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CIVIL AERONAUTICS MANUALS—Volume II

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

This supplement is issued to incorporate in CAM 4 Civil Air Regulations Amendment 4b–9, Supplemental Oxygen Requirements. Amendment 4b–9 was effective September 1, 1958, and provides changes to section 4b.651. Also, figure 4b–21 was deleted.

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161 and 162	161 and 162
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Roy Keeley

ROY KEELEY,
Director, Office of Flight Operations and Airworthiness.

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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.

[Figure 4b.21—Deleted.]

Safety Equipment

4b.640 *Ice protection.* Compliance with this section is optional. The requirements of this section are intended to provide for safe flight in icing conditions. When compliance is shown with the provisions of this section, the type certificate shall include certification to that effect. When an airplane is certificated to include ice protection provisions, the recommended procedures for the use of the ice protection equipment shall be set forth in the Airplane Flight Manual (see sec. 4b.742 (a)). It shall be shown, as prescribed in paragraphs (a) and (b) of this section, that the airplane is capable of operating safely in continuous maximum and intermittent maximum icing conditions as defined in sections 4b.1 (b) (7) and 4b.1 (b) (8).

(a) An analysis shall be performed to establish, on the basis of the airplane's operational needs, the adequacy of the ice protection system for the various components of the airplane.

(b) In addition to the analysis and physical evaluation prescribed in paragraph (a) of this section, the effectiveness of the ice protection system and its components shall be shown by one or more of the following means:

(1) Laboratory dry air and/or simulated icing tests of the actual components or models thereof.

(2) Flight dry air tests of the ice protection system as a whole, or of its components individually.

(3) Flight tests of the airplane or its components in measured simulated icing conditions.

(4) Flight tests of the airplane in measured natural atmospheric icing conditions.

NOTE: For turbine-powered airplanes, the ice protection provisions of this section are considered to be primarily applicable to the airframe. For the powerplant installation, certain additional provisions of Subpart E of this Part may be found applicable.

4b.641 *Hand fire extinguishers.* (See secs. 4b.381, 4b.382, and 4b.383.)

4b.642 *Flare installation.*

(a) Parachute flares shall be releasable from the pilot compartment and installed to minimize the danger of accidental discharge.

(b) It shall be demonstrated in flight that the flare installation is such that ejection can be accomplished without hazard to the airplane and its occupants.

(c) If recoil loads are involved in the ejection of the flares, the structure of the airplane shall withstand such loads.

4b.642–1 *Procedure for testing flare ejection (CAA policies which apply to sec. 4b.642 (b)).* When flares are released, they should clear the aircraft structure when the airplane is flown at a speed of 1.4 Vs_1 with the wing flaps and landing gear in both extended and retracted positions. If it is obvious that the flaps and gear have no effect upon the flare's path, the test may be conducted at one configuration. It is permissible to use dummy flares with parachutes for this test.

4b.643 *Safety belts.* Safety belts shall be of an approved type. In no case shall the rated strength of the safety belt be less than that corresponding with the ultimate load factors specified in section 4b.260 (a), taking due account of the dimensional characteristics of the safety belt installation for the specific seat or berth arrangement. Safety belts shall be attached so that no part of the anchorage will fail at a load lower than that corresponding with the ultimate load factors equal to those specified in section 4b.260 (a) multiplied by a factor of 1.33. In the case of safety belts for berths, the forward load factor need not be applied.

4b.644 *Safety belt signal.* When means are provided to indicate to the passengers when seat belts should be fastened, the device shall be so installed that it can be operated from the seat of either pilot or copilot.

4b.645 *Ditching equipment.* When the airplane is certificated for ditching in accordance with section 4b.361, and when required by the operating rules for the particular route to be flown, the ditching equipment shall be as prescribed in paragraphs (a) through (d) of this section.

(a) *Life rafts.* Life rafts shall be of an approved type. Unless excess rafts of sufficient capacity are provided, the buoyancy and seating capacity beyond the rated capacity of the rafts shall be such as to accommodate all occupants of the airplane in the event of a loss of one life raft of the largest rated capacity on board. Each life raft shall be equipped with a

trailing line and with a static line, the latter designed to hold the raft near the airplane but to release it in case the airplane becomes totally submerged. Each raft shall contain obvious markings of instruction on the operation of the raft.

(b) *Life raft equipment.* Approved equipment intended for survival shall be attached to each life raft and marked for identification and method of operation.

NOTE: The extent and type of survival equipment will depend upon the route over which the airplane is operated.

(c) *Long-range signalling device.* An approved long-range signalling device shall be provided for use in one of the life rafts.

(d) *Life preservers.* Life preservers shall be of an approved type. They shall be reversible and shall contain obvious markings of instruction on their use.

(e) *Life Line.* Provisions shall be made for the storage of life lines, one attached to each side of the fuselage and arranged so that they can be used to enable occupants to stay on the wing after a ditching.

4b.646 *Stowage of safety equipment.* Special stowage provisions shall be made for all prescribed safety equipment to be used in emergencies. The stowage provision shall be such that the equipment is directly accessible and its location is obvious. All safety equipment shall be protected against inadvertent damage. The stowage provisions shall be marked conspicuously to identify the contents and to facilitate removal of the equipment. In addition, the following shall specifically apply:

(a) *Emergency exit means.* The stowage provisions for the emergency exit means required by section 4b.362 (e) (7) shall be located at the exits which they are intended to serve.

(b) *Life rafts.* The provisions for the stowage of life rafts required by section 4b.645 (a) shall accommodate a sufficient number of rafts for the maximum number of occupants for which the airplane is certificated for ditching. Stowage shall be near exits through which the rafts can be launched during an unplanned ditching. Rafts automatically or remotely released on the outside of the airplane shall be attached to the airplane by means of the static line prescribed in section 4b.645 (a).

(c) *Long-range signalling device.* The stowage provisions for the long-range signalling device required by section 4b.645 (c) shall be located near an exit to be available during an unplanned ditching.

(d) *Life preservers.* The provisions for the stowage of life preservers required by section 4b.645 (d) shall accommodate one life preserver for each occupant for which the airplane is certificated for ditching. They shall be located so that a life preserver is within easy reach of each occupant while seated.

Miscellaneous Equipment

4b.650 *Radio and electronic equipment.* (a) In showing compliance with section 4b.606 (a) and (b) with respect to radio and electronic equipment and their installations, consideration shall be given to critical environmental conditions.

NOTE: Critical environmental conditions may include temperature, pressure, humidity, ventilation, position, acceleration, vibration, and presence of detrimental substances.

(b) Radio and electronic equipment shall be supplied with power in accordance with the provisions of section 4b.623 (c).

(c) All radio and electronic equipment, controls, and wiring shall be so installed that operation of any one unit or system of units will not affect adversely the simultaneous operation of any other radio or electronic unit or system of units required by the regulations in this subchapter.

4b.651 *Oxygen equipment and supply.* When required by the operating rules of the regulations in this subpart, the supplemental and protective breathing equipment and its installation shall meet the following requirements:

(a) *General.* The oxygen system installed shall be free from hazards in itself, in its method of operation, and in its effect upon other components of the airplane. Means shall be provided to enable the crew to determine readily during flight the quantity of oxygen available in each source of supply. For airplanes certificated for operation at flight altitudes

above 40,000 feet, oxygen flow rate and equipment shall be approved by the Administrator.

[(b) *Required minimum mass flow of supplemental oxygen.* The minimum mass flow of supplemental oxygen required per person at various cabin pressure altitudes shall be that necessary to comply with the following requirements as applicable:

[(1) Where continuous flow equipment is used by flight crew members, the minimum mass flow of supplemental oxygen required for each crew member shall not be less than that which will maintain during inspiration a mean tracheal oxygen partial pressure of 149 mm. Hg. when breathing 15 liters per minute, BTPS, and having a maximum tidal volume of 700 cc. with a constant time interval between respirations.

[(2) Where demand equipment is used by flight crew members, the minimum mass flow of supplemental oxygen required for each crew member shall not be less than that which will maintain during inspiration a mean tracheal oxygen partial pressure of 122 mm. Hg. to and including a cabin pressure altitude of 35,000 feet and 95 percent oxygen between cabin pressure altitudes of 35,000 and 40,000 feet, when breathing 20 liters per minute BTPS. Provision shall be made to allow use of undiluted oxygen by crew members when they so desire.

[(3) For passengers and cabin attendants the minimum mass flow of supplemental oxygen required for each person at various cabin pressure altitudes shall not be less than that which will maintain during inspiration the following mean tracheal oxygen partial pressures when using the oxygen equipment provided, including masks:

[(i) At cabin pressure altitudes above 10,000 feet to and including 18,500 feet, a mean tracheal oxygen partial pressure of 100 mm. Hg. when breathing 15 liters per minute, BTPS, and having a tidal volume of 700 cc. with a constant time interval between respirations.

[(ii) At cabin pressure altitudes above 18,500 feet to and including 40,000 feet, a mean tracheal oxygen partial pressure of 83.8 mm. Hg. when breathing 30 liters per minute, BTPS, and having a tidal volume of 1,100 cc. with a constant time interval between respirations.

[(4) Where first-aid oxygen equipment is required, the minimum mass flow of oxygen to each user shall not be less than 4 liters per minute, STPD, except that means may be provided to decrease this flow to not less than 2 liters per minute, STPD, at any cabin altitude. The quantity of oxygen required shall be based upon an average flow rate of 3 liters per minute per person for whom first-aid oxygen is required.

[(5) Where portable oxygen equipment is required for crew members, the minimum mass flow of supplemental oxygen shall be as specified in section 4b.651 (b) (1) or (2), whichever is applicable.]

(c) *Equipment standards for distribution system.* Where oxygen is to be supplied to both crew and passengers, the distribution system shall be designed to provide either:

(1) A source of supply for the flight crew on duty and a separate source for the passengers and other crew members, or

(2) A common source of supply with means provided so that the minimum supply required by the flight crew on duty can be separately reserved.

[(d) *Equipment standards for dispensing units.* Where oxygen dispensing units are required, they shall comply with the provisions of subparagraphs (1) through (3) of this paragraph.

[(1) An individual dispensing unit shall be provided for each occupant for whom supplemental oxygen is required to be furnished. All units shall be designed to cover the nose and mouth and shall be equipped with a suitable means for retaining the unit in position on the face for use. Flight crew masks for supplemental oxygen shall provide for the use of communication equipment. (For crew masks to be used for protective breathing purposes, see paragraph (h) of this section.)

[(2) In airplanes certificated to operate at flight altitudes to and including 25,000 feet, there shall be available to and within reach of each flight crew member an oxygen supply terminal and unit of oxygen dispensing equipment to provide for the immediate use of oxygen

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by such crew member. For all other occupants the supply terminals and dispensing equipment shall be located so as to permit the use of oxygen as required by the operating rules of the regulations in this subchapter.

[(3) In airplanes certificated to operate above 25,000 feet flight altitude, the provisions of subdivisions (i) through (iv) of this subparagraph shall apply:

[(i) An oxygen dispensing unit connected to oxygen supply terminals shall be immediately available to each occupant wherever seated. In addition, in airplanes certificated to operate above 30,000 feet, the dispensing units providing the required oxygen flow rate shall be automatically presented to the occupants. To insure that sufficient dispensing units and outlets are available for all occupants, the total number shall exceed the number of seats by at least 10 percent with the extra units being as uniformly distributed throughout the cabin as practicable;

[(ii) Crew members on flight deck duty shall be provided with demand equipment. An oxygen dispensing unit connected to an oxygen supply terminal shall be immediately available to each flight crew member when seated at his station;

[(iii) Not less than two outlets and units of dispensing equipment of a type similar to that required by section 4b.651 (d) (3) (i) shall be located in each washroom; and in each lavatory if separate from the washroom; and

[(iv) Portable oxygen equipment shall be immediately available for each cabin attendant.

[(e) *Means for determining use of oxygen.* Means shall be provided to enable the crew to determine whether oxygen is being delivered to the dispensing units.]

(f) *Fire protection.*

(1) Oxygen equipment and lines shall not be located in any designated fire zone.

(2) Oxygen equipment and lines shall be protected from heat which may be generated in or escape from any designated fire zone.

(3) Oxygen equipment and lines shall be so installed that escaping oxygen cannot cause ignition of accumulations of grease, fluids, or vapors which are likely to be present in normal operation or as a result of failure or malfunctioning of any system.

(g) *Protection from rupture.* Oxygen pressure tanks and lines between tanks and the shutoff means shall be protected from the effects of unsafe temperatures, and shall be so located in the airplane as to minimize the possibility and the hazards of rupture in a crash landing.

(h) *Protective breathing system.* When protective breathing equipment is required by the Civil Air Regulations, it shall be designed to protect the flight crew from the effects of smoke, carbon dioxide, and other harmful gases while on flight deck duty and while combating fires in cargo compartments (see sec. 4b.380 (c)). The protective breathing equipment and the necessary supply of oxygen shall be in accordance with the following provisions:

(1) The protective breathing equipment shall include masks covering the eyes, nose, and mouth, or only the nose and mouth when accessory equipment is provided to protect the eyes. Such equipment while in use shall not prevent the flight crew from using the radio equipment of the airplane or from communicating with each other while at their assigned duty stations. That part of the equipment provided to protect the eyes shall be of a type and construction which will not cause any appreciable adverse effect on vision and shall permit wearing corrective glasses by individual members of the flight crew.

(2) A supply of protective oxygen per crew member shall be of 15-minute duration at a pressure altitude of 8,000 feet and a respiratory minute volume of 30 liters per minute BTPD.

NOTE: When a demand type oxygen system is employed, a supply of 300 liters of free oxygen at 70° F. and 760 mm. Hg. pressure is considered to be of 15-minute duration at the prescribed altitude and minute volume. When a continuous flow protective breathing system is used, including a mask with a standard rebreather bag, a flow rate of 60 liters per minute at 8,000 feet (45 liters per minute at sea level) and a supply

of 600 liters of free oxygen at 70° F. and 760 mm Hg. pressure is considered to be of 15-minute duration at prescribed altitude and minute volume. (BTPD refers to body temperature conditions, i. e., 37° C., at ambient pressure, dry.)

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

4b.651–1 *Safety precautions (CAA policies which apply to sec. 4b.651 (a)).* The oxygen system should be so located that leakage or failure in other systems carrying inflammable liquids or gases will not cause the inflammable liquid or gas to come in contact with oxygen lines or equipment. A relief valve or some other means is desirable in low pressure (400 p. s. i.) oxygen systems to safely relieve excessive pressures such as might be caused by overcharging. (See also sec. 4b.481 concerning location of tanks containing inflammable fluids.)

(15 F. R. 8904, Dec. 15, 1950, effective Jan. 1, 1951.)

4b.651–2 *Protective breathing equipment (CAA policies which apply to sec. 4b.651 (h)).*

(a) *Conditions under which protective breathing equipment may be necessary.* These conditions are those outlined in sections 4b.484–1, 40.205–2, 41.24c–2, and 42.29–2.

(b) *Oxygen systems for flight deck duty.* The demand type oxygen system, or the diluter-demand type system with the lever of the diluter-demand regulator set at "100% OXYGEN" (Automix "OFF") are recommended for use as protective breathing equipment. However, a continuous flow protective breathing system may also be used. In any case the equipment should meet the requirements of section 4b.651 (h).

(c) *Portable equipment for flight deck duty.* Portable protective breathing units of the demand type may be used to meet the requirement of section 4b.651 in lieu of installing a fixed protective breathing system. Portable continuous flow protective breathing units may also be used, but should not be used during fire fighting in Class A or B cargo compartments since any unused oxygen escaping from around the face mask might aggravate the existing fire.

(d) *Masks and goggles.*

(1) Protective breathing masks should fit snugly to prevent the entry of noxious gases. Continuous flow protective breathing masks should have no apertures through which outside air could be drawn into the system and should have a rebreathing bag of at least ⅔ liter capacity. The masks should be installed so as to be readily available to the appropriate crew members. It should be possible for at least the pilot or copilot to maintain ground to air radio voice communications when utilizing the protective breathing masks.

(2) Eye protecting goggles may be a part of or separate from the breathing mask. The goggles should provide an adequate field of vision and a means should be provided to overcome any unsatisfactory fogging tendency of the goggles. Periodic application of an effective antifogging agent on the lens is a satisfactory means of overcoming fogging.

(e) *Operating Instructions.* Operating instructions appropriate to the type of system and masks installed should be provided for the flight crew on placards and/or in the Airplane Flight Manual.

(15 F. R. 8904, Dec. 15, 1950, effective Jan. 1, 1951, revised 19 F. R. 4446, July 20, 1954, effective Sept. 1, 1954.)

4b.651–3 *Supplemental breathing equipment (CAA policies which apply to sec. 4b.651).*

(a) *Oxygen systems.*

(1) Either a continuous flow type system which uses a rebreather type mask or a diluter-demand type system with the lever of the diluter-demand regulator set in the "NORMAL" (Automix "ON") position will satisfactorily provide the supplemental oxygen required for protection against anoxia. The continuous flow system may be of the type which controls the oxygen flow by means of a hand adjustment type regulator, or an automatic type regulator.

(2) A diluter-demand type system with the lever of the diluter-demand regulator set in the "100% OXYGEN" (Automix "OFF") position or a straight demand type system which uses a nondiluter-demand regulator may be used for supplementary breathing purposes as protection against anoxia. However, such use is not recommended due to the lack of oxygen economy of these systems when used to supply supplementary oxygen. As mentioned in sec-

tion 4b.651–2, either of these closed demand systems is satisfactory for protection against toxic gases.

(b) *Operating instructions.* Operating instructions appropriate to the type of system and masks installed should be provided for the flight crew and other crew members concerned.

These instructions should include a graph or a table which will show the duration of the