tion, adjustment for proper alignment and functioning, and lubrication of moving parts.

§ 4b.306 *Material strength properties and design values.* (a) Material strength properties shall be based on a sufficient number of tests of material conforming to specifications to establish design values on a statistical basis.

(b) The design values shall be so chosen that the probability of any structure being understrength because of material variations is extremely remote.

(c) ANC–5, ANC–18, and ANC–23, Part II values shall be used unless shown to be inapplicable in a particular case.

NOTE: ANC–5, "Strength of Metal Aircraft Elements," ANC–18, "Design of Wood Aircraft Structures," and ANC–23, "Sandwich Construction for Aircraft," are published by the Subcommittee on Air Force-Navy-Civil Aircraft Design Criteria, and may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

(d) The strength, detail design, and fabrication of the structure shall be such as to minimize the probability of disastrous fatigue failure.

NOTE: Points of stress concentration are one of the main sources of fatigue failure.

§ 4b.307 *Special factors.* Where there is uncertainty concerning the actual strength of a particular part of the structure, or where the strength is likely to deteriorate in service prior to normal replacement of the part, or where the strength is subject to appreciable variability due to uncertainties in manufacturing processes and inspection methods, the factor of safety prescribed in § 4b.200 (a) shall be multiplied by a special factor of a value such as to make the probability of the part being understrength from these causes extremely remote. The following special factors shall be used:

(a) *Casting factors.* (1) Where only visual inspection of a casting is to be employed, the casting factor shall be 2.0, except that it need not exceed 1.25 with respect to bearing stresses.

(2) It shall be acceptable to reduce the factor of 2.0 specified in subparagraph (1) of this paragraph to a value of 1.25 if such a reduction is substantiated by testing at least three sample castings and if the sample castings as well as all production castings are visually and radiographically inspected in accordance with an approved inspection specification. During these tests the samples shall withstand the ultimate load multiplied by the factor of 1.25 and in addition shall comply with the corresponding limit load multiplied by a factor of 1.15.

(3) Casting factors other than those contained in subparagraphs (1) and (2) of this paragraph shall be acceptable if they are found to be appropriately related to tests and to inspection procedures.

(4) A casting factor need not be employed with respect to the bearing surface of a part if the bearing factor used (see paragraph (b) of this section) is of greater magnitude than the casting factor.

(b) *Bearing factors.* (1) Bearing factors shall be used of sufficient magnitude to provide for the effects of normal relative motion between parts and in joints with clearance (free fit) which are subject to pounding or vibration. (Bearing factor values for control surface and system joints are specified in §§ 4b.313 (a) and 4b.329 (b).)

(2) A bearing factor need not be employed on a part if another special factor prescribed in this section is of greater magnitude than the bearing factor.

(c) *Fitting factors.* (1) A fitting factor of at least 1.15 shall be used on all fittings the strength of which is not proven by limit and ultimate load tests in which the actual stress conditions are simulated in the fitting and the surrounding structure. This factor shall apply to all portions of the fitting, the means of attachment, and the bearing on the members joined.

(2) In the case of integral fittings the part shall be treated as a fitting up to the point where the section properties become typical of the member.

(3) The fitting factor need not be employed where a type of joint made in accordance with approved practices is based on comprehensive test data, e. g., continuous joints in metal plating, welded joints, and scarf joints in wood.

(4) A fitting factor need not be employed with respect to the bearing surface of a part if the bearing factor used (see paragraph (b) of this section) is of greater magnitude than the fitting factor.

§ 4b.308 *Flutter, deformation, and vibration.* Compliance with the following provisions shall be shown by such calculations, resonance tests, or other tests as are found necessary by the Administrator.

(a) *Flutter prevention.* The airplane shall be designed to be free from flutter of wing and tail units, including all control and trim surfaces, and from divergence (i. e. unstable structural distortion due to aerodynamic loading), at all speeds up to 1.2 V_D. A smaller margin above V_D shall be acceptable if the characteristics of the airplane (including the effects of compressibility) render a speed of 1.2 V_D unlikely to be achieved, and if it is shown that a proper margin of damping exists at speed V_D. In the absence of more accurate data, the terminal velocity in a dive of 30 degrees to the horizontal shall be acceptable as the maximum speed likely to be achieved. If concentrated balance weights are used on control surfaces, their effectiveness and strength, including supporting structure, shall be substantiated.

(b) *Loss of control due to structural deformation.* The airplane shall be designed to be free from control reversal and from undue loss of longitudinal, lateral, and directional stability and control as a result of structural deformation, including that of the control surface covering, at all speeds up to the speed prescribed in paragraph (a) of this section for flutter prevention.

(c) *Vibration and buffeting.* The airplane shall be designed to withstand all vibration and buffeting which might occur in any likely operating conditions.

CONTROL SURFACES

§ 4b.310 *General.* The requirements of §§ 4b.311 through 4b.313 shall apply to the design of fixed and movable control surfaces.

§ 4b.311 *Proof of strength.* (a) Control surface limit load tests shall be conducted to prove compliance with limit load requirements.

(b) Control surface tests shall include the horn or fitting to which the control system is attached.

(c) Analyses or individual load tests shall be conducted to demonstrate compliance with the special factor requirements for control surface hinges. (See §§ 4b.307 and 4b.313 (a).)

§ 4b.312 *Installation.* (a) Movable tail surfaces shall be so installed that there is no interference between any two surfaces when one is held in its extreme position and all the others are operated through their full angular movement.

(b) When an adjustable stabilizer is used, stops shall be provided which will limit its travel, in the event of failure of the adjusting mechanism, to a range equal to the maximum required to trim the airplane in accordance with § 4b.140.

§ 4b.313 *Hinges.* (a) Control surface hinges, except ball and roller bearings, shall incorporate a special factor of not less than 6.67 with respect to the ultimate bearing strength of the softest material used as a bearing.

(b) For hinges incorporating ball or roller bearings, the approved rating of the bearing shall not be exceeded.

(c) Hinges shall provide sufficient strength and rigidity for loads parallel to the hinge line.

CONTROL SYSTEMS

§ 4b.320 *General.* All controls and control systems shall operate with ease, smoothness, and positiveness appropriate to their function. (See also §§ 4b.350 and 4b.353.)

§ 4b.321 *Two-control airplanes.* Two-control airplanes shall be capable of continuing safely in flight and landing in the event of failure of any one connecting element in the directional-lateral flight control system.

§ 4b.322 *Trim controls and systems.* (a) Trim controls shall be designed to safeguard against inadvertent or abrupt operation.

(b) Each trim control shall operate in the plane and with the sense of motion of the airplane. (See fig. 4b–16.)

(c) Means shall be provided adjacent to the trim control to indicate the direction of the control movement relative to the airplane motion.

(d) Means shall be provided to indicate the position of the trim device with respect to the range of adjustment. The indicating means shall be clearly visible.

(e) Trim devices shall be capable of continued normal operation in the event of failure of any one connecting or transmitting element of the primary flight control system.

(f) Trim tab controls shall be irreversible, unless the tab is appropriately balanced and shown to be free from flutter.