speed drives.

[7] An electric utilization system is a system of electric equipment, devices and connected wiring which utilizes electric energy to perform a specific aircraft function.

[8] The specific electric utilization systems which are necessary to maintain controlled flight and effect a safe landing will vary with the type of aircraft and with the nature of the operation in which the aircraft is utilized. Examples of systems which may be in this category are as follows: Basic flight instruments, minimum navigation equipment, minimum two-way radio communications, and control system boost.

(2) Controls should be so located as to permit such corrective action during any probable flight situation.

(3) If corrective action must be taken within a specified time interval for continued safe operation of the generating system, it should be demonstrated that such corrective action can be accomplished within the specified time interval during any probable flight situation.

(4) The procedure to be followed by the crew should be detailed in the Operating Procedures Section of the Airplane Flight Manual (see § 4b.740).

(d) *Electric system smoke and fire procedures (see § 4b.371 (c)).* To cope with electrical smoke or fire of undetermined origin, generating system controls should be designed to permit electrical disconnection of overheated equipment in flight without hazardous interruption of service to electric utilization systems. Procedures for this purpose should be contained in the Operating Procedures Section of the Airplane Flight Manual (see § 4b.740).

[Supp. 33, 22 F. R. 6885, Aug. 27, 1957]

§ 4b.623 Distribution system.

(a) The distribution system shall be considered to include all distribution busses, their associated feeders, and control and protective devices.

(b) Individual distribution systems shall be designed to insure that essential load circuits can be supplied in the event of reasonably probable faults or open circuits.

(c) Where two independent sources of electrical power for particular equipment or systems are required by the Civil Air Regulations, their electrical energy supply shall be assured.

NOTE: Various means may be used to assure a supply, such as duplicate electrical equipment, throw-over switching, and multichannel or loop circuits separately routed.

[Amdt. 4b-6, 17 F. R. 1098, Feb. 5, 1952]

§ 4b.624 Electrical protection.

(a) Automatic protective devices shall be provided to minimize distress to the electrical system and hazard to the airplane in the event of wiring faults or serious malfunctioning of the system or connected equipment.

(b) In the generating system the protective and control devices shall be such as to de-energize and disconnect faulty power sources and power transmission equipment from their associated busses with sufficient rapidity to provide protection against hazardous overvoltage and other malfunctioning.

(c) All resettable type circuit protective devices shall be so designed that, when an overload or circuit fault exists, they will open the circuit irrespective of the position of the operating control.

(d) If the ability to reset a circuit breaker or to replace a fuse is essential to safety in flight, such circuit breaker or fuse shall be so located and identified that it can be readily reset or replaced in flight.

(e) Circuits for essential loads shall have individual circuit protection.

NOTE: This provision does not necessarily require individual protection for each circuit in an essential load system (e. g., each position light in the system).

(f) If fuses are used, there shall be provided spare fuses for use in flight equal to at least 50 percent of the number of fuses of each rating required for complete circuit protection.

[Amdt. 4b-6, 17 F.R. 1098, Feb. 5, 1952, as amended by Amdt. 4b-12, 27 F.R. 2994, Mar. 30, 1962]

§ 4b.624-1 Automatic reset circuit breaker (FAA policies which apply to § 4b.624).

Automatic reset circuit breakers (which automatically reset themselves periodically) should not be applied as circuit protective devices.[11] 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.

[Supp. 25, 20 F. R. 2280, Apr. 8, 1955]

[11] Circuit protective devices are normally installed to limt 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.

§ 4b.625 Electrical equipment and installation.

(a) In showing compliance with § 4b.606 (a) and (b) with respect to the electrical system, equipment, and installation, consideration shall be given to critical environmental conditions.

NOTE: Critical environmental conditions may include temperature, pressure, humidity, ventilation, position, acceleration, vibration, and presence of detrimental substances.

(b) All electrical equipment, controls, and wiring shall be so installed that operation of any one unit or system of units will not affect adversely the simultaneous operation of any other electrical unit or system of units essential to the safe operation of the airplane.

(c) Cables shall be grouped, routed, and spaced so that damage to essential circuits will be minimized in the event of faults in heavy current-carrying cables.

(d) Storage batteries shall be of such design and be so installed that:

(1) Safe cell temperatures and pressures are maintained during any probable charging or discharging condition. No uncontrolled increase in cell temperature shall result when the storage battery is recharged (after previous complete discharge) at maximum regulated voltage, during a flight of maximum duration, under the most adverse cooling conditions likely to occur in service. Tests to demonstrate compliance with this regulation shall not be required if satisfactory operating experience with similar batteries and installations has shown that maintaining safe cell temperatures and pressures presents no problem.

(2) Explosive or toxic gases emitted by the storage battery in normal operation, or as the result of any probable malfunction in the charging system or battery installation, shall not accumulate in hazardous quantities within the airplane.

(3) Corrosive fluids or gases which may be emitted or spilled from the storage battery shall not damage the surrounding airplane structure or adjacent essential equipment.

[Amdt. 4b-6, 17 F.R. 1098, Feb. 5, 1952, as amended by Amdt. 4b-11, 24 F.R. 7071, Sept. 1, 1959]

§ 4b.625-1 Environmental tests for electrical equipment[1] (FAA policies which apply to § 4b.625(a)).

The ability of electrical equipment to provide continuous safe service under foreseeable environmental conditions may be demonstrated by means of environmental tests, design analyses, or reference to previous comparable service experience on other aircraft. For environmental testing, the test procedures contained in Appendix (I)[2] are acceptable, subject to the following objective criteria:

(a) The extremes of climatic and environmental conditions given in Appendix (I)[2] may be reduced in specific aircraft applications when it can be shown that these extremes would not be reached in normal service. Conversely, these extremes should be extended when individual applications indicate the need, such as may occur when electrical equipment is exposed to high intensity acoustic noise generated by turbo-jet engines.

(b) In all cases the ability of the equipment to safely withstand exposure to temperature extremes, temperature shock, humidity, altitude, vibration, flight and normal landing impact shocks, and acceleration should be demonstrated. Tests for each of these conditions are set forth in Appendix (I).[2] Tests in environments such as sand and dust, fungus and saltspray may be limited to equipment likely to be exposed to these conditions.

(c) Electrical equipment altitude testing should be conducted at an altitude 15 percent above the maximum altitude to which the equipment would be exposed in normal service. However, testing of certain equipment installed in pressurized areas should be under conditions of altitude and time which will assure that, in case of rapid decompression:

(1) Equipment necessary for the execution of an emergency descent would remain operative for the probable period required for such descent.

(2) Other equipment is not rendered permanently inoperative if the operation

[1] This policy applies to all electrical generation, distribution, and utilization equipment required by or utilized in complying with the applicable Civil Air Regulations, except those items covered by Technical Standard Orders containing environmental test procedures.

[2] Not filed with Office of the Federal Register.

of the equipment is necessary to maintain controlled flight or effect a safe landing.

(3) No equipment will constitute a hazard due to arcing, fire, or smoke. However, altitude testing for hazard from arcing, fire, or smoke is not required where any hazard is satisfactorily minimized independently of altitude by design and installation features.

[Supp. 41, 23 F. R. 10325, Dec. 25, 1958]

§ 4b.626 Electrical system fire and smoke protection.

The design and installation of all components of the electrical system shall be in compliance with pertinent fire and smoke protection provisions of §§ 4b.371 (c), 4b.385, and 4b.490. In addition, all electrical cables, terminals, and equipment which are necessary in emergency procedures and which are located in designated fire zones shall be fire-resistant.

[Amdt. 4b–6, 17 F. R. 1098, Feb. 5, 1952]

§ 4b.626–1 Fire resistant electrical equipment [9] (FAA policies which apply to § 4b.626).

When applied to the electrical equipment and components defined in the last sentence of § 4b.626, an accepted criterion for "fire resistant" is that such equipment and components, as installed in the aircraft, should withstand a 2,000° F. oxidizing flame impinging on their surfaces for at least five minutes without adverse effect on their circuit function.[10] The 2,000° F. oxidizing flame should envelop the equipment under test, using a test setup simulating the actual aircraft installation.[11] Thermocouples for measurement of flame temperature should be located within one-fourth inch of the surface exposed to the flame.

[Supp. 37, 23 F.R. 2790, Apr. 26, 1958]

§ 4b.627 Electrical system tests.

When laboratory tests of the electrical system are conducted they shall be performed on a mock-up utilizing the same generating equipment complement as in the aircraft. The equipment shall simulate the electrical characteristics of the distribution wiring and connected loads to the extent necessary for valid test results. Laboratory generator drives shall simulate the actual prime movers on the airplane with respect to their reaction to generator loading, including loading due to faults. When the conditions of flight cannot adequately be simulated in the laboratory or by ground tests on the prototype airplane, flight tests shall be conducted.

[Amdt. 4b–12, 27 F.R. 2994, Mar. 30, 1962]

§ 4b.628 Lightning strike protection.

Those portions of the airplane which are electrically insulated from the main body of the airplane shall be connected to the basic airframe through appropriate lightning arrestors, unless it is shown that a lightning strike on the insulated portion is improbable because of the shielding afforded by other portions of the airplane, or unless it is shown that a lightning strike on the insulated portion would not create a hazard to the airplane or its occupants.

[Amdt. 4b–11, 24 F.R. 7071, Sept. 1, 1959]

LIGHTS

§ 4b.630 Instrument lights.

(a) Instrument lights shall provide sufficient illumination to make all instruments, switches, etc., easily readable.

(b) Instrument lights shall be so installed that their direct rays are shielded from the pilot's eyes and so that no objectionable reflections are visible to him.

(c) A means of controlling the intensity of illumination shall be provided, unless it is shown that non-dimmed instrument lights are satisfactory under all expected conditions of flight.

§ 4b.631 Landing lights.

(a) Landing lights shall be of an approved type.

(b) Landing lights shall be installed so that there is no objectionable glare visible to the pilot and so that the pilot is not adversely affected by halation.

[9] This policy establishes a basic test standard for fire resistant electrical equipment located in designated fire zones. However, installation approval may be granted for equipment which does not conform to this standard, if it can be shown that such equipment would provide equivalent safety if exposed to the probable fire conditions at its particular location.

[10] Excessive temperature may affect the electrical equipment and components by causing such malfunctions as short circuit, open circuit, and changes in circuit paramaters (for example, reduced insulation resistance and dielectric strength).

[11] In the case of electric cable only a representative length, not less than 12 inches, need to be enveloped in the flame.

(c) Landing lights shall be installed in a location where they provide the necessary illumination for night landing.

(d) A switch for each light shall be provided, except that where multiple lights are installed at one location a single switch for the multiple lights shall be acceptable.

(e) A means shall be provided to indicate to the pilots when the landing lights are extended.

[15 F.R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 22 F.R. 5566, July 6, 1957]

§ 4b.632 Position light system installation.

(a) *General.* The provisions of §§ 4b.632 through 4b.635 shall be applicable to the position light system as a whole. The position light system shall include the items specified in paragraphs (b) through (d) of this section.

(b) *Forward position lights.* Forward position lights shall consist of a red and a green light spaced laterally as far apart as practicable and installed forward on an airplane in such a location that, with the airplane in normal flying position, the red light is displayed on the left side and the green light is displayed on the right side. The individual lights shall be of an approved type.

(c) *Rear position light.* The rear position light shall consist of a white light mounted on the airplane as far aft as practicable. The light shall be of an approved type.

(d) *Light covers and color filters.* Light covers or color filters used shall be of flame-resistant material and shall be constructed so that they will not change color or shape or suffer any appreciable loss of light transmission during normal use.

[Amdt. 4b–1, 15 F. R. 8903, Dec. 15, 1950, as amended by Amdt. 4b–7, 17 F. R. 11631, Dec. 20, 1952; Amdt. 4b–8, 18 F. R. 2216, Apr. 18, 1953; Amdt. 4b–2, 20 F.R. 5308, July 26, 1955; Amdt. 4b–4, 22 F.R. 1274, Mar. 1, 1957; Amdt. 4b–11, 24 F.R. 7071, Sept. 1, 1959]

§ 4b.632–1 Red passing lights (FAA policies which apply to § 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.

[Supp. 17, 16 F. R. 3212, Apr. 12, 1951]

§ 4b.633 Position light system dihedral angles.

The forward and rear position lights as installed on the airplane shall show unbroken light within dihedral angles specified in paragraphs (a) through (c) of this section.

(a) Dihedral angle L (left) shall be considered formed by two intersecting vertical planes, one parallel to the longitudinal axis of the airplane and the other at 110° to the left of the first, when looking forward along the longitudinal axis.

(b) Dihedral angle R (right) shall be considered formed by two intersecting vertical planes, one parallel to the longitudinal axis of the airplane and the other at 110° to the right of the first, when looking forward along the longitudinal axis.

(c) Dihedral angle A (aft) shall be considered formed by two intersecting vertical planes making angles of 70° to the right and 70° to the left, respectively, looking aft along the longitudinal axis, to a vertical plane passing through the longitudinal axis.

[Amdt. 4b–1, 15 F. R. 8903, Dec. 15, 1950]

§ 4b.634 Position light distribution and intensities.

(a) *General.* The intensities prescribed in this section are those to be provided by new equipment with all light covers and color filters in place. Intensities shall be determined with the light source operating at a steady value equal to the average luminous output of the light source at the normal operating voltage of the airplane. The light distribution and intensities of position lights shall comply with the provisions of paragraphs (b) and (c) of this section.

(b) *Forward and rear position lights.* The light distribution and intensities of forward and rear position lights shall be expressed in terms of minimum intensities in the horizontal plane, minimum intensities in any vertical plane, and maximum intensities in overlappng beams, within dihedral angles L, R, and A, and shall comply with the provisions of subparagraphs (1) through (3) of this paragraph.

(1) *Intensities in horizontal plane.* The intensities in the horizontal plane shall not be less than the values given in figure 4b–18. (The horizontal plane is the plane containing the longitudinal axis of the airplane and is perpendicular to the plane of symmetry of the airplane.)

(2) *Intensities above and below horizontal.* The intensities in any vertical plane shall not be less than the appropriate value given in figure 4b–19, where I is the minimum intensity prescribed in figure 4b–18 for the corresponding angles in the horizontal plane. (Vertical planes are planes perpendicular to the horizontal plane.)

(3) *Overlaps between adjacent signals.* The intensities in overlaps between adjacent signals shall not exceed the values given in Figure 4b–20, except that higher intensities in the overlaps shall be acceptable with the use of main beam intensities substantially greater than the minima specified in Figures 4b–18 and 4b–19 if the overlap intensities in relation to the main beam intensities are such as not to affect adversely signal clarity.

Dihedral angle (light involved)	Angle from right or left of longitudinal axis, measured from dead ahead	Intensity (candles)
L and *R* (forward red and green).	0° to 10°	40
	10° to 20°	30
	20° to 110°	5
A (Rear white)	110° to 180°	20

FIGURE 4b–18—MINIMUM INTENSITIES IN THE HORIZONTAL PLANE OF FORWARD AND REAR POSITION LIGHTS

Angle above or below horizontal	Intensity
0°	1.00 I.
0° to 5°	.90 I.
5° to 10°	.80 I.
10° to 15°	.70 I.
15° to 20°	.50 I.
20° to 30°	.30 I.
30° to 40°	.10 I.
40° to 90°	.05 I

FIGURE 4b–19—MINIMUM INTENSITIES IN ANY VERTICAL PLANE OF FORWARD AND REAR POSITION LIGHTS

Overlaps	Maximum intensity	
	Area A (candles)	Area B (candles)
Green in dihedral angle *L*	10	1
Red in dihedral angle *R*	10	1
Green in dihedral angle *A*	5	1
Red in dihedral angle *A*	5	1
Rear white in dihedral angle *L*	5	1
Rear white in dihedral angle R	5	1

NOTE: Area A includes all directions in the adjacent dihedral angle which pass through the light source and which intersect the common boundary plane at more than 10 degrees but less than 20 degrees. Area B includes all directions in the adjacent dihedral angle which pass through the light source and which intersect the common boundary plane at more than 20 degrees.

FIGURE 4b–20—MAXIMUM INTENSITIES IN OVERLAPPING BEAMS OF FORWARD AND REAR POSITION LIGHTS

[Amdt. 4b–1, 15 F. R. 8903, Dec. 15, 1950, as amended by Amdt. 4b–2, 20 F. R. 5309, July 26, 1955; Amdt. 4b–4, 22 F.R. 1274, Mar. 1, 1957; Amdt. 4b–12, 27 F.R. 2994, Mar. 30, 1962]

§ 4b.634–1 Overlaps between high intensity forward position lights (FAA policies which apply to § 4b.634(b)(3)).

When the peak intensity of the forward position lights is greater than 100 candles, the maximum overlap intensities between them may exceed the values given in Figure 4b–20 provided the overlap intensity in Area A is not greater than 10 percent of peak position light intensity and the overlap intensity in Area B is not greater than 2.5 percent of peak position light intensity.[13]

[Supp. 37, 23 F. R. 2790, Apr. 26, 1958]

§ 4b.635 Position light color specifications.

The colors of the position lights shall have the International Commission on Illumination chromaticity coordinates as set forth in paragraphs (a) through (c) of this section.

(a) *Aviation red.*

y is not greater than 0.335,
z is not greater than 0.002;

(b) *Aviation green.*

x is not greater than 0.440−0.320*y*,
x is not greater than *y*—0.170,
y is not less than 0.390−0.170*x*;

(c) *Aviation white.*

x is not less than 0.350.
x is not greater than 0.540,
$y - y_0$ is not numerically greater than 0.01, y_0 being the *y* coordinate of the Planckian radiator for which $x_0 = x$.

[Amdt. 4b–1, 15 F. R. 8903, Dec. 15, 1950]

§ 4b.636 Riding light.

(a) When a riding (anchor) light is required for a seaplane, flying boat, or amphibian, it shall be capable of showing a white light for at least two miles at night under clear atmospheric conditions.

(b) The riding light shall be installed to show the maximum unbroken light practicable when the airplane is moored or drifting on the water. Externally hung lights shall be acceptable.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–1, 15 F. R. 8903, Dec. 15, 1950]

§ 4b.637 Anti-collision light system.

An anti-collision light system shall be installed which shall consist of one or more approved anti-collision lights so located that the emitted light will not be detrimental to the crew's vision and will not detract from the conspicuity of the position lights. The system shall comply with the provisions of paragraphs (a) through (d) of this section.

(a) *Field of coverage.* The system shall consist of such lights as will afford coverage of all vital areas around the airplane with due consideration to the physical configuration and the flight characteristics of the airplane. In any case, the field of coverage shall extend in all directions within 30° above and 30° below the horizontal plane of the airplane, except that a solid angle or angles of obstructed visibility totaling not more than 0.03 steradians shall be permissible within a solid angle equal to 0.15 steradians centered about the longitudinal axis in the rearward direction.

(b) *Flashing characteristics.* The arrangement of the system, i. e., number of light sources, beam width, speed of rotation, etc., shall be such as to give an effective flash frequency of not less than 40 and not more than 100 cycles per minute. The effective flash frequency shall be the frequency at which the airplane's complete anti-collision light system is observed from a distance, and shall apply to all sectors of light including the overlaps which might exist when the system consists of more than one light source. In overlaps, flash frequencies higher than 100 cycles per minute shall be permissible, except that they shall not be higher than 180 cycles per minute.

(c) *Color.* The color of the anti-collision lights shall be aviation red in accordance with the specifications of § 4b.635 (a).

(d) *Light intensity.* The minimum light intensities in all vertical planes, measured with the red filter and expressed in terms of "effective" intensities, shall be in accordance with Figure 4b–27. The following relation shall be assumed:

$$I_e = \frac{\int_{t_1}^{t_2} I(t)\,dt}{0.2 + (t_2 - t_1)};$$

where:

I_e = effective intensity (candles),
$I(t)$ = instantaneous intensity as a function of time,
$t_2 - t_1$ = flash time interval (seconds).

NOTE: Normally, the maximum value of effective intensity is obtained when t_2 and t_1 are so chosen that the effective intensity is equal to the instantaneous intensity at t_2 and t_1.

Angle above or below horizontal plane	Effective intensity (candles)
0° to 5°	100
5° to 10°	60
10° to 20°	20
20° to 30°	10

FIGURE 4b–27—Minimum effective intensities for anti-collision lights.

[Amdt. 4b–4, 22 F. R. 1274, Mar. 1, 1957]

SAFETY EQUIPMENT

§ 4b.640 Ice protection.

Compliance with this section is optional. The requirements of this section are intended to provide for safe flight in icing conditions. When compliance is shown with the provisions of this section, the type certificate shall include certification to that effect. When an airplane is certificated to include ice protection provisions, the recommended procedures for the use of the ice protection equipment shall be set forth in the Airplane Flight Manual (see § 4b.742

[13] Overlap intensities should be determined with the position lights installed in their actual airplane locations, since adjacent airplane structure will often provide some cutoff in the overlap area.

(a)). It shall be shown, as prescribed in paragraphs (a) and (b) of this section, that the airplane is capable of operating safely in continuous maximum and intermittent maximum icing conditions as defined in §§ 4b.1(b) (7) and (8).

(a) An analysis shall be performed to establish, on the basis of the airplane's operational needs, the adequacy of the ice protection system for the various components of the airplane.

(b) In addition to the analysis and physical evaluation prescribed in paragraph (a) of this section, the effectiveness of the ice protection system and its components shall be shown by one or more of the following means:

(1) Laboratory dry air and/or simulated icing tests of the actual components or models thereof.

(2) Flight dry air tests of the ice protection system as a whole, or of its components individually.

(3) Flight tests of the airplane or its components in measured simulated icing conditions.

(4) Flight tests of the airplane in measured natural atmospheric icing conditions.

NOTE: For turbine-powered airplanes, the ice protection provisions of this section are considered to be primarily applicable to the airframe. For the powerplant installation, certain additional provisions of Subpart E of this part may be found applicable.

[Amdt. 4b-2, 20 F.R. 5309, July 26, 1955, as amended by Amdt. 4b-6, 22 F.R. 5566, July 16, 1957]

§ 4b.641 Hand fire extinguishers.

(See §§ 4b.381, 4b.382, and 4b.383.)

[Amdt. 4b-6, 17 F. R. 1099, Feb. 5, 1952]

§ 4b.642 Flare installation.

(a) Parachute flares shall be releasable from the pilot compartment and installed to minimize the probability of accidental discharge.

(b) It shall be demonstrated in flight that the flare installation is such that ejection can be accomplished without hazard to the airplane and its occupants.

(c) If recoil loads are involved in the ejection of the flares, the structure of the airplane shall withstand such loads.

[15 F.R. 3543, June 8, 1950, as amended by Amdt. 4b-12, 27 F.R. 2994, Mar. 30, 1962]

§ 4b.642-1 Procedure for testing flare ejection (FAA policies which apply to § 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 landing gear in both extended and retracted positions. If it is obvious that the flaps and gear have no effect upon the flare's path, the test may be conducted at one configuration. It is permissible to use dummy flares with parachutes for this test.

[Supp. 24, 19 F. R. 4466, July 20, 1954]

§ 4b.643 Safety belts.

Safety belts shall be of an approved type. In no case shall the rated strength of the safety belt be less than that corresponding with the ultimate load factors specified in § 4b.260(a), taking due account of the dimensional characteristics of the safety belt installation for the specific seat or berth arrangement. Safety belts shall be attached so that no part of the anchorage will fail at a load lower than that corresponding with the ultimate load factors equal to those specified in § 4b.260(a) multiplied by a factor of 1.33 in lieu of the fitting factor prescribed in § 4b.307(c). In the case of safety belts for berths, the forward load factor need not be applied.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-8, 18 F. R. 2216, Apr. 18, 1953; Amdt. 4b-2, 20 F. R. 5309, July 26, 1955; Amdt. 4b-3, 21 F.R. 994, Feb. 11, 1956; Amdt. 4b-12, 27 F.R. 2994, Mar. 30, 1962]

§ 4b.644 Safety belt signal.

When means are provided to indicate to the passengers when seat belts should be fastened, the device shall be so installed that it can be operated from the seat of either pilot or copilot.

§ 4b.645 Ditching equipment.

When the airplane is certificated for ditching in accordance with § 4b.361, and when required by the operating rules for the particular route to be flown, the ditching equipment shall be as prescribed in paragraphs (a) through (e) of this section.

(a) *Life rafts.* Life rafts shall be of an approved type. Unless excess rafts of sufficient capacity are provided, the buoyancy and seating capacity beyond the rated capacity of the rafts shall be such as to accommodate all occupants of the airplane in the event of a loss of one life raft of the largest rated capacity on board. Each life raft shall be equipped with a trailing line and with a static line, the latter designed to hold the raft near the airplane but to release it in case the airplane becomes totally submerged. Each raft shall contain obvious markings of instruction on the operation of the raft.

(b) *Life raft equipment.* Approved equipment intended for survival shall be attached to each life raft and marked for identification and method of operation.

NOTE: The extent and type of survival equipment will depend upon the route over which the airplane is operated.

(c) *Long-range signalling device.* An approved long-range signalling device shall be provided for use in one of the life rafts.

(d) *Life preservers.* Life preservers shall be of an approved type. They shall be reversible and shall contain obvious markings of instruction on their use.

(e) *Life line.* Provisions shall be made for the storage of life lines, one attached to each side of the fuselage and arranged so that they can be used to enable occupants to stay on the wing after a ditching.

[Amdt. 4b-8, 18 F.R. 2216, Apr. 18, 1953, as amended by Amdt. 4b-6, 22 F.R. 5566, July 16, 1957; Amdt. 4b-11, 24 F.R. 7071, Sept. 1, 1959; Amdt. 4b-12, 27 F.R. 2994, Mar. 30, 1962]

§ 4b.646 Stowage of safety equipment.

Special stowage provisions shall be made for all prescribed safety equipment to be used in emergencies. The stowage provision shall be such that the equipment is directly accessible and its location is obvious. All safety equipment shall be protected against inadvertent damage. The stowage provisions shall be marked conspicuously to identify the contents and to facilitate removal of the equipment. In addition, the following shall specifically apply.

(a) *Emergency exit means.* The stowage provisions for the emergency exit means required by § 4b.362 (e) (7) shall be located at the exits which they are intended to serve.

(b) *Life rafts.* The provisions for the stowage of life rafts required by § 4b.645 (a) shall accommodate a sufficient number of rafts for the maximum number of occupants for which the airplane is certificated for ditching. Stowage shall be near exits through which the rafts can be launched during an unplanned ditching. Rafts automatically or remotely released on the outside of the airplane shall be attached to the airplane by means of the static line prescribed in § 4b.645 (a).

(c) *Long-range signalling device.* The stowage provisions for the long-range signalling device required by § 4b.645 (c) shall be located near an exit to be available during an unplanned ditching.

(d) *Life preservers.* The provisions for the stowage of life preservers required by § 4b.645 (d) shall accommodate one life preserver for each occupant for which the airplane is certificated for ditching. They shall be located so that a life preserver is within easy reach of each occupant while seated.

[Amdt. 4b-8, 18 F. R. 2217, Apr. 18, 1953]

§ 4b.647 Flotation means.

If the airplane is not equipped with life preservers in accordance with § 4b.645(d), an approved individual flotation means shall be provided for each occupant. Such flotation means shall be within easy reach of each occupant while seated and readily removable from the airplane.

[Amdt. 4b-11, 24 F.R. 7071, Sept. 1, 1959]

MISCELLANEOUS EQUIPMENT

§ 4b.650 Radio and electronic equipment.

(a) In showing compliance with § 4b.606 (a) and (b) with respect to radio and electronic equipment and their installations, consideration shall be given to critical environmental conditions.

NOTE: Critical environmental conditions may include temperature, pressure, humidity, ventilation, position, acceleration, vibration, and presence of detrimental substances.

(b) Radio and electronic equipment shall be supplied with power in accordance with the provisions of § 4b.623 (c).

(c) All radio and electronic equipment, controls, and wiring shall be so installed that operation of any one unit or system of units will not affect adversely the simultaneous operation of any other radio or electronic unit or system of units required by the regulations in this subchapter.

[Amdt. 4b-6, 17 F. R. 1099, Feb. 5, 1952]

§ 4b.651 Oxygen equipment and supply.

When required by the operating rules of the regulations in this subpart, the supplemental and protective breathing equipment and its installation shall meet the following requirements.

(a) *General.* The oxygen system installed shall be free from hazards in itself, in its method of operation, and in its effect upon other components of the airplane. Means shall be provided to enable the crew to determine readily during flight the quantity of oxygen available in each source of supply. For airplanes certificated for operation at flight altitudes above 40,000 feet, oxygen flow rate and equipment shall be approved by the Administrator.

(b) *Required minimum mass flow of supplemental oxygen.* The minimum mass flow of supplemental oxygen required per person at various cabin pressure altitudes shall be that necessary to comply with the following requirements as applicable:

(1) Where continuous flow equipment is used by flight crew members, the minimum mass flow of supplemental oxygen required for each crew member shall not be less than that which will maintain during inspiration a mean tracheal oxygen partial pressure of 149 mm. Hg. when breathing 15 liters per minute, BTPS, and having a maximum tidal volume of 700 cc. with a constant time interval between respirations.

(2) Where demand equipment is used by flight crew members, the minimum mass flow of supplemental oxygen required for each crew member shall not be less than that which will maintain during inspiration a mean tracheal oxygen partial pressure of 122 mm. Hg. to and including a cabin pressure altitude of 35,000 feet and 95 percent oxygen between cabin pressure altitudes of 35,000 and 40,000 feet, when breathing 20 liters per minute BTPS. Provision shall be made to allow use of undiluted oxygen by crew members when they so desire.

(3) For passengers and cabin attendants the minimum mass flow of supplemental oxygen required for each person at various cabin pressure altitudes shall not be less than that which will maintain during inspiration the following mean tracheal oxygen partial pressures when using the oxygen equipment provided, including masks:

(i) At cabin pressure altitudes above 10,000 feet to and including 18,500 feet, a mean tracheal oxygen partial pressure of 100 mm. Hg. when breathing 15 liters per minute, BTPS, and having a tidal volume of 700 cc. with a constant time interval between respirations.

(ii) At cabin pressure altitudes above 18,500 feet to and including 40,000 feet, a mean tracheal oxygen partial pressure of 83.8 mm. Hg. when breathing 30 liters per minute, BTPS, and having a tidal volume of 1,100 cc. with a constant time interval between respirations.

(4) Where first-aid oxygen equipment is required, the minimum mass flow of oxygen to each user shall not be less than 4 liters per minute, STPD, except that means may be provided to decrease this flow to not less than 2 liters per minute, STPD, at any cabin altitude. The quantity of oxygen required shall be based upon an average flow rate of 3 liters per minute per person for whom first-aid oxygen is required.

(5) Where portable oxygen equipment is required for crew members, the minimum mass flow of supplemental oxygen shall be as specified in subparagraph (1) or (2) of this paragraph, whichever is applicable.

(c) *Equipment standards for distribution system.* Where oxygen is to be supplied to both crew and passengers, the distribution system shall be designed to provide either:

(1) A source of supply for the flight crew on duty and a separate source for the passengers and other crew members, or

(2) A common source of supply with means provided so that the minimum supply required by the flight crew on duty can be separately reserved.

(d) *Equipment standards for dispensing units.* Where oxygen dispensing units are required, they shall comply with the provisions of subparagraphs (1) through (3) of this paragraph.

(1) An individual dispensing unit shall be provided for each occupant for whom supplemental oxygen is required to be furnished. All units shall be designed to cover the nose and mouth and shall be equipped with a suitable means for retaining the unit in position on the face for use. Flight crew masks for supplemental oxygen shall provide for the use of communication equipment. (For crew masks to be used for protective breathing purposes, see paragraph (h) of this section.)

(2) In airplanes certificated to operate at flight altitudes to and including 25,000 feet, there shall be available to and within reach of each flight crew member an oxygen supply terminal and unit of oxygen dispensing equipment to provide for the immediate use of oxygen by such crew member. For all other occupants the supply terminals and dispensing equipment shall be located so as to permit the use of oxygen as required

by the operating rules of the regulations in this subchapter.

(3) In airplanes certificated to operate above 25,000 feet flight altitude, the provisions of subdivisions (i) through (iv) of this subparagraph shall apply:

(i) An oxygen dispensing unit connected to oxygen supply terminals shall be immediately available to each occupant wherever seated. In addition, in airplanes certificated to operate above 30,000 feet, the dispensing units providing the required oxygen flow rate shall be automatically presented to the occupants. To insure that sufficient dispensing units and outlets are available for all occupants, the total number shall exceed the number of seats by at least 10 percent with the extra units being as uniformly distributed throughout the cabin as practicable;

(ii) Crew members on flight deck duty shall be provided with demand equipment. An oxygen dispensing unit connected to an oxygen supply terminal shall be immediately available to each flight crew member when seated at his station;

(iii) Not less than two outlets and units of dispensing equipment of a type similar to that required by subdivision (i) of this subparagraph shall be located in each washroom; and in each lavatory if separate from the washroom; and

(iv) Portable oxygen equipment shall be immediately available for each cabin attendant.

(e) *Means for determining use of oxygen.* Means shall be provided to enable the crew to determine whether oxygen is being delivered to the dispensing units.

(f) *Fire protection.* (1) Oxygen equipment and lines shall not be located in any designated fire zone.

(2) Oxygen equipment and lines shall be protected from heat which may be generated in or escape from any designated fire zone.

(3) Oxygen equipment and lines shall be so installed that escaping oxygen cannot cause ignition of accumulations of grease, fluids, or vapors which are likely to be present in normal operation or as a result of failure or malfunctioning of any system.

(g) *Protection from rupture.* Oxygen pressure tanks and lines between tanks and the shutoff means shall be protected from the effects of unsafe temperatures, and shall be so located in the airplane as to minimize the possibility and the hazards of rupture in a crash landing.

(h) *Protective breathing system.* When protective breathing equipment is required by the Civil Air Regulations, it shall be designed to protect the flight crew from the effects of smoke, carbon dioxide, and other harmful gases while on flight deck duty and while combating fires in cargo compartments (see § 4b.380 (c)). The protective breathing equipment and the necessary supply of oxygen shall be in accordance with the following provisions.

(1) The protective breathing equipment shall include masks covering the eyes, nose, and mouth, or only the nose and mouth when accessory equipment is provided to protect the eyes. Such equipment while in use shall not prevent the flight crew from using the radio equipment of the airplane or from communicating with each other while at their assigned duty stations. That part of the equipment provided to protect the eyes shall be of a type and construction which will not cause any appreciable adverse effect on vision and shall permit wearing corrective glasses by individual members of the flight crew.

(2) A supply of protective oxygen per crew member shall be of 15-minute duration at a pressure altitude of 8,000 feet and a respiratory minute volume of 30 liters per minute BTPD.

NOTE: When a demand type oxygen system is employed, a supply of 300 liters of free oxygen at 70° F. and 760 mm Hg. pressure is considered to be of 15-minute duration at the prescribed altitude and minute volume. When a continuous flow protective breathing system is used, including a mask with a standard rebreather bag, a flow rate of 60 liters per minute at 8,000 feet (45 liters per minute at sea level) and a supply of 600 liters of free oxygen at 70° F. and 760 mm Hg. pressure is considered to be of 15-minute duration at prescribed altitude and minute volume. (BTPD refers to body temperature conditions, i. e., 37° C., at ambient pressure, dry.)

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b-1, 15 F. R. 8903, Dec. 15, 1950; Amdt. 4b-6, 17 F. R. 1099, Feb. 5, 1952; Amdt. 4b-8, 18 F. R. 2217, Apr. 18, 1953; Amdt. 4b-8, 23 F. R. 2591, Apr. 19, 1958; Amdt. 4b-9, 23 F. R. 6743, Aug. 30, 1958]

§ 4b.651-1 Safety precautions (FAA policies which apply to § 4b.651(a)).

The oxygen system should be so located that leakage or failure in other systems carrying inflammable liquids or gases will not cause the inflammable liquid or gas to come in contact with oxygen lines or equipment. A relief valve or some other means is desirable in low pressure (400 psi) oxygen systems to safely relieve excessive pressures such as might be caused by overcharging. (See also § 4b.481 concerning location of tanks containing flammable fluids.)

[Supp. 11, 15 F.R. 8904, Dec. 15, 1950]

§ 4b.651–2 Protective breathing equipment (FAA policies which apply to § 4b.651(h)).

(a) *Conditions under which protective breathing equipment may be necessary.* These conditions are those outlined in § 4b.484.1, and §§ 40.205–2, 41.24c–2 and 42.29–2 this chapter.

(b) *Oxygen systems for flight deck duty.* The demand type oxygen system, or the diluter-demand type system with the lever of the diluter-demand regulator set at "100% OXYGEN" (Automix "OFF") are recommended for use as protective breathing equipment. However, a continuous flow protective breathing system may also be used. In any case the equipment should meet the requirements of § 4b.651 (h).

(c) *Portable equipment for flight deck duty.* Portable protective breathing units of the demand type may be used to meet the requirement of § 4b.651 in lieu of installing a fixed protective breathing system. Portable continuous flow protective breathing units may also be used, but should not be used during fire fighting in Class A or B cargo compartments since any unused oxygen escaping from around the face mask might aggravate the existing fire.

(d) *Masks and goggles.* (1) Protective breathing masks should fit snugly to prevent the entry of noxious gases. Continuous flow protective breathing masks should have no apertures through which outside air could be drawn into the system and should have a rebreathing bag of at least ⅔ liters capacity. The masks should be installed so as to be readily available to the appropriate crew members. It should be possible for at least the pilot or copilot to maintain ground to air radio voice communications when utilizing the protective breathing masks.

(2) Eye protecting goggles may be a part of or separate from the breathing mask. The goggles should provide an adequate field of vision and a means should be provided to overcome any unsatisfactory fogging tendency of the goggles. Periodic application of an effective anti-fogging agent on the lens is a satisfactory means of overcoming fogging.

(e) *Operating instructions.* Operating instructions appropriate to the type of system and masks installed should be provided for the flight crew on placards and/or in the Airplane Flight Manual.

[Supp. 24, 19 F. R. 4466, July 20, 1954]

§ 4b.651–3 Supplemental breathing equipment (FAA policies which apply to § 4b.651).

(a) *Oxygen systems.* (1) Either a continuous flow type system which uses a rebreather type mask or a diluter-demand type system with the lever of the diluter-demand regulator set in the "NORMAL" (Automix "ON") position will satisfactorily provide the supplemental oxygen required for protection against anoxia. The continuous flow system may be of the type which controls the oxygen flow by means of a hand adjustment type regulator, or an automatic type regulator.

(2) A diluter-demand type system with the lever of the diluter-demand regulator set in the "100% OXYGEN" (Automix "OFF") position or a straight demand type system which uses a non-diluter-demand regulator may be used for supplementary breathing purposes as protection against anoxia. However, such use is not recommended due to the lack of oxygen economy of these systems when used to supply supplementary oxygen. As mentioned in § 4b.651–2, either of these closed demand systems is satisfactory for protection against toxic gases.

(b) *Operating instructions.* Operating instructions appropriate to the type of system and masks installed should be provided for the flight crew and other crew members concerned. These instructions should include a graph or a table which will show the duration of the oxygen supply for the various bottle pressures and pressure altitudes.

[Supp. 21, 17 F. R. 11712, Dec. 24, 1952]

§ 4b.651–4 Design considerations for fixed systems (FAA policies which apply to § 4b.651).

(a) *Location of outlets and equipment for crew members.* Protective breathing equipment should be immediately

available for use. It is also desirable that supplementary breathing equipment be available for immediate use; however, the supplemental masks may be stowed in any location in the airplane provided operation procedures require that supplemental masks are at each crew member location when needed. The oxygen outlet should be within reach; the oxygen mask should be stored in such a way that there will be a minimum delay in removing it and putting it into use. Provisions for keeping the masks sanitary and clean are desirable, but cumbersome wrapping or packaging of the mask which involve unnecessary effort and time to open should be avoided. The location of the oxygen outlet for a crew member and the length of tubing connecting the mask of the crew member and his oxygen outlet should be such that the visibility and the movement required of the crew member in the performance of his duties are not impaired or restricted in any way. It should not be necessary for the crew member to loosen or unfasten his seat belt in order for him to obtain his oxygen equipment and to put the system into use.

(b) *Location of outlets for passengers.* The operating regulations require that oxygen be furnished for certain percentages of the passengers at cabin pressure altitudes below 15,000 feet. The number of oxygen outlets need only be sufficient to administer oxygen to the percentage of passengers indicated by the operating rules; however, it is desirable in fixed systems to provide an outlet for each seat to enable a crew member to readily administer oxygen to any passenger requiring it. If this is not accomplished, it is recommended that provision be made by means of portable equipment, extension tubing, or otherwise to reduce the probability of having to move any passenger who may require the administration of oxygen. At cabin pressure altitudes above 15,000 feet the operating regulations require that oxygen be furnished to all of the passengers, in which case an outlet should be provided for each seat. (See also § 4b.651–5 concerning portable walk-around units.)

(c) *Line supports.* In a fixed installation, the oxygen lines should be supported to prevent excessive vibration and should be kept clear of the airplane structure or any other lines as a protection against chafing. Supports approximately every 24 inches along the length of the line should be adequate.

(d) *Shut-off valves.* System shut-off valves should be accessible in flight and should be installed as close as practicable to the cylinders in order to minimize the possibility of oxygen escape due to leakage or damage of lines between cylinders and valves.

(e) *Cylinder supports.* The supporting brackets for all cylinders should be capable of withstanding the inertia forces stipulated under the emergency landing conditions. (See § 4b.260.)

[Supp. 21, 17 F. R. 11713, Dec. 24, 1952]

§ 4b.651–5 Portable walk-around oxygen units (FAA policies which apply to § 4b.651).

(a) Portable walk-around oxygen units of the continuous flow, diluter-demand and straight demand types may be used to satisfy part or all of crew or passenger breathing requirements.

(b) Each portable oxygen unit should be considered as a complete oxygen system and any regulations or pertinent interpretative material relative to oxygen systems should also be applicable to each portable unit.

(c) The supporting brackets for portable oxygen units should be capable of withstanding the inertia forces stipulated under the emergency landing conditions. (See § 4b.260.)

[Supp. 21, 17 F. R. 11713, Dec. 24, 1952]

§ 4b.651–6 Oxygen pressure gage (FAA policies which apply to § 4b.651(a)).

At least one pressure gage, which can be observed by a flight crew member during flight, should be installed to indicate the pressure in each source of oxygen supply.

[Supp. 21, 17 F. R. 11713, Dec. 24, 1952]

§ 4b.651–7 Supply required for continuous flow supplementary breathing systems (FAA policies which apply to § 4b.651(b)).

(a) (1) In computing the supply of oxygen required for a continuous flow system, the formula presented in the following paragraph may be used.

$$S = S_1 + S_2 + - - S_n$$

where:

S=Total supply of oxygen required in cubic feet. $S_1, S_2, - - S_n$ = the supply of O_2 needed for each of the various cabin pressure altitudes which will be maintained during the flight.

(2) Each of the above supplies, namely S_1, S_2, $--S_n$, may be computed as follows:

$S = N \times F \times T \times 2.12$

S = supply of oxygen required in cubic feet (STPD). (To obtain supply in terms of cubic feet at 70° F. multiply cubic feet (STPD) by 1.08.)

N = number of oxygen users.

F = the actual flow in LPM (STPD) delivered to each oxygen mask at the cabin altitude under consideration. (See § 4b.651–7 (b).)

T = time in hours at the cabin altitude under consideration.

2.12 = multiplying factor for converting the oxygen mass flow from liters per minute to cubic feet per hour.

NOTE: In computing the supply of oxygen for a given installation, those operating rules of the Civil Air Regulations which specify the amount of oxygen to be carried for operating at various altitudes should be considered.

(b) (1) The intent of § 4b.651 (b) is to insure that for each oxygen user, a partial pressure of 149 mm H_g of oxygen is maintained in the inspired air at a breathing rate of 15 lpm BTPD, at altitudes up to 25,000 feet. The rates of flow specified in Figure 4b–21 satisfy the intent of § 4b.651 (b) and constitute the values for "F" in the supply equation when there is no loss of bottle oxygen from the system (including the mask) when a 15 lpm BTPD breathing rate is maintained.

(2) The oxygen mask, since it constitutes part of the system, will influence the value of "F". Continuous flow masks with rebreather bags which are currently standard types for aviation usage are satisfactory with the flow rates indicated by Fig. 4b–21. Where a receptacle or mask design differs from these, the manufacturer should be requested to supply information concerning the flow rate necessary to maintain the 149 mm H_g partial pressure at a 15 lpm BTPD breathing rate. If the actual mass flow is greater than the minimum required, then the higher flow rate should be used as the value for "F".

(3) It is possible that certain automatic continuous flow regulators will furnish oxygen flows in excess of the minimum required; in this case, the actual flow rates should be used as the values for "F".

NOTE: (1) BTPD signifies gas at 37° C. (body temperature), ambient pressure, dry.

(2) STPD signifies gas at 0° C., 760 mm Hg., dry.

[Supp. 24, 19 F. R. 4467, July 20, 1954]

§ 4b.651–8 Supply required for diluter-demand system (FAA policies which apply to § 4b.651).

(a) Tests conducted by the Armed Forces on currently available diluter-demand regulators indicate that some types deliver more oxygen than is required by Fig. 4b–21. Consequently, in computing the supply required for a diluter-demand system, the flow characteristics at various altitudes should be obtained from the manufacturer of the regulator. Where this information is not available, the values listed in the following table may be used for Air Force-Navy approved diluter-demand regulators:

Altitude in feet:	*Flow per person in LPM (STPD)*[1]
8,000	1.90
10,000	1.90
15,000	2.10
20,000	2.50
25,000	4.10

[1] These values are based on tests on a large group of men using the equipment at the altitude specified. The values listed are those calculated to completely protect 95 percent of the population.

(b) The formula outlined in § 4b.651–7 (a) may be used in computing the supply of oxygen for supplementary breathing purposes.

[Supp. 24, 19 F. R. 4467, July 20, 1954]

§ 4b.651–9 Requirements for approval of oxygen systems. (FAA policies which apply to § 4b.651(b).

Prior to the approval of an oxygen system, the system should be examined to determine that the flow of oxygen through each outlet is at least equal to the minimum required by § 4b.651(b) at all altitudes for which the aircraft is certificated. This can be accomplished by one of the following methods or by any other satisfactory procedure:

(a) (1) In a continuous flow system when the calibration (inlet pressure vs. flow) of the orifices used at the plug-in outlets is known, the pressure in the low pressure distribution line can be measured at the point which is subject to the greatest pressure drop. This should be done with oxygen flowing from all outlets. The pressure thus measured should indicate a flow equal to or greater than the minimum flow required.

(2) In lieu of the above procedure, the flow of oxygen through the outlet which is subject to the greatest pressure drop may be measured. This should be accomplished with all other outlets open. Gas meters, rotometers, or other suitable means may be used to measure flows.

(3) The measurement of oxygen flows in a continuous flow system which uses a manually adjusted regulator can be accomplished at sea level. However, in a continuous flow system which uses an automatic type regulator, it may be necessary to check the flows at the maximum altitude which will be encountered during the normal operation of the aircraft. The manufacturer of the particular continuous flow regulator being used should be able to furnish data on the operating characteristics of the regulator from which it can be determined whether flight tests are necessary.

(b) (1) The checking of the amount of oxygen flow through the various outlets in a diluter-demand or straight demand system is not necessary since the flow characteristics of the particular regulator being used may be obtained from the manufacturer of the regulator. However, in such systems the availability of oxygen to each regulator should be checked as follows:

(i) Turn the lever of the diluter-demand regulator to the "100% OXYGEN" position and inhale through the tube via the mask to determine whether the regulator valve and the flow indicator are operating. Deficient units should be replaced.

[Supp. 21, 17 F. R. 11713, Dec. 24, 1952]

§ 4b.651–10 Means for determining oxygen flow to crew members (FAA policies which apply to § 4b.651(e)).

(a) *Supplementary breathing systems.* (1) Where continuous flow or diluter-demand systems are used for supplementary breathing purposes, each crew member should have an individual flow indicator for determining oxygen flow or the operator may establish a suitable procedure for determining oxygen flow and should include such procedures in the Airplane Flight Manual.

(2) If flow indicators are used, the indicator for any particular crew member should be located so as to be easily observed by him while he is at his crew station. Acceptable flow indicators are listed in § 4b.651–12.

(3) If a suitable procedure is to be used for determining oxygen flow in non-pressurized cabin aircraft, the procedure should include initial and periodic checking of the oxygen flow by each crew member by any acceptable method. Some of the acceptable methods are described under § 4b.651–11 (a) and (b). In pressurized cabin aircraft when supplementary oxygen is required immediately following cabin pressurization failure, positive means for determining flow under emergency conditions should be established which would not involve delay or activities which would interfere with a flight crew member's performance of his primary duties. Since utilizing one of the methods for determining oxygen flow permitted for supplementary breathing equipment described under § 4b.651–11 (a) and (b) involves some time delay a flight crew member could don his protective breathing equipment following a pressurization failure because with such equipment oxygen flow is immediately apparent. As soon as some degree of control of the emergency has been established and sufficient time is available to determine oxygen flow by one of the methods mentioned above, he could change over to his supplementary breathing equipment.

(b) *Protective breathing systems.* No flow indicators are required in protective breathing systems since with these systems the lack of oxygen flow would be immediately evidenced by the oxygen user's inability to inhale while wearing mask.

[Supp. 24, 19 F. R. 4467, July 20, 1954]

§ 4b.651–11 Means for determining oxygen flow to passengers (FAA policies which apply to § 4b.651(e)).

Each passenger may be supplied with an individual flow indicator of a type specified in § 4b.641–12 or the operator involved may establish a suitable procedure for checking the oxygen flow to each oxygen user. Procedures which utilize the following means for checking oxygen flow to such user will be satisfactory.

(a) In the case where a continuous flow system is used the means may be the observing of the rebreather bag on each continuous flow mask by a trained crew member. If oxygen flow is occurring the rebreather bag will continue to expand when the oxygen user periodically refrains from exhaling when the bag is empty or partially empty, or in cases where high oxygen flows are occurring, the rebreather bag may not empty completely during normal inhalation. Any alternate method of checking oxygen flow may be used providing positive indication of flow is given. For example, prior to giving a mask to a passenger, the crew member may find it expedient to feel the flow of oxygen at the oxygen outlet in the mask or to constrict the tubing and listen to audible sounds characteristic of gas flow. If a listening test is employed to determine the flow of oxygen, it should be demonstrated in flight that the test is satisfactory.

(b) In the case where a diluter-demand system is used, the procedure may be checking of the oxygen flow by a trained crew member by momentarily moving the regulator lever to "AUTO-MIX OFF" (100% OXYGEN) while the mask is being worn. Lack of oxygen flow will be immediately evidenced by the user's inability to inhale while wearing his mask.

(c) The oxygen flow to each passenger should be checked when the passenger is first given oxygen and at subsequent intervals if the circumstances prevailing at the time indicate such a check is desirable.

(d) Any crew member assigned by an air carrier for the performance of duty on the aircraft during flight may check the oxygen flow to the passengers if trained to do so.

[Supp. 21, 17 F. R. 11714, Dec. 24, 1952]

§ 4b.651–12 Types of flow indicators (FAA policies which apply to § 4b.651(e)).

A pith ball flow indicator, vane, or wheel anemometer, lateral pressure indicator which fluctuates with changes in flow or any other satisfactory flow indicator may be used in a continuous flow type system. An Air Force-Navy flow indicator or equivalent may be used in a diluter-demand type system. Each flow indicator should give positive indication when oxygen flow is occurring.

[Supp. 21, 17 F. R. 11714, Dec. 24, 1952]

§ 4b.653 Hydraulic systems; strength.

(a) *Structural loads.* All elements of the hydraulic system shall be designed to withstand, without detrimental permanent deformation, all structural loads which may be imposed simultaneously with the maximum hydraulic loads occurring in operation.

(b) *Proof pressure tests.* All elements of the hydraulic system shall be tested to a proof pressure of 1.5 times the maximum pressure to which the part will be subjected in normal operation. In such test no part of the hydraulic system shall fail, malfunction, or suffer detrimental deformation.

(c) *Burst pressure strength.* Individual hydraulic system elements shall be designed to withstand pressures which are sufficiently increased over the pressures prescribed in paragraph (b) of this section to safeguard against rupture under service conditions.

NOTE: The following pressures, in terms of percentage of maximum operating pressure for the particular element, in most instances are sufficient to insure against rupture in service: 250 percent in units under oil pressure, 400 percent in units containing air and oil under pressure and in lines, hoses, and fittings, 300 percent in units of system subjected to back pressure.

[Amdt. 4b–6, 17 F. R. 1099, Feb. 5, 1952]

§ 4b.654 Hydraulic systems; design.

(a) *Pressure indication.* A means shall be provided to indicate the pressure in each main hydraulic power system.

(b) *Pressure limiting provisions.* Provision shall be made to assure that pressures in any part of the system will not exceed a safe limit above the maximum operating pressure of the system and to insure against excessive pressures resulting from fluid volumetric changes in all lines which are likely to remain closed long enough for such changes to take place. In addition, consideration shall be given to the possible occurrence of detrimental transient (surge) pressures during operation.

(c) *Installation.* Hydraulic lines, fittings, and components shall be installed and supported to prevent excessive vibration and to withstand inertia loads. All elements of the installation shall be protected from abrasion, corrosion, and mechanical damage.

(d) *Connections.* Flexible hose, or other means of providing flexibility, shall be used to connect points in a hydraulic fluid line between which there is relative motion or differential vibration.

[Amdt. 4b–6, 17 F. R. 1099, Feb. 5, 1952]

§ 4b.655 Hydraulic system fire protection.

When flammable type hydraulic fluid is used, the hydraulic system shall comply with the provisions of §§ 4b.385, 4b.481, 4b.482, and 4b.483.

[Amdt. 4b–6, 17 F. R. 1099, Feb. 5, 1952]

§ 4b.658 Vacuum systems.

(a) Means, in addition to the normal pressure relief, shall be provided to relieve automatically the pressure in the discharge lines from the vacuum pump, if the delivery temperature of the air reaches an unsafe value.

(b) Vacuum system lines and fittings on the discharge side of the pump which might contain flammable vapors or fluids shall comply with § 4b.483 if they are located in a designated fire zone. Other vacuum system components located in designated fire zones shall be fire-resistant.

[Amdt. 4b–6, 17 F. R. 1099, Feb. 5, 1952]

§ 4b.660 Draining of fluids subject to freezing.

When liquids subject to freezing are drained overboard either in flight or during ground operation, drains shall be located and designed to prevent the formation of ice on the airplane as a result of such drainage.

[Amdt. 4b–11, 24 F.R. 7071, Sept. 1, 1959]

Subpart G—Operating Limitations and Information

GENERAL

§ 4b.700 Scope.

(a) The operating limitations listed in §§ 4b.710 through 4b.723 shall be established as prescribed in this part.

(b) The operating limitations, together with any other information concerning the airplane found necessary for safety during operation, shall be included in the Airplane Flight Manual (§ 4b.740), shall be expressed as markings and placards (§ 4b.730), and shall be made available by such other means as will convey the information to the crew members.

§ 4b.700–1 Automatic propeller feathering operating limitations and information (FAA policies which apply to § 4b.700).

(a) All limitations on the use of automatic feathering system, including flight conditions when the system must be operative or inoperative should be determined and noted when appropriate.

(b) Any placards found necessary should be provided in the airplane.

(c) A complete statement of operating limitations and instructions for the use of the system should be included in the Airplane Flight Manual.

(d) If certification is desired both with and without the feathering system operative, two corresponding sets of performance data properly identified should be included in the Airplane Flight Manual. (See also § 4b.10–2.)

[Supp. 23, 19 F. R. 1818, Apr. 2, 1954]

OPERATING LIMITATIONS

§ 4b.710 Air-speed limitations; general.

When air-speed limitations are a function of weight, weight distribution, altitude, or Mach number, the values corresponding with all critical combinations of these values shall be established.

§ 4b.711 Maximum operating limit speed V_{MO}/M_{MO}.

The maximum operating limit speed is a speed which shall not be deliberately exceeded in any regime of flight (climb, cruise, or descent), except where a higher speed is authorized for flight test or pilot training operations. This operating limitation, denoted by the symbols V_{MO}/M_{MO} (airspeed or Mach number, whichever is critical at a particular altitude), shall be established to be not greater than the design cruising speed V_C and sufficiently below V_D/M_D or V_{DF}/M_{DF} to make it highly improbable that the latter speeds will be inadvertently exceeded in operations. The speed margin between V_{MO}/M_{MO} and V_D/M_D or V_{DF}/M_{DF} shall be determined in accordance with either paragraph (a) or (b) of this section, but shall not be less than the margin found necessary in flight tests in accordance with § 4b.191. (Also see § 4b.603(k) concerning speed warning means.)

(a) The minimum margin shall be the greater of the values determined in accordance with subparagraphs (1) and (2) of this paragraph.

(1) From an initial condition of stabilized flight at V_{MO}/M_{MO}, the airplane shall be assumed to be upset, flown for 20 seconds along a flight path 7.5 degrees below the initial path and pulled up at a load factor of 1.5 (.5g acceleration increment). It shall be acceptable to calculate the speed increase occurring in this maneuver, provided reliable or conservative aerodynamic data are used. Power, as specified in § 4b.155(a), shall be assumed until the pullup is initiated,

at which time power reduction and the use of pilot controlled drag devices may be assumed.

(2) The margin shall be sufficient to provide for atmospheric variations, such as horizontal gusts, penetration of jet stream or cold front, and for instrument errors and airframe production variations. It shall be acceptable to consider these factors on a probability basis, but the margin at altitudes where M_{MO} is limited by compressibility effects shall not be less than 0.05M.

(b) V_{MO}/M_{MO} shall not be greater than 0.8 V_D/M_D or 0.8 V_{DF}/M_{DF}.

[Amdt. 4b–12, 27 F.R. 2994, Mar. 30, 1962]

§ 4b.713 Maneuvering speed.

The maneuvering speed shall not exceed the design maneuvering speed V_A determined in accordance with § 4b.210 (b)(2).

§ 4b.714 Flap extended speeds, V_{FE}.

Flap extended speeds, V_{FE}, shall be established not to exceed the design flap speeds, V_F, chosen in accordance with §§ 4b.210(b)(1) and 4b.212 for the corresponding flap positions and engine powers.

[Amdt. 4b–12, 27 F.R. 2994, Mar. 30, 1962]

§ 4b.715 Landing gear operating speed V_{LO}.

The landing gear operating speed V_{LO} shall be established not to exceed a speed at which it is safe to extend or retract the landing gear as limited by design in accordance with § 4b.334 or by flight characteristics.

§ 4b.716 Landing gear extended speed V_{LE}.

The landing gear extended speed V_{LE} shall be established not to exceed a speed at which it has been shown that the airplane can be safely flown with the landing gear secured in the fully extended position, and for which the structure has been proven in accordance with § 4b.334.

§ 4b.717 Minimum control speed V_{MC}.

(See § 4b.133.)

§ 4b.718 Powerplant limitations.

The following powerplant limitations shall be established for the airplane as applicable for the type(s) of engine(s) installed. They shall not exceed the corresponding limits established as part of the type certification of the engine and propeller installed in the airplane.

(a) *Take-off operation.* (1) Maximum rotational speed (r. p. m.);

(2) Maximum permissible manifold pressure;

(3) Maximum permissible gas temperature for turbine engines;

(4) The time limit for use of the power which corresponds with the values established in subparagraphs (1) through (3) of this paragraph;

(5) When the time limit established in subparagraph (4) of this paragraph exceeds 2 minutes, the maximum allowable cylinder head and oil temperatures; and

(6) Maximum cylinder head and oil temperatures if these differ from the maximum limits for continuous operation.

(b) *Maximum continuous operation.* (1) Maximum rotational speed (r. p. m.);

(2) Maximum permissible manifold pressure; and

(3) Maximum permissible cylinder head, oil, and gas temperatures.

(c) *Fuel grade or specification designation.* The minimum fuel grade for reciprocating engines or the fuel designation for turbine engines, required for the operation of the engine within the limitations prescribed in paragraphs (a) and (b) of this section.

(d) *Maximum ambient atmospheric temperature.* The maximum ambient atmospheric temperature at which compliance with the cooling provisions of §§ 4b.450 through 4b.452 is established.

[Amdt. 4b–8, 23 F.R. 2591, Apr. 19, 1958, as amended by Amdt. 4b–12, 27 F.R. 2994, Mar. 30, 1962]

§ 4b.718–1 Powerplant limitations governing minimum quantity of anti-detonant fluid required for takeoff. (FAA policies which apply to § 4b.718).

The Airplane Flight Manual should include a limitation indicating that the minimum quantity of anti-detonant fluid required is that determined from § 4b.420–1 (a) or (b). If the performance characteristics of the airplane are such that wet power is required for take-off but may or may not be required for landing, depending upon airport location or characteristics, the Airplane Flight Manual may include information covering minimum allowable quantities under both conditions.

[Supp. 25, 20 F. R. 2281, Apr. 8, 1955]

§ 4b.719 Airplane weight, center of gravity, and weight distribution limitations.

The airplane weight, center of gravity, and weight distribution limitations shall be those prescribed in §§ 4b.101, 4b.102 and 4b.103. Where the airplane is certificated for more than one center of gravity range, the appropriate limitations with regard to weight and loading procedures shall be set forth in the Airplane Flight Manual for each separate center of gravity range.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–8, 18 F. R. 2217, Apr. 18, 1953; 18 F. R. 2397, Apr. 24, 1953]

§ 4b.720 Minimum flight crew.

The minimum flight crew shall be established by the Administrator as that number of persons which he finds necessary for safety in the operations authorized under § 4b.721. This finding shall be based upon the work load imposed upon individual crew members with due consideration given to the accessibility and the ease of operation of all necessary controls by the appropriate crew members.

§ 4b.721 Types of operation.

The types of operation to which the airplane is limited shall be established by the category in which it has been found eligible for certification and by the equipment installed. (See the operating rules in this subchapter.)

§ 4b.722 Maximum operating altitude.

A maximum altitude shall be established up to which operation is permitted, as limited by flight, structural, powerplant, functional, or equipment characteristics.

§ 4b.723 Maneuvering flight load factors.

Load factor limitations shall be established not to exceed the positive limit load factors determined from the maneuvering diagram, figure 4b–2. (See § 4b.211(a).)

MARKINGS AND PLACARDS

§ 4b.730 General.

(a) Markings and placards shall be displayed in conspicuous places and shall be such that they cannot be easily erased, disfigured, or obscured.

(b) Additional information, placards, and instrument markings having a direct and important bearing on safe operation of the airplane shall be required when unusual design, operating, or handling characteristics so warrant.

§ 4b.730–1 Reverse thrust placards (FAA policies which apply to § 4b.730).

The policies outlined in § 4b.402–1(b) will apply.

[Supp. 25, 20 F.R. 2281, Apr. 8, 1955]

§ 4b.731 Instrument markings; general.

(a) When markings are placed on the cover glass of the instrument, provision shall be made to maintain the correct alignment of the glass cover with the face of the dial.

(b) All arcs and lines shall be of sufficient width and so located that they are clearly visible to the pilot.

§ 4b.732 Air-speed limitation information.

The air-speed limitations (see § 4b.741 (a)) shall be presented in such a manner that they can be easily read and interpreted by the flight crew.

[Amdt. 4b–8, 23 F. R. 2591, Apr. 19, 1958]

§ 4b.733 Magnetic direction indicator.

A placard shall be installed on or in close proximity to the magnetic direction indicator which shall comply with the following.

(a) The placard shall contain the calibration of the instrument in a level flight attitude with engine(s) operating.

(b) The placard shall state whether the calibration was made with radio receiver(s) on or off.

(c) The calibration readings shall be in terms of magnetic headings in not greater than 45° increments.

§ 4b.734 Powerplant instruments; general.

All required powerplant instruments shall be marked as follows:

(a) The maximum and the minimum (if applicable) safe operational limits shall be marked with red radial lines.

(b) The normal operating ranges shall be marked with a green arc not extending beyond the maximum and minimum safe operational limits.

(c) The take-off and precautionary ranges shall be marked with a yellow arc.

(d) Engine or propeller speed ranges which are restricted because of excessive vibration stresses shall be marked with red arcs.

[Amdt. 4b–6, 17 F. R. 1099, Feb. 5, 1952]

§ 4b.735 **Oil quantity indicators.**

Oil quantity indicators shall be marked in sufficient increments to indicate readily and accurately the quantity of oil.

§ 4b.736 **Fuel quantity indicator.**

When the unusable fuel supply for any tank exceeds 1 gallon or 5 percent of the tank capacity, whichever is the greater, a red arc shall be marked on the indicator extending from the calibrated zero reading to the lowest reading obtainable in the level flight attitude. A notation in the Airplane Flight Manual shall be made to indicate that the fuel remaining in the tank when the quantity indicator reaches zero is not usable in flight. (See § 4b.613 (b).)

§ 4b.737 **Control markings; general.**

All cockpit controls, with the exception of the primary flight controls and other controls the function of which is obvious, shall be plainly marked and/or identified as to their function and method of operation. The markings shall include the following.

(a) *Aerodynamic controls.* The secondary aerodynamic controls shall be marked to comply with §§ 4b.322 and 4b.323.

(b) *Powerplant fuel controls.* (1) Controls for fuel tank selector valves shall be marked to indicate the position corresponding with each tank and with all possible cross-feed positions.

(2) When more than one fuel tank is provided, and if safe operation depends upon the use of tanks in a specific sequence, the fuel tank selector controls shall be marked adjacent to or on the control itself to indicate the order in which the tanks should be used.

(3) Controls for engine selector valves shall be marked to indicate the position corresponding with each engine.

(c) *Accessory and auxiliary controls.* (1) When a retractable landing gear is used, the visual indicator required in § 4b.334 (e) shall be marked so that the pilot can ascertain at all times when the wheels are locked in either extreme position.

(2) Emergency controls, including fuel jettisoning and fluid shutoff controls, shall be colored red and shall be marked to indicate their function and method of operation.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 17 F. R. 1100, Feb. 5, 1952]

§ 4b.738 **Miscellaneous markings and placards.**

(a) *Baggage compartments and ballast location.* Each baggage and cargo compartment as well as the ballast location shall bear a placard stating the maximum allowable weight of contents and, if applicable, any other limitation on contents found necessary due to loading requirements.

(b) *Fuel and oil filler openings.* The following information shall be marked on or adjacent to the appropriate filler cover:

(1) The word "fuel", the minimum permissible fuel grade or designation for the engines installed, and the usable fuel tank capacity (see § 4b.416).

(2) The word "oil" and the oil tank capacity.

(c) *Emergency exit placards.* (See § 4b.362 (f).)

(d) *Safety equipment.* (1) Safety equipment controls which the crew is expected to operate in time of emergency, such as flares, automatic life raft releases, etc., shall be readily accessible and plainly marked as to their method of operation.

(2) When fire extinguishers and signaling and other lifesaving equipment are carried in lockers, compartments, etc., these locations shall be marked accordingly.

(e) *Air-speed placard.* A placard shall be installed in clear view of each pilot giving the maximum air speeds for flap extension to the takeoff, approach, and landing positions.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–6, 17 F. R. 1100, Feb. 5, 1952; Amdt. 4b–3, 21 F.R. 994, Feb. 11, 1956; Amdt. 4b–11, 24 F.R. 7071, Sept. 1, 1959; Amdt. 4b–12, 27 F.R. 2994, Mar. 30, 1962]

AIRPLANE FLIGHT MANUAL

§ 4b.740 **General.**

(a) An Airplane Flight Manual shall be prepared by the applicant for the type certificate and shall be furnished with each airplane except with those airplanes which specifically are not required by the operating parts of the Civil Air Regulations to carry such manual.

(b) The portions of the manual listed in §§ 4b.741 through 4b.743 as are appropriate to the airplane shall be verified and approved and shall be segregated, identified, and clearly distinguished from portions not so approved.

(c) Additional items of information having a direct and important bearing on safe operation shall be required when unusual design, operating, or handling characteristics so warrant.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–2, 20 F. R. 5309, July 26, 1955]

§ 4b.740–1 **Preparation of airplane flight manuals for aircraft certificated in the transport category (FAA policies which apply to § 4b.740).**

The primary purpose of the manual is to provide for the crew who will operate the airplane any information concerning the airplane considered by the Federal Aviation Agency essential to or likely to promote safety during such operation. This will ordinarily require a certain amount of descriptive material concerning those parts of the airplane directly operated or otherwise used by the crew, an understanding by them of the nature, location, and functioning of which is therefore essential. The manual should also contain, in order to serve this purpose, a description and chronological outline of the procedure to be followed by the crew during various phases of the operation both "normal" and "emergency" in which special attention and emphasis should be given to any precaution which should be observed therein in the interest of safety.

Another important purpose of the manual is to implement the operating requirements of Parts 40, 41, and 42 of this subchapter; i. e., to furnish a source for all the airplane information necessary to establish the limitations specified by those requirements as well as that necessary to enable the crew readily to operate the airplane within the limitations so established. This purpose requires the inclusion in the manual of all operating limitations peculiar to the airplane under any circumstances likely to be encountered during its life as well as information concerning each of the items of performance involved by Parts 40, 41, and 42 of this subchapter as functions of weight, altitude, outside air temperature, wind velocity, flap setting, etc., throughout the range of these variables for which it is desired by the applicant to provide; the point being that the scheduled operation of the airplane by an air carrier will be limited to values of all such variables within the range(s) covered by information available in the manual. This situation requires that the applicant consider the extent to which he wishes to limit the usefulness of the airplane subsequent to its certification as a type.

It may be noted, concerning the material to be included in the manual, that two types are involved. The first of these is the operating limitations which are, in effect, a partial statement of the terms upon which the airworthiness certificate is issued. Compliance with these operating limitations is therefore required by law (see section 610 (a) of the Civil Aeronautics Act of 1938 and § 4b.738 (d). The second type of material is the performance information, recommended operating procedures, and loading instructions, the observance or use of which is not legally required of the operator of the airplane by this part, but may be required by Parts 40, 41, and 42 of this subchapter. This second type of material is intended to convey information believed likely to promote or contribute to safety in operation.

The following outlines an acceptable arrangement of the Airplane Flight Manual. This policy does not affect the status of manuals which already have final approval. However, whenever such manuals are revised for other reasons, it is recommended that the terminology of this policy be incorporated wherever it will increase clarity and uniformity. It should be noted that not all the items outlined below for inclusion in the document for a given airplane, and the Federal Aviation Agency is desirous of holding the document to the smallest practicable amount of material as it is believed that the usefulness of the manual will bear some inverse relation to its physical bulk and to the extent of its complexity. It is, therefore, strongly recommended that great care be taken to prepare it in the simplest, most compact form consistent with the completeness and clarity of presentation of the necessary information. Also it is suggested that consideration be given to the likelihood of revisions and the manner in and ease with which this may be accomplished. Only the material (listed below) required by this part should be included in the Federal Aviation Agency approved portion of the manual. However, if desired, the manufacturer or operator may add other data in a distinctly separate section in the same cover. The portion of the material (outlined below) that is to be approved by the Federal Aviation Agency must be so marked, and clearly separated from any other material so that no one could easily err in regard to the part that is approved. The aircraft specification for the type will list the manual as an item of required equipment and the manual must be made available upon request to any FAA agent issuing an original airworthiness certificate under the type certificate in order that he may verify that the manual furnished with that individual airplane conforms with the approval manual. Since the manual is necessary for safe operation of the airplane, the manual is considered to be public information.

There is no objection to air carrier operators incorporating the subject manual in their own Operations Manual which is assigned to individual crew members in lieu of carrying two separate manuals provided the manual which is furnished by the air carrier includes a separate and properly identified chapter which contains the manufacturer's issue of the FAA Approved Airplane Flight Manual or a satisfactory reproduction identical in both form and contents. The Airplane Flight Manual or its equivalent may, in lieu of individual identification by serial or N numbers, contain a list of the airplane to which the manual is applicable. Such manuals may be installed in the aircraft or be issued to members of the flight crew. Regardless of the procedure in effect, it is the air carrier operator's responsibility to establish a satisfactory system whereby an up-to-date copy of the appropriate manual for the particular airplane is readily available to the flight crew during the operation of the airplane. Inasmuch as the subject manual constitutes a required item of equipment, it is the responsibility of the assigned Air Carrier Maintenance Agent to ascertain that an appropriate and up-to-date copy, or its equivalent, is available to the crew at all times during flight.

The page size for the Airplane Flight Manual will be left to the decision of the manufacturer, although it is believed that an 8" x 10½" size will probably be found most convenient and this size is recommended. A cover should be provided and it should indicate the nature of the contents with the following title: "Airplane Flight Manual." Each page of the approved portion should bear the notation "FAA Approved" and the date of issuance. The material should be bound in a semi-permanent fashion so that the pages will not be lost easily, yet should be so bound that revised pages can be inserted. The aircraft specification will identify the manual, and when different types of the airplane are covered in separate manuals, each will be listed. Also, the latest approved revisions will be shown on the aircraft specification when these changes are considered to be of major importance to airworthiness.

The Airplane Flight Manual should contain as much of the following as is applicable to the individual model. It is suggested that the document be divided into sections as indicated in paragraphs (a)-(g) of this section. The sequence of sections and of items within sections should follow this outline insofar as practicable. This will facilitate revising the document when an airplane is altered in the field. It is recommended that revisions to the manual resulting from major alterations to the airplane be in the form of supplements to the original manual with individual log of revision pages.

(a) *Introduction*—(1) *Title page.* This page should include the manufacturer's name, airplane model, registration or serial number, date of approval and space for the signature of the Chief, Aircraft Division. In addition the following note should be included: "This airplane must be operated in compliance with the Operating Limitations herein."

(2) *Table of contents.*

(3) *Log of revisions.* This page should be in the form of a table in which to record for each revision an identifying symbol, a date, and the page numbers involved. All revised pages should show a revision date and a vertical bar should be placed along the left hand margin to indicate the latest revised portion of each page.

(b) *Operating limitations.* The purpose of this section is merely to state the limitations without any unnecessary explanation of what they are. The manual should point out that observance of these limitations is required by law.

(1) *Weight limits.* Indicate the range of maximum take-off and landing weight approved by means of a table or suitable diagram showing these weights at various altitudes throughout the range for which performance information is contained in the manual. State that airplane weight in excess of maximum landing weight must be disposable fuel. State any other limitations on weight. In addition to the maximum weights and any relative

information, a statement to the effect that the airplane must be loaded in accordance with the approved loading schedule should be included. (See paragraph (e) of this section.) The following is a typical example:

(i) Maximum take-off weight at sea level is 92,000 pounds.

(ii) Maximum landing weight at sea level is 73,000 pounds.

NOTE: This airplane is to be operated in accordance with the approved loading schedule. (See paragraph (e) of this section.) For maximum permissible weights at various altitudes, see paragraph (d), *Performance information*, of this section. In scheduled or irregular passenger operations, operating weights are limited in accordance with Parts 41, 42, or 61 of this subchapter.

(iii) All weight in excess of the maximum permissible landing weight must consist of disposable fuel.

(iv) All weight in excess of 68,000 pounds must consist of fuel for structural reasons.

(v) All fuel weight must be distributed equally on both sides of the airplane. All main tanks must be filled (equally) first, alternate second, and then auxiliaries. Fuel must be used in reverse order from fuel loading except for take-off, climb and landing—at which time the main tanks should be used.

(2) *Center of gravity limits.* State all authorized C. G. limits and refer to paragraph (e) of this section for weight and balance data. All C. G. limits should be given in inches from the datum, which should be identified and in percent of the mean aerodynamic chord, with the landing gear extended in all cases.

(3) *Power plant.* State all power plant limitations; i. e., manifold pressure, r. p. m., maximum time for use of take-off power, cylinder head and barrel and oil temperatures, minimum fuel octane number, etc. Give any limitation on r. p. m. due to vibration, tip speed, etc.; also propeller pitch, cowl flap position limitations, etc. The items should be listed as follows:

(i) *Engine.*

(*a*) Manufacturer.

(*b*) Model.

(*c*) Propeller drive gear ratio.

(*d*) Fuel, minimum octane.

(*e*) Temperatures—Maximum permissible cylinder head and oil inlet.

(*f*) Power limits—Those given by the engine specification; i. e., excluding the effect of ram on critical altitude.

(*g*) Any limitations, such as rpm ranges in which operation is prohibited due to engine or propeller vibration.

(ii) *Propellers.*

(*a*) Manufacturer.

(*b*) Model designation.

(iii) *Instrument markings.* An explanation of the instrument markings should be included. A typical example follows:

(*a*) General: Red radial line—Maximum and minimum limits. Yellow arc—Take-off and precautionary ranges. Green arc—Normal operating ranges. Red arc—Ranges in which operation is prohibited.

(*b*) Fuel quantity indicator (when applicable—Reference § 4b.736). Red arc—Fuel which cannot be used safely in flight.

(4) *Speed limitations.* The speeds and explanations of their significance given in subdivisions (i) through (vi) of this subparagraph should be included. Section 4b.710 does specify whether airspeed limitations should be expressed in terms of calibrated or indicated airspeed. However, to agree with past practice it is suggested that the airspeed values be expressed in terms of calibrated airspeed. The indicated airspeed values may also be included, but should be properly identified, e. g. by parentheses.

(i) *Maximum operating limit speed,* V_{MO}/M_{MO}. In accordance with § 4b.741 (a)(1), the manual should include a statement that the maximum operating limit speed shall not be deliberately exceeded in any regime of flight (climb, cruise, or descent), except where a higher speed is authorized for flight test or pilot training operations.

(ii) [Reserved]

(iii) *Maneuvering speed.* V_A, plus a statement of its significance, of which the following is an example: "Maximum use" of the primary flight controls should be confined to speeds below this value. For this purpose, "maximum use" is defined as the lesser of the following: Rudder—full throw, or ______ pounds force. Elevator—full throw, or ______ pounds force. Aileron—full throw, or ______ pounds force with each hand.

(iv) *Flaps extended speed.* V_{FE} at least the speed determined in accordance with § 4b.714 must be given. However, when desired, speeds for various combinations of flap settings and power conditions may be given, the following is an example:

Flap setting	Maximum speed (m. p. h.)	Maximum power
Take-off	----------	Take-off.
Approach	----------	Continuous.
	----------	Take-off.
Landing	----------	Idling.
	----------	Take-off.

(A note should be added to indicate which of the values is to be marked on the airspeed indicator.)

(v) *Landing gear operating speed.* V_{LO}, plus a statement that this is the maximum speed at which the landing gear may be lowered or raised.

(vi) *Landing gear extended speed.* V_{LE}, plus a statement that this is the maximum speed with landing gear extended and locked.

(vii) *Compressibility effects.* Where a speed limitation (e.g., M_{MO}) is based on compressibility effects, the manual should include information concerning warning symptoms, probable behavior of the airplane, and recovery procedures.

(viii) *Airspeed and Mach indicator markings and placards.* An explanation of any markings, limit hands, placards, etc., provided in complying with § 4b.732, should be included.

(5) *Demonstrated crosswind.* The statement on this item should indicate the maximum cross component of wind velocity at which it has been demonstrated to be safe to take-off or land. If the value established during the tests is considered the maximum up to which it is considered safe to operate the airplane on the ground, including take-offs and landings, it should be entered under this item; i. e., as a limitation. However, if the value established is not considered limiting it should be included as performance information, as outlined in paragraph (d) of this section, instead of a limitation. In the case of flying boats and additional maximum cross component of wind velocity for taxiing may be appropriate material. Cross-wind should be based on reported wind velocities measured at 50 feet above the ground.

(6) *Flight load acceleration limits.* Flaps up ______ (at take-off weight). Flaps down ______ (at landing weight).

(7) *Type of airplane operation.* A typical example would be as follows:

(i) Transport category.

(ii) Instrument night flying (when required equipment is installed).

(iii) Atmospheric icing conditions—should stipulate "none, trace, light, moderate or heavy."

(8) *Minimum crew.* Information should be given in this item for all operations specified under subparagraph (7) of this paragraph and any additional conditions if desired or considered pertinent. The number and identity of members of minimum crew necessary to safe operation should be stated.

(9) *Miscellaneous.* This item should include any information not given under the preceding headings that is restrictive and considered necessary for the safe operation of the airplane. Some typical examples are as follows:

(i) The wing and tail anti-icing heaters should not be operated in flight when the outside air temperature is above 50° F.

(ii) Pressurized cabin differential pressure limits, etc.

(iii) A notation should be included to warn flight personnel against jettisoning fuel while the flaps are lowered unless it has been demonstrated that flap position does not adversely affect fuel jettisoning. (See § 4b.437 (b).)

(iv) Propeller reversing to be used for taxiing only.

(v) The windshield temperature limits or head adjustment setting should be specified if resistance to bird penetration is dependent upon operation within a particular windshield temperature range.

(c) *Operating procedures; general.* This section of the manual should contain information peculiar to the airplane, concerning normal and emergency procedures, knowledge of which might enhance the safety of operation of the airplane. The manual should state that these procedures are not made mandatory by this part. However, they may be made mandatory by other parts of the regulations such as Parts 40, 41, 42, etc., of this subchapter.

(1) *Normal procedures.* This section should contain information and instructions regarding peculiarities of: Starting and warming engines, taxiing, operation of wing flaps, landing gear, automatic pilot, etc. Outline normal procedures for each, noting any special precautions in the interests of safety. Describe or refer to procedure in any emergency likely to occur in each. Also included in this section should be

instructions for the operation of any equipment that is considered new in the aeronautical field or comparatively complicated.

(i) A typical example of the former would be: "Wing flaps should be exercised through three complete cycles prior to all initial take-offs. This operation accomplishes the automatic bleeding and the equalization of pressure to the eight separate hydraulic flap actuating cylinders."

(ii) Typical examples of the latter are: "Recommended operating procedures for thermal ice prevention system, recommended operating procedures for reversible pitch propellers, and cabin pressurization."

(2) *Emergency procedures*—(i) *Engine failure.* This section should include the procedure to be used in the event of an engine failure, including recommended minimum speeds, trim, operation of remaining engine(s), etc. A typical example would be as follows: "Engine Failure on Take-Off. The minimum speed (V_1) at which the airplane can be controlled directionally on the runway with an outboard engine inoperative and its propeller windmilling, and with take-off power on the remaining engines, is 60 m. p. h. CAS. The minimum speed at which the airplane is controllable in flight with the sudden failure of an outboard engine, with take-off power on the remaining engines, is 96 m.p.h. CAS. If an engine fails during the ground roll below speed V_1, cut the throttles on all engines and apply brakes. If ground contact has already been broken, land straight ahead if sufficient runway remains. If not, retract landing gear, maintain full power on live engines, and continue take-off. Feather the dead engine as outlined in subdivision (ii) of this subparagraph. Use minimum cowl flap setting on live engines to maintain cylinder temperatures within limits. Retrim airplane as necessary. Speed for best climb under these conditions is 115 m. p. h. CAS. See paragraph (d) *Performance information*, of this section, for criterion and V_1 speeds used in determining the runway lengths."

(ii) *Propeller feathering.* This section of the manual should outline the procedure to be followed in stopping the rotation of propellers in flight. A typical procedure is outlined below:

(*a*) Throttle—"Closed."

(*b*) Push feathering switch button. When propeller blades are fully feathered the button will kick out automatically.

(*c*) Mixture control—Idle cut-off."

(*d*) Fuel and oil fire wall shut-off switches—"Off" (closed).

(*e*) Cowl flaps—"Closed."

(*f*) Fuel booster pump—"Off."

(*g*) Tank selector for engine being feathered—"Off." (Do not shut tank selector "Off" if crossfeed is being used.)

(*h*) Ignition for dead engine—"Off."

(*i*) Propeller pitch control—"Full decrease r. p. m."

(iii) *Automatic propeller feathering.*

(iv) *Unusual procedures.* Information on any emergency procedures that are considered unusual or in which a specific sequence of events are required to accomplish the operation satisfactorily should be specified. Some typical examples are as follows:

(*a*) All-engine go-around when it is recommended practice to retract the flap prior to retracting the gear resulting from a design condition in which the flap creates more drag than the landing gear.

(*b*) Fire control procedures.

(*c*) Emergency cabin depressurization.

(*d*) Emergency landing gear extension.

(*e*) Emergency brake operation.

(*f*) Fuel dumping.

(*g*) Electrical: In addition to other electrical items, the manual should specify the circuits in which overriding breakers, if any, are used and contain instructions concering operation of both overriding and non-over-riding types. The following is a typical example: "All circuit breakers are of the non-over-riding type except the fuel booster pumps and propeller feathering circuits. In an emergency, the breakers in these two circuits may be held closed with the possible risk of fire hazard due to short circuits, etc. Discretion should also be used in repeatedly resetting non-overriding breakers due to the fact that resetting may reestablish an arc and increase the fire hazard."

(*h*) Emergency by day and/or night.

(*i*) Flare release procedure.

(*j*) Wheels up landing procedure.

(*k*) Ditching procedure.

(3) *Other special operating procedures (if any).*

(4) *Alternate operating procedures.* After gaining a large amount of experience with a particular model airplane, some operators may develop various operating procedures that they consider equivalent or better than some of those originally described in the manual. If an operator wants to incorporate new procedures in the Airplane Flight Manual, the operator should apply to the FAA office in the region where he is located for approval of the alternate procedures in the same manner that he would normally use in the case of a structural change or alteration. The local FAA regional office will coordinate the application with the FAA regional office containing the airplane technical data file if the proposed change in procedure is considered to be of sufficient importance.

(i) *For scheduled air carrier operators only.* For greater flexibility and to avoid duplication of instructions to pilots when operators desire to incorporate Airplane Flight Manual Operating Procedures in their operations manuals or devise their own operating procedures, the FAA will permit the removal of the Operating Procedures Section from the Airplane Flight Manual by scheduled air carrier operators provided the operators include the same or equivalent material in their operations manual and at the same time assume full responsibility of proving the equivalency of any new or altered procedures if called upon to do so by the FAA in connection with airplane accident investigations, etc. When the Operating Procedure Section is removed from the Airplane Flight Manual by an operator, an appropriate notation to this effect should be added to the Airplane Flight Manual of each airplane affected.

In accordance with the foregoing, the following statement should be included under the Operating Procedure Section of the Airplane Flight Manual when the Operating Procedure Section is transferred verbatim from the Airplane Flight Manual to the air carrier operations manual:

> The airplane operating procedures prescribed by § 4b.742 *Operating procedures* are included in ------ (show reference to appropriate section of the air carrier operations manual) ------.

If an air carrier operator desires to reword or restate the FAA approved operating procedures or establish new or alternate operating procedures without obtaining prior approval of these procedures from the FAA, the following additional statement should be included with the above statement:

> Where the procedures in the air carrier operations manual differ from those contained in the FAA Approved Airplane Flight Manual for this airplane, (------name of air carrier operator------) has determined that equivalent safety is provided by such alternate procedures and assumes full responsibility for this determination.

If for any reason the alternate operating procedures become inapplicable or inappropriate to the operation of the airplanes affected, the original FAA Approved Operating Procedures Section should be reinserted in the Airplane Flight Manual in order that the contents of the manual will revert to the same text as originally approved by the FAA.

(d) *Performance information.* This section should contain all the performance information necessary to implement the operating requirements of Part 40 of this subchapter, etc., and to operate the airplane safely.

(1) *Introductory information.* This should include any general information or any pertinent descriptions of the conditions under which the performance data were determined. The following examples are considered typical and appropriate:

(i) All climb data are for standard atmospheric conditions.

(ii) The minimum effective take-off runway lengths given in this section are defined as the longer "accelerate-stop distance" and the distance required to take off and clear a 50-foot obstacle with one engine becoming inoperative at speed V_1.

(*a*) The accelerate-stop distance is the distance required to accelerate the airplane from a standing start to the speed V_1, and assuming an engine to fail at this point, to stop.

(*b*) The take-off distance is defined as the sum of the following: Distance to accelerate to speed V_1 with all engines operating, distance to accelerate from speed V_1 to speed V_2 with one engine inoperative and propeller windmilling in low pitch. (It is assumed that gear retraction is initiated at the end of this segment), and the horizontal distance traveled in climbing to a height of 50 feet at speed V_2 with one engine inoperative. (It is assumed that propeller feathering is not commenced prior to the end of this segment.)

(*c*) Speed V_1 is defined as the critical engine failure speed and is a speed at which the controllability has been demonstrated to be adequate to permit proceeding safely with the take-off when the critical engine is suddenly made inoperative. The minimum V_1 speed for this airplane is 60 m. p. h. CAS (airspeed calibration should include ground effect); however, as explained below, speeds in excess of this value were used in determining the runway lengths.

(*d*) Speed V_2 is defined as the minimum take-off climb speed and is the greater of the following: 1.15 times the power-off stalling speed with the flaps in the take-off position (assuming a four-engine airplane). 1.10 times the minimum control speed, V_{mc}.

(*e*) The minimum control speed, V_{mc}, is defined as the minimum speed at which the airplane is controllable in flight with the sudden failure of an outboard engine with take-off power on the remaining engines.

(*f*) All runway lengths given in this manual are based upon optimum V_1 speeds; i. e., the speed selected for V_1 is such that the accelerate-stop distance is equal to the distance to clear a fifty foot obstacle with one engine becoming inoperative at this speed. Consequently, V_1 varies with weight, altitude, wind, gradient, temperature, etc. Values for V_1 for the various conditions are given under subparagraph (2) of this paragraph.

(*g*) All take-off and landing distances are given for dry, concrete runways.

(*h*) If the maximum cross component wind velocity in which landings and take-offs were demonstrated was not considered limiting, it should be included in this section of the manual. A typical example would be as follows: "The maximum crosswind component in which this airplane has been tested in 20 m. p. h. measured at a height of 50 feet above the ground. Consequently, in determining the effective take-off and landing runway lengths, a crosswind component greater than this value may not be used."

(2) *Performance data.* These data may be given in either graphical or tabular form and should cover the weight range and all airport and terrain altitudes at which the airplane is intended to be operated. The scale of the charts should permit accurate reading within approximately 0.25 of one percent. The following should be included:

(i) *Airspeed calibration.* This should be given for the normal and alternate static sources. Ground effect should be included for V_1 speed range. (A plot of CAS vs. IAS @ various flap positions, preferably on one page.)

(ii) *Altimeter calibration.* This should be given for the normal and alternate static source.

(iii) *Stalling speeds.* A table or diagram of calibrated stalling speeds at various weights at all authorized flap settings, power-off should be given.

(iv) *Gross weight summary.* A summary of permissible operating landing and take-off gross weights as limited by the climb or structural requirements should be provided.

(v) *Minimum take-off runway length.* Unless optimum values of V_1 are selected, establishing equal distances to accelerate to speed V_1 and stop or to make a take-off over a 50-foot obstacle with the critical engine becoming inoperative at speed V_1, inclusion of both the accelerate-stop distance and runway length required to take-off and clear a 50-foot obstacle will be necessary. It is recommended that these data be given for a range of temperatures (see § 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) *Take-off information.* Take-off flight paths through the final climb segment, flight path slope or data supplementary to that obtained in subdivision (v) of this subparagraph that may be used for dispatching purposes should be included. These should be for the same range of temperatures (see § 4b.117) and runway gradients as subdivision (v) of this subparagraph.

(vii) *Minimum take-off climb speed, V_2.* This speed should be listed for the range of weights, altitudes and conditions covered in subdivisions (v) and (vi) of this subparagraph. 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 subdivisions (v) and (vi) of this subparagraph 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) *Maximum 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 take-off.* If it is desired to take advantage of wind in determining landing and take-off 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 (flay position, gear position, etc.), and should be given for the following when applicable:

(*a*) First segment take-off climb (§ 4b.120 (a)).

(*b*) Second segment take-off climb (§ 4b.120 (b)).

(*c*) Third segment take-off climb (§ 4b.116 (d)).

(*d*) Final segment take-off climb (§ 4b.116 (e)).

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

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

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

(*h*) Approach climb (§ 4b.120 (d)).

(*i*) Landing climb (§ 4b.119 (b)).

(xii) *Engine power curve.* A copy of the FAA approved power chart of BHP vs. MP, @ RPM and BHP vs. altitude @ RPM and @ 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 FAA 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 FAA 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 paragraph (b) (1) of this section.)

(2) *Responsibility for control of weight and balance.* It is the intention of the Federal Aviation Agency 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 Federal Aviation Agency'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 empty 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) of this paragraph 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 Federal Aviation Agency 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.

[Supp. 14, 16 F. R. 1052, Feb. 6, 1951, as amended by Supp. 24, 19 F. R. 4446, July 20, 1954; Supp. 39, 23 F.R. 7482, Sept. 26, 1958; Amdt. 4b-12, 27 F.R. 2995, Mar. 30, 1962]

§ 4b.740-2 Reverse thrust operating limitations and procedures (FAA policies which apply to § 4b.740).

The policies outlined in § 4b.402-1(b) will apply.

[Supp. 25, 20 F. R. 2281, Apr. 8, 1955]

§ 4b.741 Operating limitations.

(a) *Air-speed limitations.* The following air-speed limitations shall be included together with sufficient information to permit the presentation of the air-speed limitations to the flight crew in accordance with §4b.732:

(1) The maximum operating limit speed V_{MO}/M_{MO} (see § 4b.711), together with a statement that this speed limit shall not be deliberately exceeded in any regime of flight (climb, cruise, or descent), except where a higher speed is authorized for flight test or pilot training operations.

(2) [Reserved]

(3) When an air-speed limitation is based upon compressibility effects, a statement to this effect, together with information as to any symptoms, the probable behavior of the airplane, and the recommended recovery procedures;

(4) The maneuvering speed (see § 4b.210 (b) (2)), together with a statement to the effect that full application of rudder and aileron controls as well as those maneuvers which involve angles of attack near the stall should be confined to speeds below this value;

(5) The flap extended speed (see § 4b.714), together with a description of the pertinent flap positions and engine powers;

(6) The landing gear operating speed (see § 4b.715), together with a statement to the effect that this is the maximum speed at which it is safe to extend or retract the landing gear;

(7) The landing gear extended speed (see § 4b.716), if greater than the landing gear operating speed, together with a statement to the effect that this is the maximum speed at which the airplane can be flown safely with the landing gear in the extended position.

(b) *Powerplant limitations.* Information shall be included to outline and to explain all powerplant limitations (see § 4b.718) and to permit marking the instruments as required by §§ 4b.734 through 4b.736.

(c) *Weight and loading distribution.* The airplane weights and center of gravity limits required by §§ 4b.101 and 4b.102 shall be included, together with the items of equipment on which the empty weight is based. Where the variety of possible loading conditions warrants, instructions shall be included to facilitate observance of the limitations.

(d) *Flight load acceleration limits.* The positive maneuvering limit load factors for which the airplane structure has been proven shall be described in terms of accelerations, together with a statement to the effect that these accelerations limit the angle of bank in turns and limit the severity of pull-up maneuvers.

(e) *Flight crew.* The number and functions of the minimum flight crew determined in accordance with § 4b.720 shall be described.

(f) *Type of operation.* The type(s) of operating(s) shall be listed for which the airplane and its equipment installations have been approved. (See § 4b.721.)

(g) *Maximum operating altitude.* The altitude established in accordance with § 4b.722 shall be included, together with an explanation of the limiting factors.

[15 F.R. 3543, June 8, 1950, as amended by Amdt. 4b–8, 23 F.R. 2591, Apr. 19, 1958; Amdt. 4b–12, 27 F.R. 2995, Mar. 30, 1962]

§ 4b.742 Operating procedures.

(a) *Normal.* Information and instructions shall be included regarding peculiarities of starting and warming the engines, taxiing, operation of wing flaps, landing gear, automatic pilot, etc.

(b) *One engine inoperative.* The recommended procedure shall be described to be followed in the event of engine failure, including minimum speeds, trim, operation of remaining engine(s), operation of flaps, etc.

(c) *Propeller feathering.* The recommended procedure shall be described to be followed in stopping the rotation of propellers in flight.

(d) *Restarting of turbine engines.* The recommended procedures to be followed in restarting turbine engines in flight shall be described. These procedures shall include the effects of altitude.

(e) *Emergency procedures.* Recommended emergency procedures shall be described to be followed in the event of fire, decompression, ditching, etc.

[15 F.R. 3543, June 8, 1950, as amended by Amdt. 4b–8, 23 F.R. 2391, Apr. 19, 1958]

§ 4b.743 Performance information.

(a) *Performance data.* A summary of all pertinent performance data shall be given, including the performance data necessary for the application of the operating rules of this subchapter, together with descriptions of the conditions, air speeds, etc., under which these data were determined.

(b) *Flap controls.* Instructions shall be included describing the use and adjustment of the flap controls necessary to obtain the performance referred to in paragraph (a) of this section.

(c) *Air speeds.* The indicated air speeds corresponding with those determined for take-off shall be listed together with the procedures to be followed in the event the critical engine becomes inoperative during take-off (see § 4b.742 (b)).

(d) *Miscellaneous.* An explanation shall be included of any significant or unusual flight or ground handling characteristics.

Cross Reference: For Special Civil Air Regulations applicable to turbine-powered transport category airplanes of current design in lieu of the requirements contained in § 4b.743, see SR–422, SR–422A, and SR–422B, *supra.*

Airplane Identification Data

§ 4b.750 Identification plate.

A fireproof identification plate shall be securely attached to the structure in an accessible location where it will not likely be defaced during normal service. The identification plate shall not be placed in a location where it might be expected to be destroyed or lost in the event of an accident. The identification plate shall contain the identification data required by § 1.50 of this subchapter.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–1, 15 F. R. 8904, Dec. 15, 1950]

§ 4b.751 Identification marks.

The nationality and registration marks shall be permanently affixed in accordance with § 1.100 of this subchapter.

[15 F. R. 3543, June 8, 1950, as amended by Amdt. 4b–1, 15 F. R. 8904, Dec. 15, 1950]

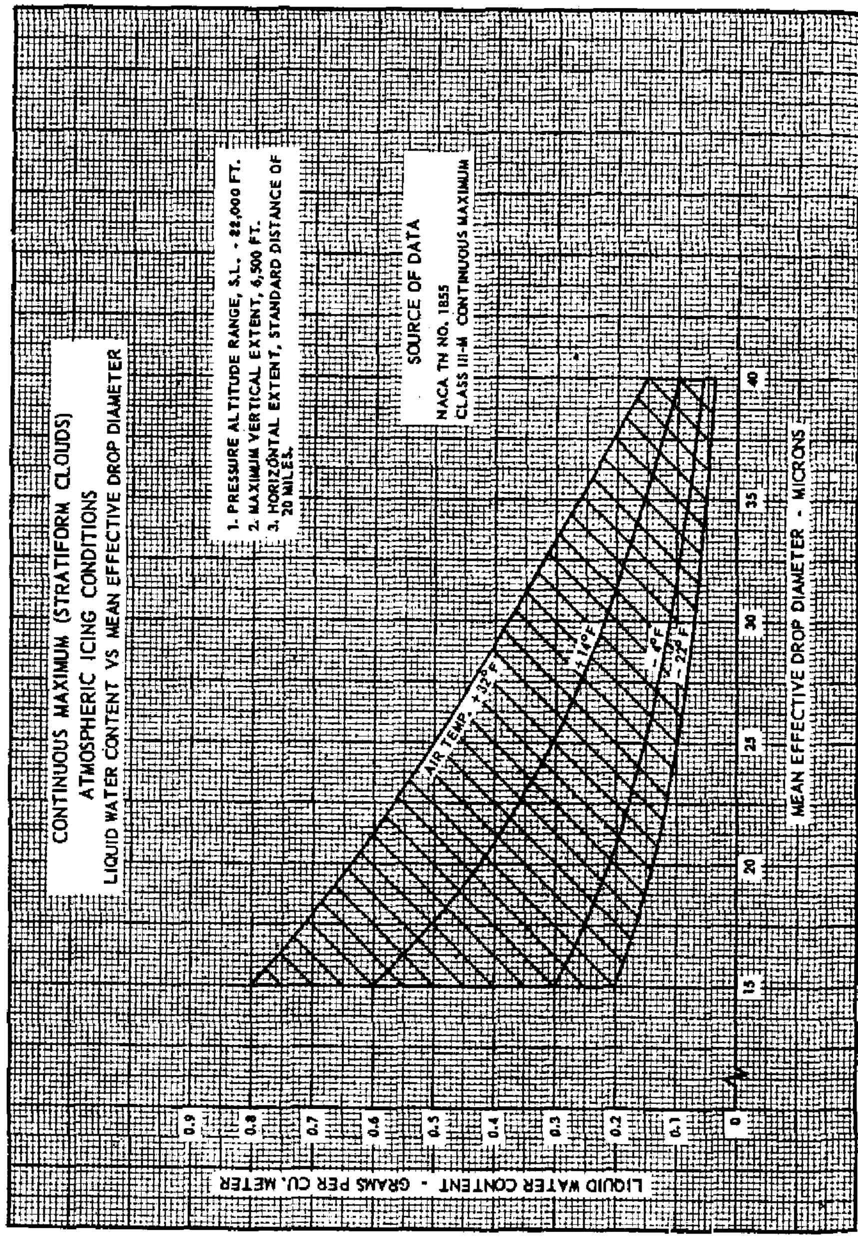


FIGURE 4b–24a

[Amdt. 4b–2, 20 F. R. 5305, July 26, 1955]

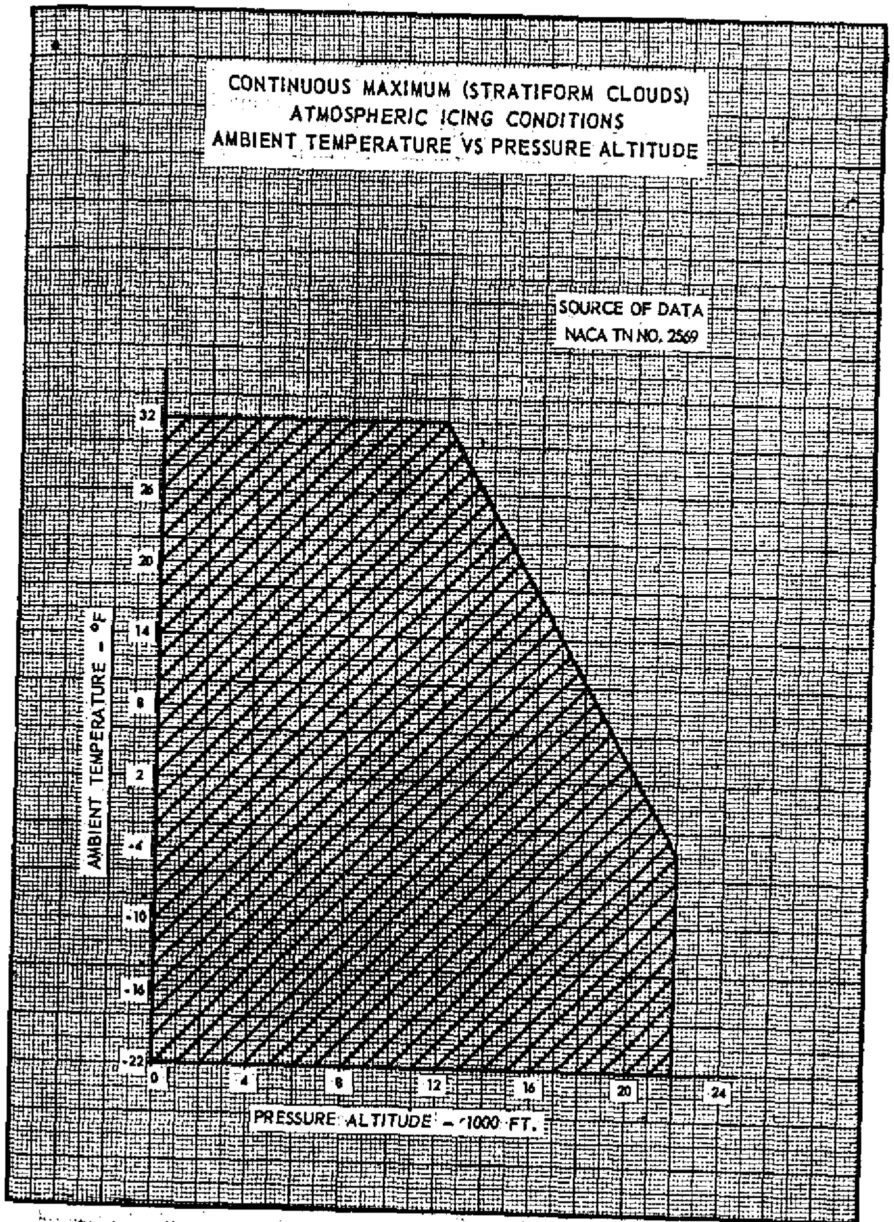


FIGURE 4b-24b

[Amdt. 4b-2, 20 F. R. 5306, July 26, 1955]

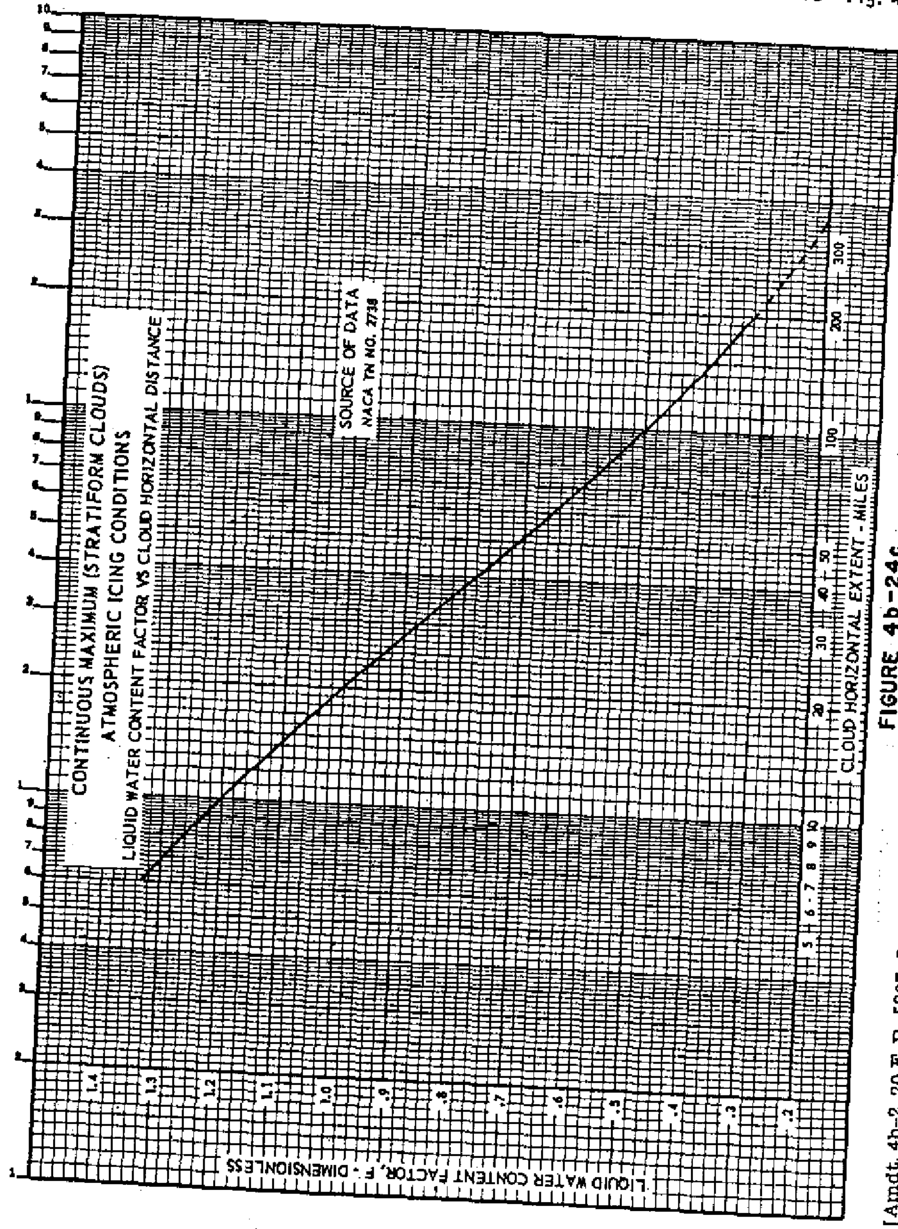


FIGURE 4b-24c

[Amdt. 4b-2, 20 F. R. 5307, July 26, 1955]

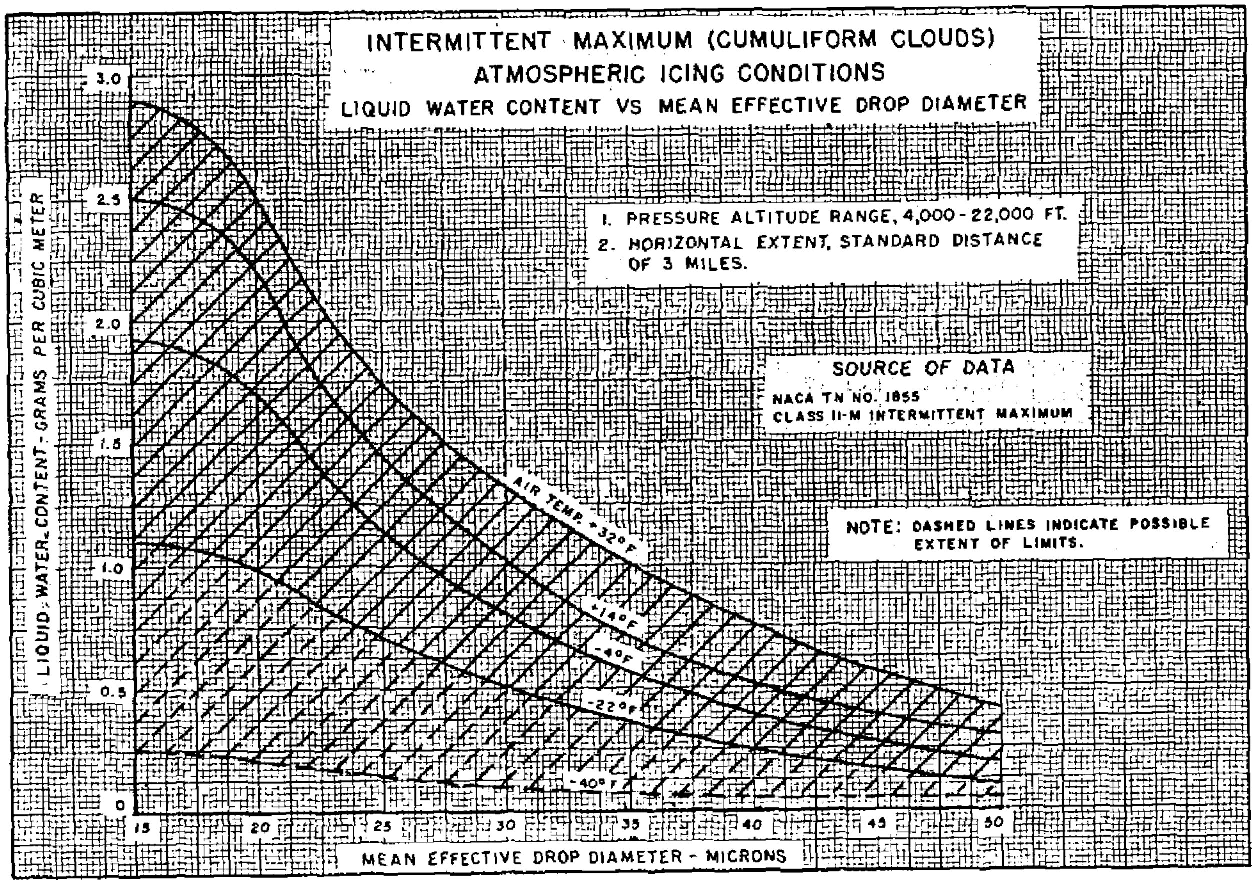


FIGURE 4b-25a

COMM-DC-30017

[Amdt. 4b-6, 22 F. R. 5566, July 16, 1957]

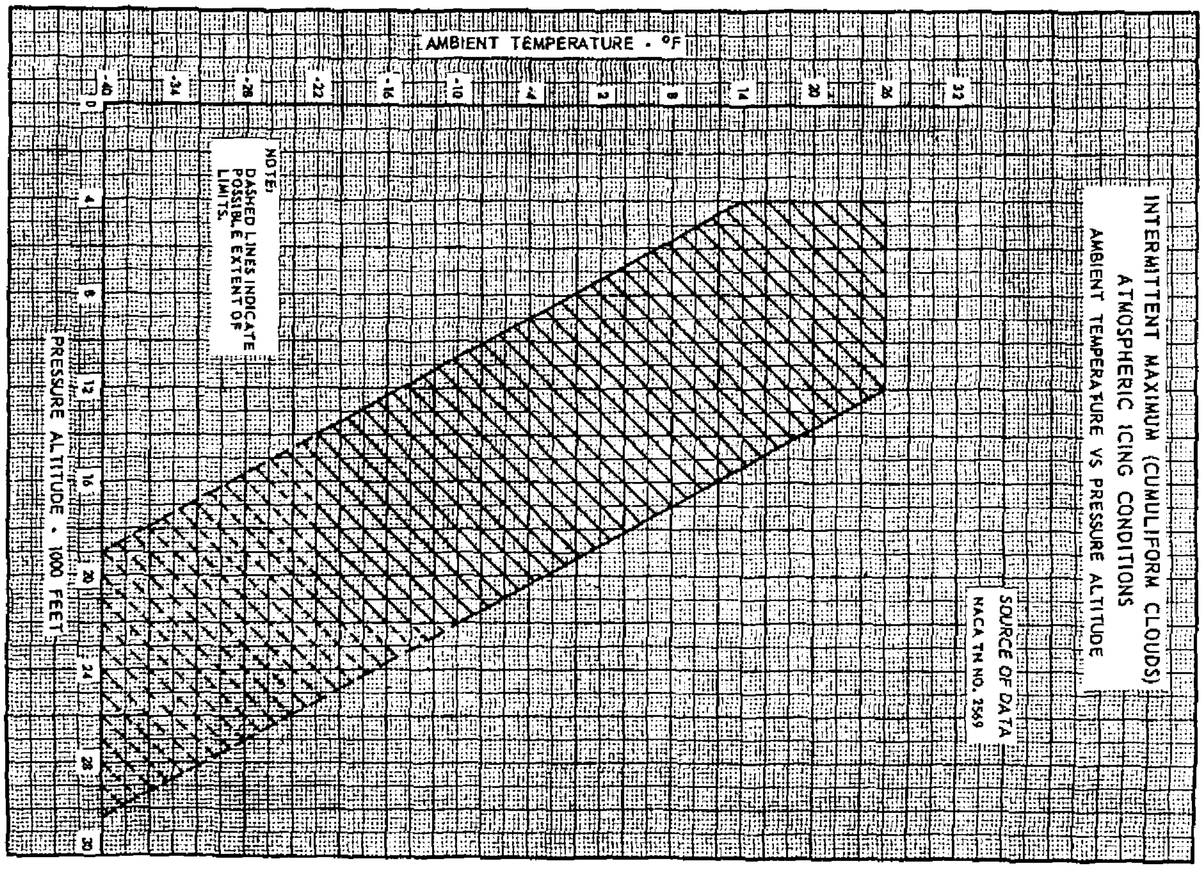


FIGURE 4b-25b

[Amdt. 4b-2, 20 F. R. 5308, July 26, 1955]