CAM-4b

CIVIL AERONAUTICS MANUALS—Volume II

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

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

Supplement No. 19 **May 1, 1958**

Subject: Revisions to Civil Aeronautics Manual 4b dated January 1958.

This supplement corrects misprints in sections 4b.210, 4b.430, and 4b.611 of the Civil Air Regulations and an error in the policy of section 4b.626–1, fire-resistant electrical equipment; deletes the provisions for an indicating means for antiskid installations in section 4b.337–4 (b) (2) (ii); and includes policies on the emergency exit requirements of section 4b.362, acceptable warning indications for cabin pressure control in section 4b.375–1, installation of flight recorders in section 4b.606–2, connection of additional instruments to duplicate instrument systems in section 4b.612–5, and overlaps between high intensity forward position lights in section 4b.634–1.

New and revised material is indicated by brackets.

Remove and destroy the following pages:	*Insert the following new pages:*
XI through XVIII	XI through XVIII
63 and 64	63 and 64
101 and 102	101 and 102
111 through 114	111 through 114–2
131 and 132	131 and 132
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(c) All loads shall be distributed in a manner closely approximating or conservatively representing actual conditions.

(d) If deflections under load significantly change the distribution of external or internal loads, the redistribution shall be taken into account.

4b.201 *Strength and deformation.*

(a) The structure shall be capable of supporting limit loads without suffering detrimental permanent deformations.

(b) At all loads up to limit loads the deformation shall be such as not to interfere with safe operation of the airplane.

(c) The structure shall be capable of supporting ultimate loads without failure. It shall support the load for at least 3 seconds, unless proof of strength is demonstrated by dynamic tests simulating actual conditions of load application.

(d) Where structural flexibility is such that any rate of load application likely to occur in the operating conditions might produce transient stresses appreciably higher than those corresponding with static loads, the effects of such rate of application shall be considered.

4b.202 *Proof of structure.*

(a) Proof of compliance of the structure with the strength and deformation requirements of section 4b.201 shall be made for all critical loading conditions.

(b) Proof of compliance by means of structural analysis shall be acceptable only when the structure conforms to types for which experience has shown such methods to be reliable. In all other cases substantiating tests shall be required.

(c) In all cases certain portions of the structure shall be tested as specified in section 4b.300.

(d) Proof of compliance of the structure with the fatigue evaluation requirements of section 4b.270 shall be made.

Flight Loads

4b.210 *General.* Flight load requirements shall be complied with at critical altitudes within the range selected by the applicant at all weights from the design minimum weight to the maximum weight appropriate to each particular flight condition, with any practicable distribution of disposable load within prescribed operating limitations stated in the Airplane Flight Manual. (See sec. 4b.740.) [Compressibility effects shall be taken into account at all speeds.]

(a) *Flight load factor.* The flight load factors specified in this subpart shall represent the component of acceleration in terms of the gravitational constant. The flight load factor shall be assumed to act normal to the longitudinal axis of the airplane, shall be equal in magnitude, and shall be opposite in direction to the airplane inertia load factor at the center of gravity.

(b) *Design air speeds.* The design air speeds shall be equivalent air speeds (EAS) and shall be chosen by the applicant, except that they shall not be less than the speeds defined in subparagraphs (1) through (5) of this paragraph. Where estimated values of the speeds V_{S_0} and V_{S_1} are used, such estimates shall be conservative.

(1) *Design flap speed,* V_F. The minimum value of the design flap speed shall be equal to 1.4 V_{S_1} or 1.8 V_{S_0}, whichever is the greater, where V_{S_1} is the stalling speed with flaps retracted at the design landing weight, and V_{S_0} is the stalling speed with flaps in the landing position at the design landing weight. (See sec. 4b.212 (d) regarding automatic flap operation.)

(2) *Design maneuvering speed,* V_A. The design maneuvering speed V_A shall be equal to $V_{S_1}\sqrt{n}$ where n is the limit maneuvering load factor used (see sec. 4b.211 (a)) and V_{S_1} is the stalling speed with flaps retracted at the design take-off weight. (See fig. 4b–2.)

(3) *Design speed for maximum gust intensity,* V_B. V_B shall be either the speed determined by the intersection of the line representing the maximum positive lift $C_{N_{max}}$ and the line representing the rough air gust velocity on the gust V-n diagram or $(\sqrt{n_g})\ V_{S_1}$, whichever is the lesser; where n_g is the positive airplane gust load factor due to gust at speed V_C in accordance with section 4b.211 (b) (2) at the particular weight under consideration and V_{S_1} is the stalling speed with flaps retracted at the particular weight under consideration. V_B need not be greater than V_C.

(4) ***Design cruising speed,*** V_C. The minimum design cruising speed V_C shall be sufficiently greater than V_B to provide for inadvertent speed increases likely to occur as a result of severe atmospheric turbulence. In the absence of a rational investigation substantiating the use of other values, V_C shall not be less than V_B+50 (m. p. h.), except that it need not exceed the maximum speed in level flight at maximum continuous power for the corresponding altitude. At altitudes where V_D is limited by Mach number, it shall be acceptable to limit V_C to a Mach number selected by the applicant.

(5) ***Design dive speed*** V_D. The minimum design dive speed V_D shall be sufficiently greater than V_C to provide for safe recovery from inadvertent upsets occurring at V_C. In the absence of a rational investigation the minimum value of V_D shall not be less than 1.25 V_C or V_C+70 (m. p. h.), whichever is the greater, in the altitude range between sea level and an altitude selected by the applicant. At higher altitudes it shall be acceptable to limit V_D to a Mach number selected by the applicant. (See fig. 4b–1.)

(c) ***Design fuel loads.*** The disposable load combinations shall include all fuel loads in the

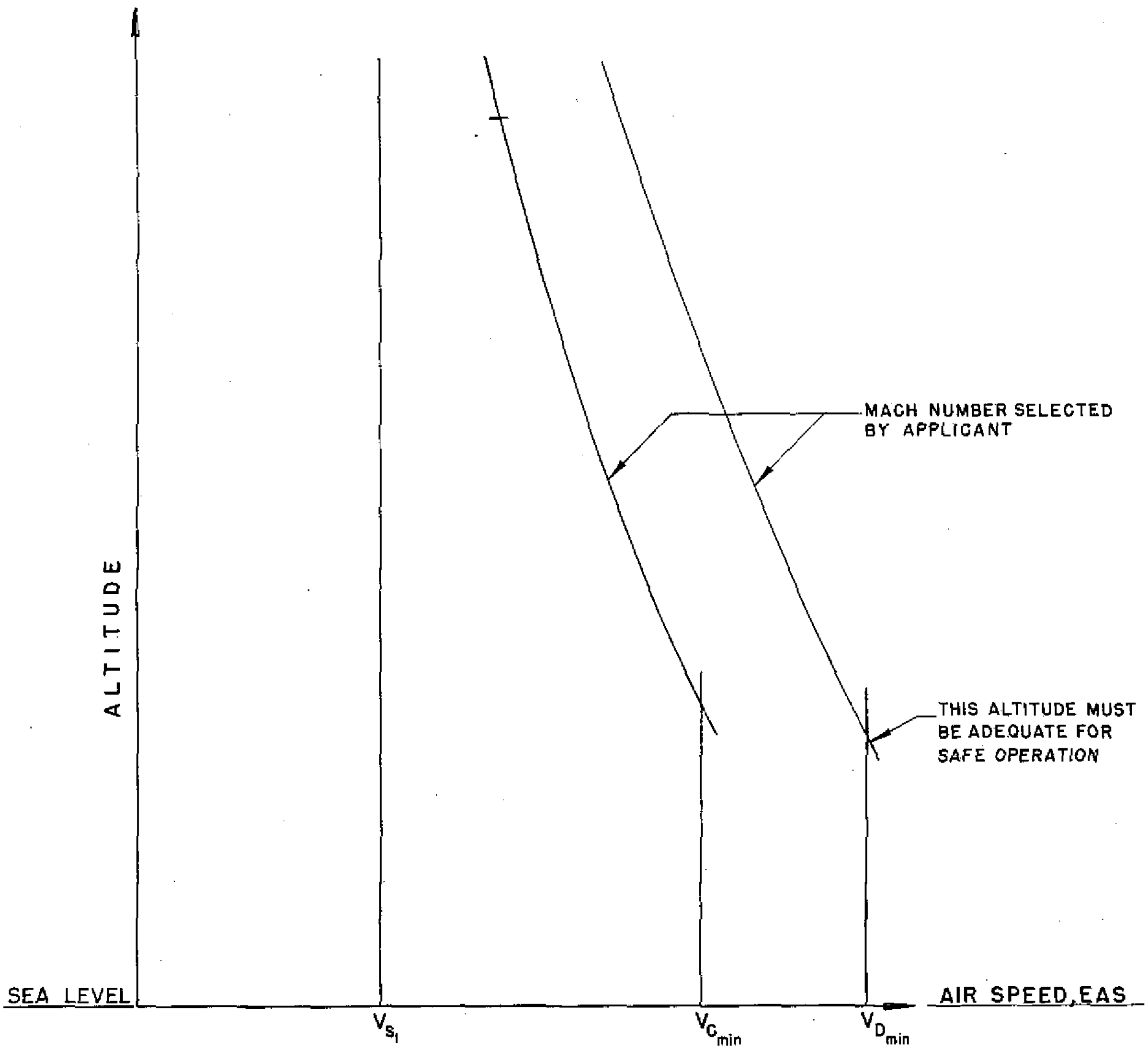

Figure 4b–1.—Minimum design air speeds vs. altitude.

or more brake units, those brake units affected should automatically revert to normal braking.

(ii) [Deleted]

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

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

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

(c) *Tests and analyses.*

(1) When an antiskid system is included as original equipment on an airplane, it is not required that field length data,[11] with antiskid inoperative, be determined.

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

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

(i) Conduct at least one accelerate-stop test at each of the following speeds: 80, 90, and 100 percent of the highest V_1 speed for which the airplane is certificated.[12] 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 sec. 4b.115–1.)

(ii) Conduct at least one landing deceleration test at each of the following weights: maximum landing weight, an intermediate landing weight and normal minimum landing weight.[13] All landings should be made from the highest corresponding contact speeds used in determining CAA Approved Airplane Flight Manual field lengths.

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

[11] 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.

[12] 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.

[13] 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.

versely affect controllability, that malfunction need not be simulated in flight tests.

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

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

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

(21 F. R. 2558, Apr. 18, 1956, effective May 15, 1956, amended in 23 F. R. 2789, Apr. 26, 1958, effective May 5, 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 secs. 4b.230 through 4b.236.)

Hulls and Floats

4b.340 *General.* The requirements of sections 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 section 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.

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.

Personnel and Cargo Accommodations

4b.350 *Pilot compartment; general.* All references to flight crew in sections 4b.350 through 4b.353 shall mean the minimum flight crew established in accordance with section 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.

(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.

Passenger seating capacity	Emergency exits required on each side of the fuselage			
	Type I	Type II	Type III	Type IV
1 to 19 inclusive			1	
20 to 39 inclusive		1		1
40 to 59 inclusive	1			1
60 to 79 inclusive	1		1	
80 to 109 inclusive	1		1	1
110 to 139 inclusive	2		1	
140 to 179 inclusive	2		2	
180 to 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.* It shall be shown that there is not less than one emergency exit located above the water line for every 35 passengers and at least one such exit per side shall meet the minimum dimensions of the exit specified in paragraph (b) (3) of this section. It shall be permissible to substitute for any side exit an easily accessible overhead hatch of not less than the clear dimensions of the exit specified in paragraph (b) (3) of this section.

(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.

(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 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 exit markings. Such lights shall be

designed to function automatically in a crash landing and shall also be operable manually.

(3) All emergency exits 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.

(h) *Width of main aisle.* The main passenger aisle at any point between seats shall not be less than 15 inches wide up to a height above the floor of 25 inches and not less than 20 inches wide above that height.

For airplanes having a maximum passenger seating capacity of 19 or less, these aisle widths shall not be less than 12 inches wide up to a height above the floor of 25 inches and not less than 20 inches above that height.

[4b.362–1 *Flight crew emergency exits (CAA policies which apply to sec. 4b.362 (a)).*

[(a) A flight crew area emergency exit should be a minimum of 19 by 20 inches 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 section 4b.362 (e) (2) through (8) and 4b.362 (f) are also applicable to flight crew emergency exits. When the internal exit "opening means" involves 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.

(23 F. R. 2789, Apr. 26, 1958, effective May 5, 1958.)

[4b.362–2 *Step-down distance (CAA interpretations which apply to sec. 4b.362 (b)).* The step-down distances specified in section 4b.362 (b) (2), (3), and (4) mean the actual distances between the bottom of the required openings and a usable foothold which extends out from the fuselage and is large enough to be effective without searching visually or by feel.

(23 F. R. 2789, Apr. 26, 1958, effective May 5, 1958.)

[4b.362–3 *Number of passengers (CAA policies which apply to sec. 4b.362 (c)).*

[(a) Cabin attendants are considered part of the crew and are not included in the passenger seating capacity (section 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 section 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.

(23 F. R. 2789, Apr. 26, 1958, effective May 5, 1958.)

[4b.362–4 *Emergency exit design descent means*[15a] *(CAA policies which apply to sec. 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-pound static load.

[[15a] Consideration should be given to such factors affecting the utility of Type III and Type IV exits as weight, ease of handling, provision of handholds, 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.

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

(23 F. R. 2789, Apr. 26, 1958, effective May 5, 1958.)

[4b.362-5 *Emergency exit marking (CAA policies which apply to sec. 4b.362 (f))*.

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

(23 F. R. 2790, Apr. 26, 1958, effective May 5, 1958.)

[4b.362-6 *Emergency exit access (CAA policies which apply to sec. 4b.362 (g))*.

[(a) Attendant seating facilities [15b] should not normally result in any reduction in required aisle widths, passageways between compartments, or the minimum 20-inch passageway leading to Types I and II exits. Attendants 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- by 20-inch area with the long dimension parallel to and clear of the required 20-inch 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 could be compressed without special effort by the person(s) using the exit.

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

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

(23 F. R. 2790, Apr. 26, 1958, effective May 5, 1958.)

[4b.362-7 *Width of main aisle (CAA policies which apply to sec. 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 inches forward of the leading edge of each seat.]

(23 F. R. 2790, Apr. 26, 1958, effective May 5, 1958.

Ventilation, Heating, and Pressurization

4b.370 *General*. The requirements of sections 4b.371 through 4b.376 shall apply to the

[[15b] Under such seating arrangements, particular attention should be directed to compliance with section 4b.260 (c) to protect the attendant from incapacitation by aircraft or galley equipment.

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 sec. 4b.374 (b)).

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

(d) Where partitions between compartments are equipped with louvres or other means allowing air to flow between such compartments, provision convenient to the crew shall be made for stopping the flow of air through the louvres or other means when such action is found necessary. (See also sec. 4b.357.)

(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.

4b.371–1 *Carbon monoxide detection (CAA policies which apply to sec. 4b.371).* Policies outlined in section 4b.467–1 will apply.

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

4b.372 *Heating systems.* Combustion heaters shall be of an approved type and shall comply with the fire protection requirements of section 4b.386. Engine exhaust heaters shall comply with the provisions of section 4b.467 (c) and (d).

4b.372–1 *Combustion heaters equipped with carbon dioxide fire extinguishers (CAA policies which apply to sec. 4b.372).* The policies as outlined in section 4b.484–1 apply.

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

4b.373 *Pressurized cabins; general.* The design of pressurized cabins shall comply with the requirements of sections 4b.374 through 4b.376. (See also secs. 4b.216 (c) and 4b.352.)

4b.374 *Pressure equipment and supply.* (See sec. 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.

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 sec. 4b.216 (c)), a warning placard shall be placed at the pilot or flight engineer station.

[4b.375-1 *Warning indication (CAA policies which apply to sec. 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.]

(23 F. R. 2790, Apr. 26, 1958, effective May 5, 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 section 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 altitudes elected 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 sections 4b.381 through 4b.386. (See also secs. 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 sec. 4b.371.)

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

4b.380–1 *Protective breathing equipment (CAA policies which apply to sec. 4b.380 (c)).* The policies outlined in section 4b.651–2 apply.

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

4b.380–2 *Approved hand fire extinguishers (CAA policies which apply to sec. 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 section 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[16] likely to be encountered. Consideration should also be given to the agent's ratio of extinguishing ability to quantity required, toxicity,[17] 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.[18]

(c) *Types of extinguishers.*

(1) *Carbon dioxide extinguishers.*[19] 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.*[20] Water extinguishers are acceptable when the principal

[16] *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.

[17] 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

[18] Many transport type airplanes, due to their type certification basis, are not required to comply with section 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.

[19] 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.

[20] 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 covers a minimum 1½ quart capacity approved water extinguisher. Water extinguishers of the kinds currently on the market are not acceptable for flammable liquid or electrical fires.

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.

Fuel System Components

4b.430 *Fuel pumps.*

(a) *Main pumps.*

(1) If the engine fuel supply is maintained by means of pumps, one fuel pump for each engine shall be engine-driven.

(2) Fuel pumps shall meet the pertinent flow requirements of section 4b.413.

(3) All positive displacement fuel pumps shall incorporate an integral bypass, unless provision is made for a continuous supply of fuel to all engines in case of failure of any one pump. [Reciprocating engine] fuel injection pumps which are approved as an integral part of the engine need not incorporate a by-pass.

(4) If the emergency fuel pumps are all dependent upon the same source of motive power, the main fuel pumps shall be capable of providing sufficient fuel flow and pressure to maintain level flight at maximum weight and normal cruising power at an altitude of 6,000 feet with 110° F. fuel without the aid of any emergency fuel pump.

(b) *Emergency pumps.*

(1) Emergency fuel pumps shall be provided to permit supplying all engines with fuel in case of failure of any one main fuel pump, except in the case of [reciprocating engine] installations in which the only fuel pump used in the system is an engine fuel injection pump which is approved as an integral part of the engine.

(2) Emergency fuel pumps shall be available for immediate use in case of failure of any other fuel pump. No manipulation of fuel valves shall be necessary on the part of the crew to make an emergency fuel pump available to the engine which it is normally intended to serve when the fuel system is being operated in the configuration complying with the provisions of section 4b.411.

4b.431 *Fuel pump installation.*

(a) Provision shall be made to maintain the fuel pressure at the inlet to the carburetor within the range of limits established for proper engine operation. In turbine engine fuel systems, provisions shall be made to maintain the fuel pressure at the inlet to the engine fuel system within the limits established for engine operation.

(b) 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.

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.

4b.433 *Fuel lines and fittings in designated fire zones.* Fuel lines and fittings in all designated fire zones (see sec. 4b.480) shall comply with the provisions of section 4b.483.

4b.434 *Fuel valves.* In addition to the requirements of section 4b.482 for shutoff 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.

4b.435 *Fuel strainer.* A fuel strainer 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 shall be located between the tank outlet and the engine-driven pump inlet.

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

(c) The strainer 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) When filter or strainers susceptible to icing are incorporated in the fuel system, a means shall be provided to maintain automatically the fuel flow in the event ice particles accumulate and restrict flow by clogging the filter or screen.

4b.436 *Fuel system drains.* Drainage of the system shall be accomplished by fuel strainer drains and other drains as provided in section 4b.424. The following shall apply:

(a) 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.

(b) All fuel system drains shall be accessible.

(c) If drainage of the fuel strainer permits compliance with paragraphs (a) and (b) of this section, no additional drains need be provided unless it is possible for a hazardous quantity of water or sediment to be trapped therein. (See also sec. 4b.483 (c).)

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 sec. 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 sec. 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.

(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 sec. 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 sec. 4b.485.)

(q) Thrust indicator for each turbo-jet engine.

(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 sec. 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.

4b.605 *Miscellaneous equipment.*

(a) Approved seats for all occupants (see sec. 4b.358),

(b) Approved safety belts for all occupants (see sec. 4b.643),

(c) Deleted.

(d) Source(s) of electrical energy (see sec. 4b.620),

(e) Electrical protective devices (see sec. 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 sec. 4b.472),

(j) Approved portable fire extinguisher (see sec. 4b.641).

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.

4.606–1 *Safety criteria*[32] *for electric utilization systems (CAA policies which apply to sec. 4b.606 (a) and (b)).* Electric utilization systems[33] 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,[34] if operation of this system is necessary to maintain controlled flight or effect a safe landing for any authorized flight operation.

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

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

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

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

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

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

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

[4b.606–2 *Installation of flight recorders (CAA policies which apply to sec. 4b.606).* Flight recorders required under Parts 40, 41, and 42 of the Civil Air Regulations 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—At any location exclusive of the areas lower than the main structure of the wing center section, or forward of and lower than the top of the wing at the fuselage,

Type II—Aft of the most rearward pressure dome on aircraft with conventional powerplant locations,

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 as close to the center of gravity range of the airplane as practicable.

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

[33] 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.

[34] 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.

[(2) The vertical acceleration sensor, or the unit of the instrument 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 airspeed, altitude, and heading data should be obtained from either [34a] the existing duplicate instrument system (copilot system), 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 copilot's airspeed and 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 or data which are independent of required flight and navigation instruments.

[(d) *Connection to electrical power.* The flight recorder instrument 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 instrument should be connected to a bus of the next lower reliability.]

(23 F. R. 2728, Apr. 24, 1958, effective May 5, 1958.)

Instruments; Installation

4b.610 ***General.*** **The provisions of sections 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 section 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 section 4b.612 (f).

[[34a] See section 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 section 4b.603 shall be grouped on the instrument panel and centered as early 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.

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

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

4b.612 *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 airspeed at sea level in the standard atmosphere with a minimum practicable instrument calibration error when the corresponding pitot 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_2, 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 section 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_{NO} 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 reading more than 20 feet high nor more than 50 feet low in the speed range between 1.3 V_{S_0} (flaps extended) and 1.8 V_{S_1} (flaps retracted).

(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 $\pm 10°$ on any heading.

(3) A calibration placard shall be provided as specified in section 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 actuat-

ing 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 section 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.* Each required flight instrument utilizing a power supply shall be provided with two independent sources of power, a means of selecting either power source, and a means of indicating the adequacy of the power being supplied to the instrument. The installation and power supply system shall be such that failure of one instrument, or of the energy supply from one source, or a fault in any part of the power distribution system, will not interfere with the proper sypply of energy from the other source. (See also secs. 4b.606 (c) and 4b.623.)

(f) *Duplicate instrument systems.* If duplicate flight instruments are required by the operating parts of the Civil Air Regulations (see note under sec. 4b.610), the operating system for a duplicate instrument shall be completely independent of the operating system for the duplicated instrument. Additional instruments shall not be connected to the first pilot system. If additional instruments are connected to the other system, provision shall be made to disconnect or isolate in flight such additional instruments.

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

(a) Unless a calibrated referenced airspeed system is provided, the airplane's system should be calibrated throughout as wide a range as necessary to cover the intended flight tests. The tests in (c) are for the purpose of showing compliance with section 4b.612(a) and not in-form its intended function, and the following should apply:

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

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

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

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

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

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

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

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

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

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

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

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

(1) Servo motor and gear train model numbers

(2) Servo unit pulley sizes

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

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

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

(2) Under the operating procedures section, normal operation information.

(3) Under the emergency operating procedures section, a statement of altitude lost in the cruising configuration (see subparagraph (a) (1) of this section); a statement of altitude lost on ILS approaches (see paragraph (c) (1) (i) of

this section); and any other applicable emergency procedure information.

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

[4b.612–5 *Connection of additional instruments to duplicate instrument system (CAA policies which apply to sec. 4b.612 (f))*. Neither the accuracy nor the performance of any instrument in the duplicate instrument system should be adversely affected when an additional instrument is connected to or is subsequently disconnected from that system.]

(23 F. R. 2728, Apr. 24, 1958, effective May 5, 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 sections 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 section 4b.416 (see sec. 4b.736).

(c) *Fuel flowmeter system.* When a flowmeter system is installed, the metering component shall include a means for bypassing 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 sec. 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 section 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.

Electrical Systems and Equipment

4b.620 *General.* The provisions of sections 4b.621 through 4b.627 shall apply to all electrical systems and equipment. (See also sec. 4b.606.)

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 section 4b.606 (c).

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 so designed that the power sources function properly both when connected in combination and independently, and the failure or malfunctioning of any power source cannot create a hazard or impair the ability of the remaining sources to supply essential loads.

(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.

4b.622–1 *Generating system reliability (CAA policies which apply to sec. 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 section 4b.606 (c).

(b) *Generating system malfunctions.* No probable malfunction [37] in the generating system, or in the generator drive system,[38] should result in the permanent loss of service to electric utilization systems [39] which are necessary to maintain controlled flight and to effect a safe landing,[40] 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 (a) and (b) above,

(1) Adequate warning should be provided for any malfunction or failure requiring such corrective action.

(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 sec. 4b.740).

[37] 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.

[38] The generator drive system includes the prime movers (propulsion engines or other) and coupling devices such as gear-boxes or constant-speed drives.

[39] An electric utilization system is a system of electric equipment, devices and connected wiring which utilizes electric energy to perform a specific aircraft function.

[40] 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, control system boost.

(d) *Electric system smoke and fire procedures (see sec. 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 sec. 4b.740).

(22 F. R. 6885, Aug. 27, 1957, effective Sept. 15, 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 multi-channel or loop circuits separately routed.

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 over-voltage 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) Protective devices or their controls used in essential load circuits shall be accessible for resetting 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.

4b.624-1 *Automatic reset circuit breaker (CAA policies which apply to sec. 4b.624).* Automatic reset circuit breakers (which automatically reset themselves periodically) should not be applied as circuit protective devices.[41] They may be used as integral protectors for electrical equipment (e. g., thermal cut-outs) provided that circuit protection is also installed to protect the cable to the equipment.

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

4b.625 *Electrical equipment and installations.*

(a) In showing compliance with section 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) Batteries and their installations shall provide for ventilation, drainage of fluids, venting of gases, and protection of other parts of the airplane from corrosive battery fluids.

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 sections 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.

[4b.626-1 *Fire-resistant electrical equipment* [42] *(CAA policies which apply to sec. 4b.626).* When applied to the electrical equipment and components defined in the last sentence of section 4b.626, an accepted criterion for "fire resistant" is that such equipment and components, as installed in the aircraft, should withstand a 2000° F. oxidizing flame impinging on their surfaces for at least 5 minutes without adverse effect on their circuit function.[43] The 2000° F. oxidizing flame should envelop the equipment under test, using a test setup simulating the actual aircraft installation.[44] Thermocouples for measurement of flame temperature should be located within one-fourth inch of the surface exposed to the flame.]

(22 F. R. 6885, Aug. 27, 1957, effective Sept. 15, 1957; amended in 23 F. R. 2790, Apr. 26, 1958, effective May 5, 1958.)

4b.627 *Electrical system tests and analyses.* It shall be demonstrated by tests and analyses that the electrical system functions properly and without electrical or thermal distress.

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

[[42] This policy establishes a basic test standard for fire-resistant electrical equipment. 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 when exposed to the probable fire conditions at its particular location.

[[43] Excessive temperature may affect electrical equipment and components by causing such malfunctions as short circuit, open circuit, and changes in circuit parameters (for example, reduced insulation resistance and dielectric strength).

[[44] In the case of electric cable, only a representative length, not less than 12 inches, need be enveloped in the flame.]

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 if shown that non-dimmed instrument lights are satisfactory under all expected conditions os 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.

(c) Landing lights shall be installed in a location where they provide the necessary illumination for night landing.

P **(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.

4b.632 ***Position light system installation.***

(a) ***General.*** **The provisions of sections 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 noncombustible 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.**

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

(a) Within the left landing light unit.

(b) On the centerline of the aircraft nose.

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

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

4b.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.

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**

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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 overlapping 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°	At least 2 candles.

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.

[4b.634–1 *Overlaps between high intensity forward position lights (CAA policies which apply to sec. 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 6–3 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.[45]]

(23 F. R. 2790, Apr. 26, 1958, effective May 5, 1958.)

4b.635 *Position light color specifications.* The colors of the position lights shall have the International Commission on Illumi-

[[45] Overlap intensities should be determined with the position lights installed in their actual rotorcraft locations, since adjacent rotorcraft structure will often provide some cutoff in the overlap area.]

nation 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 $0.440-0.320y$,

x is not greater than $y-0.170$,

y is not less than $0.390-0.170x$;

(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 $x_0=x$.

CROSS REFERENCE: For Special Civil Air Regulation SR-390, modifying regulations with respect to the position light system, see Note 2 to this part, *supra*.

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.

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 .03 steradians shall be permissible within a solid angle equal to .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 section 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:

$$I_e=\frac{\int_{t_1}^{t_2} I(t)\,dt}{0.2+(t_2-t_1)};$$

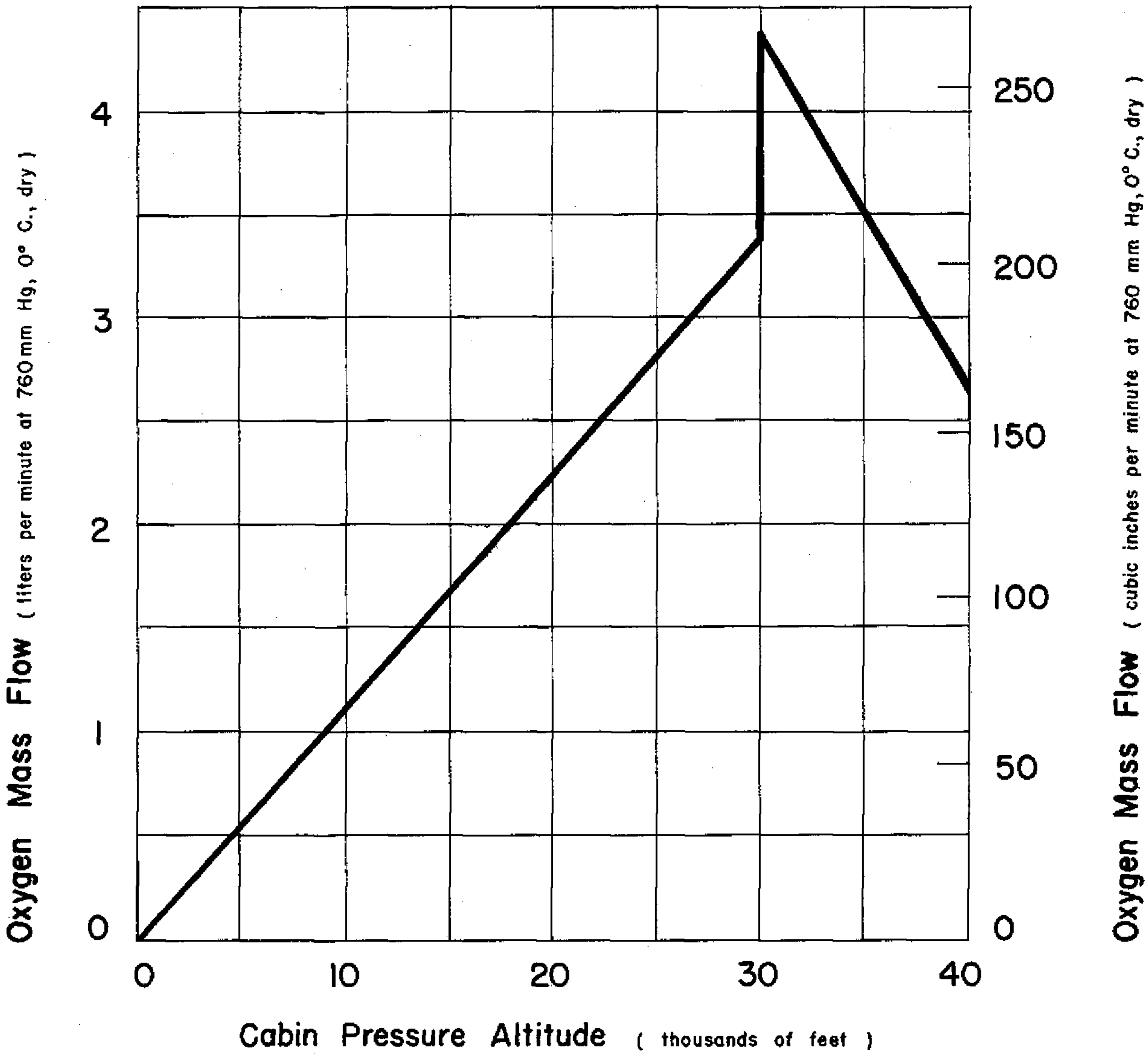
where:

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.



NOTE: 1. Data based on:

a. System 100% efficient.

b. Respiratory minute volume equals 15 liters (915 cubic inches) per minute.

c. 100% oxygen above 30,000 feet.

2. For dilutor-demand regulators use flow characteristics supplied by manufacturer to calculate required supply. Such flows must not be less than those indicated on this graph at delivery rate of 15 liters per minute.

Figure 4b–21.—Minimum flow of oxygen for operation at various altitudes.