

# CIVIL AIR REGULATIONS

## PART 3—AIRPLANE AIRWORTHINESS—NORMAL, UTILITY, ACROBATIC, AND RESTRICTED PURPOSE CATEGORIES

As amended to November 1, 1949

CIVIL AERONAUTICS BOARD  
WASHINGTON, D.C.

### SUBPART A—AIRWORTHINESS REQUIREMENTS

#### General

Sec.

3.1 Scope

3.2 Date of effectiveness.

#### AIRPLANE CATEGORIES

3.6 Airplane categories.

#### AIRWORTHINESS CERTIFICATES

3.11 Classification.

#### Type Certificates

3.15 Requirements for issuance.

3.16 Data required for NC and NR certification.

3.17 Inspection and tests for NC and NR certification.

3.18 Inspection.

3.19 Flight tests.

#### Changes

3.23 Changes.

3.24 Minor changes.

3.25 Major changes.

3.26 Service experience changes.

3.27 Application to earlier airworthiness requirements.

#### Approval of Materials, Parts, Processes, and Appliances

3.31 Specifications.

#### Definitions

3.41 Standard atmosphere.

3.42 Hot-day condition.

3.43 Airplane configuration.

- 3.44 Weights.
- 3.45 Power.
- 3.46 Speeds.
- 3.47 Structural terms.
- 3.48 Susceptibility of materials to fire.

### **Subpart B—Flight Requirements General**

- 3.61 Policy re proof of compliance.
- 3.62 Flight test pilot.
- 3.61 Policy re proof of compliance.
- 3.63 Noncompliance with test requirements.
- 3.64 Emergency egress.
- 3.65 Report.

#### Weight Range and Center of Gravity

- 3.71 Weight and balance.
- 3.72 Use of ballast.
- 3.73 Empty weight.
- 3.74 Maximum weight.
- 3.75 Minimum weight.
- 3.76 Center of gravity position.

#### Performance Requirements General

- 3.81 Performance.
- 3.82 Definition of stalling speeds.
- 3.83 Stalling speed.

#### Take-off

- 3.84 Take-off.

#### Climb

- 3.85 Climb.

#### Landing

- 3.86 Landing.

#### Flight Characteristics

- 3.105 Requirements.

#### Controllability

- 3.106 General.
- 3.107-U Approved acrobatic maneuvers.
- 3.108-A Acrobatic maneuvers.
- 3.109 Longitudinal control.
- 3.110 Lateral and directional control.

3.111 Minimum control speed ( $V_{mc}$ ).

#### Trim

3.112 Requirements.

#### Stability

3.113 General.

3.114 Static longitudinal stability.

3.115 Specific conditions.

3.116 Instrument stick force measurements.

3.117 Dynamic longitudinal stability.

3.118 Directional and lateral stability.

#### Stalls

3.120 Stalling demonstration.

3.121 Climbing stalls.

3.122 Turning flight stalls.

3.123 One-engine-inoperative stalls.

#### Spinning

3.124 Spinning.

#### Ground and Water Characteristics

3.143 Requirements.

3.144 Longitudinal stability and control.

3.145 Directional stability and control.

3.146 Shock absorption.

3.147 Spray characteristics.

#### Flutter and Vibration

3.159 Flutter and vibration.

### **Subpart C—Strength Requirements General**

3.171 Loads.

3.172 Factor of safety.

3.173 Strength and deformations.

3.174 Proof of structure.

#### Flight Loads

3.181 General.

3.182 Definition of flight load factor.

#### Symmetrical Flight Conditions (Flaps Retracted)

3.183 General.

- 3.184 Design air speeds.
- 3.185 Maneuvering envelope.
- 3.186 Maneuvering load factors.
- 3.187 Gust envelope.
- 3.188 Gust load factors.
- 3.189 Airplane equilibrium.

#### Flaps Extended Flight Conditions

- 3.190 Flaps extended flight conditions.

#### Unsymmetrical Flight Conditions

- 3.191 Unsymmetrical flight conditions.

#### Supplementary Conditions

- 3.194 Special condition for rear lift truss.
- 3.195 Engine torque effects.
- 3.196 Side load on engine mount.

#### Control Surface Loads

- 3.211 General.
- 3.212 Pilot effort.
- 3.213 Trim tab effects.

#### Horizontal Tail Surfaces

- 3.214 Horizontal tail surfaces.
- 3.215 Balancing loads.
- 3.216 Maneuvering loads.
- 3.214 Horizontal tail surfaces.
- 3.217 Gust loads.
- 3.218 Unsymmetrical loads.

#### Vertical Tail Surface

- 3.219 Maneuvering loads.
- 3.220 Gust loads.
- 3.221 Outboard fins.

#### Ailerons, Wing Flaps, Tabs, Etc.

- 3.222 Ailerons.
- 3.223 Wing flaps.
- 3.224 Tabs.
- 3.225 Special devices.

#### Control System Loads

- 3.231 Primary flight controls and systems.
- 3.232 Dual controls.
- 3.233 Ground gust conditions.

3.234 Secondary controls and systems.

#### Ground Loads

3.241 Ground loads.

3.242 Design weight.

3.243 Load factor for landing conditions.

#### Landing Cases and Attitudes

3.244 Landing cases and attitudes.

3.245 Level landing.

3.246 Tail down.

3.247 One-wheel landing.

#### Ground Roll Conditions

3.248 Braked roll.

3.249 Side load.

#### Tail Wheels

3.250 Supplementary conditions for tail wheels.

3.251 Obstruction load.

3.252 Side load.

#### Nose Wheels

3.253 Supplementary conditions for nose wheels.

3.254 Aft load.

3.255 Forward load.

3.256 Side load.

#### Skiplanes

3.257 Supplementary conditions for skiplanes.

#### Water Loads

3.265 General.

#### Design Weight

3.266 Design weight.

#### Boat Seaplanes

3.267 Local bottom pressures.

3.268 Distributed bottom pressures.

3.267 Local bottom pressures.

3.269 Step loading condition.

3.270 Bow loading condition.

3.271 Stern loading condition.

3.272 Side loading condition.

### Float Seaplanes

- 3.273 Landing with inclined reactions.
- 3.275 Landing with vertical reactions.
- 3.277 Landing with side load.
- 3.278 Supplementary load conditions.
- 3.279 Bottom loads.

### Wing-Tip Float and Sea Wing Loads

- 3.280 Wing-tip float loads.
- 3.281 Wing structure.
- 3.282 Sea wing loads.

### **Subpart D—Design and Construction General**

- 3.291 General.
- 3.292 Materials and workmanship.
- 3.293 Fabrication methods.
- 3.294 Standard fastenings.
- 3.295 Protection.
- 3.296 Inspection provisions.

### Structural Parts

- 3.301 Material strength properties and design values.
- 3.302 Special factors.
- 3.303 Variability factor.
- 3.304 Castings.
- 3.305 Bearing factors.
- 3.306 Fitting factor.
- 3.307 Fatigue strength.

### Flutter and Vibration

- 3.311 Flutter and vibration prevention measures.

### Wings

- 3.317 Proof of strength.
- 3.318 Ribs.
- 3.319 External bracing.
- 3.320 Covering.

### Control Surfaces (Fixed and Movable)

- 3.327 Proof of strength.
- 3.328 Installation.
- 3.329 Hinges.

### Control Systems

- 3.335 General.

- 3.336 Primary flight controls.
- 3.337 Trimming controls.
- 3.338 Wing flap controls.
- 3.339 Flap interconnection.
- 3.340 Stops.
- 3.341 Control system locks.
- 3.342 Proof of strength.
- 3.343 Operation test.

#### Control System Details

- 3.344 General.
- 3.345 Cable systems.
- 3.346 Joints.
- 3.347 Spring devices.

#### Landing Gear Shock Absorbers

- 3.351 Tests.
- 3.352 Shock absorption tests.
- 3.353 Limit drop tests.
- 3.354 Limit load factor determination.
- 3.355 Reserve energy absorption drop tests.

#### Retracting Mechanism

- 3.356 General.
- 3.357 Emergency operation.
- 3.358 Operation test.
- 3.359 Position indicator and warning device.
- 3.360 Control.

#### Wheels and Tires

- 3.361 Wheels.
- 3.362 Tires.

#### Brakes

- 3.363 Brakes.

#### Skis

- 3.364 Skis.
- 3.365 Installation
- 3.366 Tests.

#### Hulls and Floats

- 3.371 Buoyancy (main seaplane floats).
- 3.372 Buoyancy (boat seaplanes).
- 3.373 Water stability.

Fuselage  
Pilot Compartment

- 3.381 General.
- 3.382 Vision.
- 3.383 Pilot windshield and windows.
- 3.384 Cockpit controls.
- 3.385 Instruments and markings.

Emergency Provisions

- 3.386 Protection.
- 3.387 Exits.
- 3.388 Fire precautions.

Personnel and Cargo Accommodations

- 3.389 Doors.
- 3.390 Seats and berths.
- 3.391 Safety belt or harness provisions.
- 3.392 Cargo compartments.
- 3.393 Ventilation.

Miscellaneous

- 3.401 Leveling marks.

**SUBPART E —POWER-PLANT INSTALLATIONS; RECIPROCATING ENGINES**

General

- 3.411 Components.

Engines and Propellers

- 3.415 Engines.
- 3.416 Propellers.
- 3.417 Propeller vibration.
- 3.418 Propeller pitch and speed limitations.
- 3.419 Speed limitations for fixed pitch propellers, ground adjustable pitch propellers, and automatically varying pitch propellers which cannot be controlled in flight.
- 3.420 Speed and pitch limitations for controllable pitch propellers without constant speed controls.
- 3.421 Variable pitch propellers with constant speed controls.
- 3.422 Propeller clearance.

Fuel System

- 3.429 General.

Arrangement

- 3.430 Fuel system arrangement.



- 3.431 Multiengine fuel system arrangement.
- 3.432 Pressure cross feed arrangements.

#### Operation

- 3.433 Fuel flow rate.
- 3.434 Fuel flow rate for gravity feed systems.
- 3.435 Fuel flow rate for pump systems.
- 3.436 Fuel flow rate for auxiliary fuel systems and fuel transfer systems.
- 3.437 Determination of unusable fuel supply and fuel system operation on low fuel.
- 3.438 Fuel system hot weather operation.
- 3.439 Flow between interconnected tanks.

#### Fuel Tanks

- 3.440 General.
- 3.441 Fuel tank tests.
- 3.442 Fuel tank installation.
- 3.443 Fuel tank expansion space.
- 3.444 Fuel tank sump.
- 3.445 Fuel tank filler connection.
- 3.446 Fuel tank vents and carburetor vapor vents.
- 3.447 A Fuel tank vents.
- 3.448 Fuel tank outlet.

#### Fuel Pumps

- 3.449 Fuel pump and pump installation.

#### Lines, Fittings, and Accessories

- 3.550 Fuel system lines, fittings, and accessories.
- 3.551 Fuel valves.
- 3.552 Fuel strainer.

#### Drains and Instruments

- 3.553 Fuel system drains.
- 3.554 Fuel system instruments.

#### Oil System

- 3.561 Oil system.
- 3.562 Oil cooling.

#### Oil Tanks

- 3.563 Oil tanks.
- 3.564 Oil tank tests.
- 3.565 Oil tank installation.
- 3.566 Oil tank expansion space.
- 3.567 Oil tank filler connection.
- 3.568 Oil tank vent.

3.569 Oil tank outlet.

#### Lines, Fittings, and Accessories

3.570 Oil system lines, fittings, and accessories.

3.571 Oil valves.

3.572 Oil radiators.

3.573 Oil filters.

3.574 Oil system drains.

3.575 Engine breather lines.

3.576 Oil system instruments.

3.577 Propeller feathering system.

#### Cooling

3.581 General.

#### Tests

3.582 Cooling tests.

3.583 Maximum anticipated summer air temperatures.

3.584 Correction factor for cylinder head, oil inlet, carburetor, air, and engine coolant inlet temperatures.

3.585 Correction factor for cylinder barrel temperatures.

3.586 Cooling test procedure for single-engine airplanes.

3.587 Cooling test procedure for multiengine airplanes.

#### Liquid Cooling Systems

3.588 Independent systems.

3.589 Coolant tank.

3.590 Coolant tank tests.

3.591 Coolant tank installation.

3.592 Coolant tank filler connection.

3.593 Coolant lines, fittings, and accessories.

3.594 Coolant radiators.

3.595 Cooling system drains.

3.596 Cooling system instruments.

#### Induction System

3.605 General.

3.606 Induction system de-icing and antiicing provisions.

3.607 Carburetor de-icing fluid flow rate.

3.608 Carburetor fluid de-icing system capacity.

3.609 Carburetor fluid de-icing system detail design.

3.610 Carburetor air preheater design.

3.611 Induction system ducts.

3.612 Induction system screens.

#### Exhaust System

- 3.615 General.
- 3.616 Exhaust manifold.
- 3.617 Exhaust heat exchangers.
- 3.618 Exhaust heat exchangers used in ventilating air heating systems.

#### Fire Wall and Cowling

- 3.623 Fire walls.
- 3.624 Fire wall construction.
- 3.625 Cowling.

#### Power-Plant Controls and Accessories Controls

- 3.627 Power-plant controls.
- 3.628 Throttle controls.
- 3.629 Ignition switches.
- 3.630 Mixture controls.
- 3.631 Propeller speed and pitch controls.
- 3.632 Propeller feathering controls.
- 3.633 Fuse system controls.
- 3.634 Carburetor air preheat controls.

#### Accessories

- 3.635 Power-plant accessories.
- 3.636 Engine battery ignition systems.

#### Power-Plant Fire Protection

- 3.637 Power-plant fire protection.

### **Subpart F- Equipment**

- 3.651 General.
- 3.652 Functional and installational requirements.

#### Basic Equipment

- 3.655 Required basic equipment.

#### Instruments; Installation General

- 3.661 Arrangement and visibility of instrument installations.
- 3.662 Instrument panel vibration characteristics.

#### Flight and Navigational Instruments

- 3.663 Air-speed indicating system.
- 3.664 Air-speed indicator marking.
- 3.665 Static air vent system.
- 3.666 Magnetic direction indicator.
- 3.667 Automatic pilot system.

- 3.668 Gyroscopic indicators (air-driven type).
- 3.669 Suction gauge.

#### Power-Plant Instruments

- 3.670 Operational markings.
- 3.671 Instrument lines.
- 3.672 Fuel quantity indicator.
- 3.673 Fuel flowmeter system.
- 3.674 Oil quantity indicator.
- 3.675 Cylinder head temperature indicating system for air-cooled engines.
- 3.676 Carburetor air temperature indicating system.

#### Electrical Systems and Equipment

- 3.681 Installation.

#### Batteries

- 3.682 Batteries.
- 3.683 Protection against acid.
- 3.684 Battery vents.

#### Generators

- 3.685 Generator.
- 3.686 Generator controls.
- 3.687 Reverse current cut-out.

#### Master Switch

- 3.688 Arrangement.
- 3.689 Master switch installation.

#### Protective Devices

- 3.690 Fuses or circuit breakers.
- 3.691 Protective devices installation.
- 3.692 Spare fuses.

#### Electric Cables

- 3.693 Electric cables.

#### Switches

- 3.694 Switches.
- 3.695 Switch installation.

#### Instrument Lights

- 3.696 Instrument lights.
- 3.697 Instrument light installation.

#### Landing Lights

- 3.698 Landing lights.
- 3.699 Landing light installation.

#### Position Lights

- 3.700 Type.
- 3.701 Forward position light installation.
- 3.702 Rear position light installation.
- 3.703 Flashing rear position lights.

#### Anchor Lights

- 3.704 Anchor light.
- 3.705 Anchor light installation.

#### Safety Equipment; Installation

- 3.711 Marking.
- 3.712 De-icers.
- 3.713 Flare requirements.
- 3.714 Flare installation.
- 3.715 Safety belts.

#### Emergency Flotation and Signaling Equipment

- 3.716 Rafts and life preservers.
- 3.717 Installation.
- 3.718 Signaling device.

#### Radio Equipment; Installation

- 3.721 General.

#### Miscellaneous Equipment; Installation

- 3.725 Accessories for multiengine airplanes.

#### Hydraulic Systems

- 3.726 General.
- 3.727 Tests.
- 3.728 Accumulators.

### **Subpart G - Operating Limitation and Information**

- 3.735 General.

#### Limitations

- 3.737 Limitations.

#### Air Speed

- 3.738 Air speed.
- 3.739 Never exceed speed (Vne).
- 3.740 Maximum structural cruising speed (Vno).

- 3.741 Maneuvering speed ( $V_p$ ).
- 3.742 Flaps-extended speed ( $V_{fe}$ ).
- 3.743 Minimum control speed ( $V_{mc}$ ).

#### Power Plant

- 3.744 Power plant.
- 3.745 Take-off operation.
- 3.746 Maximum continuous operation.
- 3.747 Fuel octane rating.

#### Airplane Weight

- 3.748 Airplane weight.

#### Minimum Flight Crew

- 3.749 Minimum flight crew.

#### Types of Operation

- 3.750 Types of operation.

#### Markings and Placards

- 3.755 Markings and placards.

#### Instrument Markings

- 3.756 Instrument markings.
- 3.757 Air-speed indicator.
- 3.758 Magnetic direction indicator.
- 3.759 Power-plant instruments.
- 3.760 Oil quantity indicators.
- 3.761 Fuel quantity indicator.

#### Control Markings

- 3.762 General.
- 3.763 Aerodynamic controls.
- 3.764 Power-plant fuel controls.
- 3.765 Accessory and auxiliary controls.

#### Miscellaneous

- 3.766 Baggage compartments, ballast location, and special seat loading limitations.
- 3.767 Fuel, oil, and coolant filler openings.
- 3.768 Emergency exit placards.
- 3.769 Approved flight maneuvers.
- 3.770 Airplane category placard.

#### Airplane Flight Manual

- 3.777 Airplane Flight Manual.
- 3.778 Operating limitations.

3.779 Operating procedures.  
3.780 Performance information.

## **Subpart H - Identification Data**

3.791 Name plate.  
3.792 Airworthiness certificate number.

AUTHORITY: §§ 3.1 to 3.792 issued under sec. 205(a), 52 Stat. 984; 49 U. S. C. 425(a).  
Interpret or apply secs. 601; 52 Stat. 1007; 49 U.S.C. 551.

SOURCE: §§ 3.1 to 3.792 contained in Amendment 03-0, Civil Air Regulations, 11 F.R. 13368, except as noted following sections affected. Redesignated at 13 F.R. 5486.

## **SUBPART A—AIRWORTHINESS REQUIREMENTS GENERAL**

§ 3.1 Scope. An airplane which has no features or characteristics rendering it unsafe for the category for which it is to be certificated is eligible for type and airworthiness certification, if it complies with all applicable provisions of this part, or, in the event it does not so comply, if it is shown to meet the same level of safety as that provided for in this part.

§ 3.2 Date of effectiveness.

(a) Airplanes certificated as a type on or after November 13, 1945, shall comply either with (1) the entire provisions of Part 4a of this chapter in effect immediately prior to November 9, 1945, or (2) the entire provisions prescribed in this part, except that airplanes certificated under (1) may incorporate provisions of (2) when the Administrator finds the standard of safety to be equivalent to the particular and all related items of the latter.

(b) Airplanes certificated as a type on or after January 1, 1947, shall comply with the provisions contained in this part. If the prototype is not flown prior to January 1, 1947, and satisfactory evidence is presented indicating that the design work of the type was well advanced prior to November 13, 1945, and the delay of completion of the airplane was due to causes beyond the manufacturer's control, the Administrator may certificate the airplane as a type under the provisions of Part 4a of this chapter which were in effect prior to November 9, 1945.

(c) Unless otherwise specified, compliance with an amendment to this part shall be mandatory only for airplanes for which application for a type certificate has been received subsequent to the effective date of such amendment.

## **AIRPLANE CATEGORIES**

§ 3.6 Airplane categories.

(a) In this part airplanes are divided upon the basis of their intended operation into the following categories for the purpose of certification.

(1) *Normal—Suffix "N"*. Airplanes in this category are intended for nonacrobatic, nonscheduled passenger, and nonscheduled cargo operation.

(2) *Utility—Suffix "U"*. Airplanes in this category are intended for normal operations and limited acrobatic maneuvers. These airplanes are not suited for use in snap or inverted maneuvers.

NOTE: The following interpretation of paragraph (a) (2) was issued May 15, 1947, 12 F.R. 3434: The phrase "limited acrobatic maneuvers" as used in § 3.6 is interpreted to include steep turns, spins, stalls (except whip stalls), lazy eights, and chandelles.

(3) *Acrobatic—Suffix "A"*. Airplanes in this category will have no specific restrictions as to type of maneuver permitted unless the necessity therefor is disclosed by the required flight tests.

(4) *Restricted purpose—Suffix "R"*. Airplanes in this category are intended to be operated for restricted purposes not logically encompassed by the foregoing categories. The requirements of this category shall consist of all of the provisions for any one of the foregoing categories which are not rendered inapplicable by the nature of the special purpose involved, plus suitable operating restrictions which the Administrator finds will provide a level of safety equivalent to that contemplated for the foregoing categories.

(b) An airplane may be certificated under the requirements of a particular category, or in more than one category, provided that all of the requirements of such categories are met. Sections of this part which apply to only one or more, but not all, categories are identified in this part by the appropriate suffixes, as indicated above, added to the section number. All sections not identified by a suffix are applicable to all categories except as otherwise specified.

NOTE: For rules governing the eligibility of airplanes certificated under this part for use in air carrier operations see Parts 40, 41, 42, and 61 of this chapter.

## **AIRWORTHINESS CERTIFICATES**

### § 3.11 Classification.

(a) Airworthiness certificates are classified as follows:

(1) *NC (standard) certificates*. In order to become eligible for an NC (standard) certificate, an airplane must be shown to comply with the requirements contained in this part for at least one category, but not the restricted-purpose category.



(2) *NR (restricted) certificates.* In order to become eligible for an NR (restricted) certificate, an airplane must be shown to comply with the requirements of the restricted purpose category.

(3) *NX (experimental) certificates.* An airplane will become eligible for an NX (experimental) certificate when the applicant presents satisfactory evidence that the airplane is to be flown for experimental purposes and the Administrator finds it may, with appropriate restrictions, be operated for that purpose in a manner which does not endanger the general public. Airplanes used in racing and exhibition flying may be issued NX (experimental) certificates under the terms of this section. The applicant shall submit sufficient data, such as photographs, to identify the airplane satisfactorily and, upon inspection of the airplane, any pertinent information found necessary by the Administrator to safeguard the general public.

(b) An airplane manufactured in accordance with a type certificate (see §§ 3.15-3.19) and conforming with the type design will become eligible for an airworthiness certificate when, upon inspection of the airplane, the Administrator determines it so to conform and that the airplane is in a condition for safe operation. For each newly manufactured airplane this determination shall include a flight check by the applicant.

(Amdt. 03-0, 11 F.R. 133.68, as amended by Amdt. 03-4, 13 F.R. 2965)

## **TYPE CERTIFICATES**

§ 3.15 *Requirements for issuance.* A type certificate will be issued when the following requirements of §§ 3.16 to 3.19 are met.

§ 3.16 *Data required for NC and NR certification.* The applicant for a type certificate shall submit to the Administrator such descriptive data, test reports, and computations as are necessary to demonstrate that the airplane complies with the airworthiness requirements. The descriptive data shall be known as the type design and shall consist of drawings and specifications disclosing the configuration of the airplane and all design features covered in the airworthiness requirements as well as sufficient information on dimensions, materials, and processes to define the strength of the structure. The type design shall describe the airplane in sufficient detail to permit the airworthiness of subsequent airplanes of the same type to be determined by comparison with the type design.

[Amdt. 03-0, 11 F.R. 13368, as amended by Amdt. 03-4, 13 F.R. 2965]

§ 3.17 *Inspection and tests for NC and NR certification.* The authorized representatives of the Administrator shall have access to the airplane and may witness or conduct such inspections and tests as are necessary to determine compliance with the airworthiness requirements.

[Amdt. 03-0, 11 F.R. 13368, as amended by Amdt. 03-4, 13 F.R. 2965]

§ 3.18 *Inspection.* Inspections and tests shall include all those found necessary by the Administrator to insure that the airplane conforms with the following:

(a) All materials and products are in accordance with the specification given in the type design.

(b) All parts of the airplane are constructed in accordance with the drawings contained in the type design.

(c) All manufacturing processes, construction, and assembly are such that the design strength and safety contemplated by the type design will be realized in service.

§ 3.19 *Flight tests.* (Applicable to all airplanes certificated as a type on or after May 15, 1947.) After proof of compliance with the structural requirements contained in this part, and upon completion of all necessary inspection and testing on the ground, and proof of the conformity of the airplane with the type design, and upon receipt from the applicant of a report of flight tests conducted by him, there shall be conducted such official flight tests as the Administrator finds necessary to determine compliance with §§ 3.61 through 3.780. After the conclusion of these flight tests such additional flight tests shall be conducted as the Administrator finds necessary to ascertain whether there is reasonable assurance that the airplane, its components, and equipment are reliable and function properly. The extent of such additional flight tests shall depend upon the complexity of the airplane, the number and nature of new design features, and the record of previous tests and experience for the particular airplane model, its components, and equipment. If practicable, the flight tests performed for the purpose of ascertaining the reliability and proper functioning shall be conducted on the same airplane which was used in flight tests to show compliance with §§ 3.61 through 3.780.

[Amdt. 03-1, 12 F.R. 1028, as amended by Amdt. 03-2, 12 F.R. 2086]

## **CHANGES**

§ 3.23 *Changes.* Changes shall be substantiated to demonstrate compliance of the airplane with the appropriate airworthiness requirements in effect when the particular airplane was certificated as a type, unless the holder of the type certificate chooses to show compliance with the currently effective requirements subject to the approval of the Administrator, or unless the Administrator finds it necessary to require compliance with current airworthiness requirements.

§ 3.24 *Minor changes.* Minor changes to certificated airplanes which obviously do not impair the condition of the airplane for safe operation shall be approved by the authorized representatives of the Administrator prior to the submittal to the Administrator of any required revised drawings.

§ 3.25 *Major changes.* A major change is any change not covered by minor changes as defined in § 3.24.

§ 3.26 *Service experience changes.* When experience shows that any particular part of characteristic of an airplane is unsafe, the holder of the type certificate for such airplane shall submit for approval of the Administrator the design changes which are necessary to correct the

unsafe condition after the unsafe condition becomes known the Administrator shall withhold the issuance of airworthiness certificates for additional airplanes of the type involved until he has approved the design changes and until the additional airplanes are modified to include such changes. Upon approval by the Administrator the design changes shall be considered as a part of the type design, and descriptive data covering these changes shall be made available by the holder of the type certificate to all owners of airplanes previously certificated under such type certificate.

§ 3.27 *Application to earlier airworthiness requirements.* In the case of airplanes approved as a type under the terms of earlier airworthiness requirements, the Administrator may require that an airplane submitted for an original airworthiness certificate comply with such portions of the currently effective airworthiness requirements as may be necessary for safety.

## **APPROVAL OF MATERIALS, PARTS, PROCESSES, AND APPLIANCES**

§ 3.31 Specifications.

(a) Materials, parts, processes, and appliances shall be approved upon a basis and in a manner found necessary by the Administrator to implement the pertinent provisions of this subchapter. The Administrator may adopt and publish such specifications as he finds necessary to administer this section, and shall incorporate therein such portions of the aviation industry, Federal, and military specifications respecting such materials, parts, processes, and appliances as he finds appropriate.

(b) Any material, part, process, or appliance shall be deemed to have met the requirements for approval when it meets the pertinent specifications adopted by the Administrator, and the manufacturer so certifies in a manner prescribed by the Administrator.

[Amdt. 03-3, 12 F.R. 7898]

## **DEFINITIONS**

§ 3.41 *Standard atmosphere.* The standard atmosphere shall be based upon the following assumptions:

- (a) The air is a dry perfect gas.
- (b) The temperature at sea level is 59° F.
- (c) The pressure at sea level is 29.92 inches Hg.
- (d) The temperature gradient from sea level to the altitude at which the temperature becomes -67° F. is -0.003566° F. per foot and zero there above.
- (e) The density  $\rho_0$  at sea level under the above conditions is 0.002378 lbs. sec.<sup>2</sup>/ft<sup>4</sup>.

§ 3.42 *Hot-day condition*. See § 3.583.

§ 3.43 *Airplane configuration*. This term refers to the position of the various elements affecting the aerodynamic characteristics of the airplane, such as landing gear and flaps.

§ 3.44 Weights.

	Reference sections
Empty weight: The actual weight used as a basis for determining operating weights	3.73
Maximum weight: The maximum weight at which the airplane may operate in accordance with the airworthiness requirements	3.74
Minimum weight: The minimum weight at which compliance with the airworthiness requirements is demonstrated.	3.75
Maximum design weight: The maximum weight used for the structural design of the airplane.	3.181
Minimum design weight: The minimum weight condition investigated in the structural flight load conditions, not greater than the minimum weight specified in §3.75.	3.181
Design landing weight: The weight used in the structural investigation of the airplane for normal landing conditions. Under the provisions of §3.242, this weight may be equal to or less than the maximum design weight.	3.242

Unit weights for design purposes:

Gasoline..... 6 pounds per United States gallon.

Lubricating oil..... 7.5 pounds per United States gallon.

Crew and passengers.... 170 pounds per person.

§ 3.45 Power.

One horsepower: 33,000 foot-pounds per minute.

Take-off power: the take-off rating of the engine established in accordance with Part 13, Aircraft Engine Airworthiness.

Maximum continuous power: The maximum continuous rating of the engine established in accordance with Part 13, Aircraft Engine Airworthiness.

§ 3.46 Speeds.

$V_t$  True air speed of the airplane relative to the undisturbed air.

In the following symbols having subscripts,  $V$  denotes:

- (a) "Equivalent" air speed for structural design purposes equal to  $\sqrt{\rho_0} V_{eip}$
- (b) "True indicated" or "calibrated" air speed for performance and operating purposes equal to indicator reading corrected for position and instrument errors.

	Reference sections
$V_{s0}$ stalling speed, in the land configuration.	3.82
$V_{s1}$ stalling speed in the configurations specified for particular conditions.	3.82
$V_{sf}$ computed stalling speed at design landing weight with flaps fully deflected.	3.190
$V_x$ speed for best angle of climb.	3.111
$V_y$ speed for best rate of climb.	
$V_{mc}$ minimum control speed.	
$V_f$ design speed for flight load conditions with flaps in landing position.	3.190
$V_{fe}$ flaps-extended speed.	3.742
$V_p$ design maneuvering speed.	3.184
$V_c$ design cruising speed.	3.184
$V_d$ design dive speed	3.184
$V_{ne}$ never-exceed speed.	3.739
$V_{no}$ maximum structural cruising speed.	3.740

$V_h$  maximum speed in level flight at maximum continuous power.

### § 3.47 *Structural terms.*

Structure: Those portions of the airplane the failure of which would seriously endanger the safety of the airplane.

Design wing area,  $S$ : The area enclosed by the wing outline (including ailerons, and flaps in the retracted position, but ignoring fillets and fairings) on a surface containing the wing chords. The outline is assumed to extend through the nacelles and fuselage to the centerline of symmetry.

Aerodynamic coefficients:  $C_L$ ,  $C_N$ ,  $C_M$ , etc., used in this part, are nondimensional coefficients for the forces and moments acting on an airfoil, and correspond to those adopted by the United States National Advisory Committee for Aeronautics.

$C_L$  = airfoil lift coefficient.

$C_N$  = airfoil normal force coefficient (normal to wing chord line).

CNA = airplane normal force coefficient (based on lift of complete airplane and design wing area).

CM = pitching moment coefficient.

Loads	Reference Sections
Limit load: The maximum load anticipated in service.	8.171
Ultimate load: The maximum load which a part of structure must be capable of supporting.	8.173
Factor of safety: The factor by which the limit load must be multiplied to establish the ultimate load.	8.172

Load factor or acceleration factor,  $n$ : The ratio of the force acting on a mass to the weight of the mass. When the force in question represents the net external load acting on the airplane in a given direction,  $n$  represents the acceleration in that direction in terms of the gravitational constant.

Limit load factor: The load factor corresponding to limit load.

Ultimate load factor: The load factor corresponding to ultimate load.

§ 3.48 *Susceptibility of materials to fire.* Where necessary for the purpose of determining compliance with any of the definitions in this section, the Administrator shall prescribe the heat conditions and testing procedures which any specific material or individual part must meet.

(a) *Fireproof.* "Fireproof" material means a material which will withstand heat equally well or better than steel in dimensions appropriate for the purpose for which it is to be used. When applied to material and parts used to confine fires in designated fire zones "fireproof" means that the material or part will perform this function under the most severe conditions of fire and duration likely to occur in such zones.

(b) *Fire-resistant.* When applied to sheet or structural members, "fire-resistant" material shall mean a material which will withstand heat equally well or better than aluminum alloy in dimensions appropriate for the purpose for which it is to be used. When applied to fluid-carrying lines, this term refers to a line and fitting assembly which will perform its intended protective functions under the heat and other conditions likely to occur at the particular location.

(c) *Flames-resistant.* "Flame-resistant" material means material which will not support combustion to the point of propagating, beyond safe limits, a flame after removal of the ignition source.

(d) *Flash-resistant.* "Flash-resistant" material means material which will not burn violently when ignited.

(e) Inflammable. "Inflammable" fluids or gases means those which will ignite readily or explode.

## **SUBPART B—FLIGHT REQUIREMENTS GENERAL**

§ 3.61 *Policy re proof of compliance.* Compliance with the requirements specified in this subpart governing functional characteristics shall be demonstrated by suitable flight or other tests conducted upon an airplane of the type, or by calculations based upon the test data referred to above, provided that the results so obtained are substantially equal in accuracy to the results of direct testing. Compliance with each requirement must be provided at the critical combination of airplane weight and center of gravity position within the range of either for which certification is desired. Such compliance must be demonstrated by systematic investigation of all probable weight and center of gravity combinations or must be reasonably inferable from such as are investigated.

§ 3.62 *Flight test pilot.* The applicant shall provide a person holding an appropriate pilot certificate to make the flight tests, but a designated representative of the Administrator may pilot the airplane insofar as that may be necessary for the determination of compliance with the airworthiness requirements.

§ 3.63 *Noncompliance with test requirements.* Official type tests will be discontinued until corrective measures have been taken by the applicant when either:

(a) The applicant's test pilot is unable or unwilling to conduct any of the required flight tests; or

(b) Items of noncompliance with requirements are found which may render additional test data meaningless or are of such nature as to make further testing unduly hazardous.

§ 3.64 *Emergency egress.* Adequate provisions shall be made for emergency egress and use of parachutes by members of the crew during the flight tests.

§ 3.65 *Report.* The applicant shall submit to the representative of the Administrator a report covering all computations and tests required in connection with calibration of instruments used for test purposes and correction of test results to standard atmospheric conditions. The representative of the Administrator will conduct any flight tests which he finds to be necessary in order to check the calibration and correction report.

## **WEIGHT RANGE AND CENTER OF GRAVITY**

§ 3.71 *Weight and balance.*

(a) There shall be established, as a part of the type inspection, ranges of weight and center of gravity within which the airplane may be safely operated.

(b) When low fuel adversely affects balance or stability, the airplane shall be so tested as to simulate the condition existing when the amount of usable fuel on board does not exceed 1 gallon for every 12 maximum continuous horsepower of the engine or engines installed.

§ 3.72 *Use of ballast.* Removable ballast may be used to enable airplanes to comply with the flight requirements in accordance with the following provisions:

(a) The place or places for carrying ballast shall be properly designed, installed, and plainly marked as specified in § 3.766.

(b) The Airplane Flight Manual shall include instructions regarding the proper disposition of the removable ballast under all loading conditions for which such ballast is necessary, as specified in § 3.755-3.770.

§ 3.73 *Empty weight.* The empty weight and corresponding center of gravity location shall include all fixed ballast, the unusable fuel supply (see § 3.437), undrainable oil, full engine coolant, and hydraulic fluid. The weight and location of items of equipment installed when the airplane is weighed shall be noted in the Airplane Flight Manual.

§ 3.74 *Maximum weight.* The maximum weight shall not exceed any of the following:

(a) The weight selected by the applicant.

(b) The design weight for which the structure has been proven.

(c) The maximum weight at which compliance with all of the requirements specified is demonstrated, and shall not be less than the sum of the weights of the following:

(1) The empty weight as defined by § 3.73.

(2) One gallon of usable fuel (see § 3.437) for every seven maximum continuous horsepower for which the airplane is certificated.

(3) The full oil capacity.

(4) 170 pounds in all seats (normal category) or 190 pounds in all seats (utility and acrobatic category) unless placarded otherwise.

§ 3.75 *Minimum weight.* The minimum weight shall not exceed the sum of the weights of the following:

(a) The empty weight is defined by § 3.73.

(b) The minimum crew necessary to operate the airplane (170 pounds for each crew member).



(c) One gallon of usable fuel (see § 3.437) for every 12 maximum continuous horsepower for which the airplane is certificated.

(d) Either 1 gallon of oil for each 25 gallons of fuel specified in (c) or 1 gallon of oil for each 75 maximum continuous horsepower for which the airplane is certificated, whichever is greater.

§ 3.76 *Center of gravity position.* If the center of gravity position under any possible loading condition between the maximum weight as specified in § 3.74 and the minimum weight as specified in § 3.75 lies beyond (a) the extremes selected by the applicant, or (b) the extremes for which the structure has been proven, or (c) the extremes for which compliance with all functional requirements were demonstrated, loading instructions shall be provided in the Airplane Flight Manual as specified in § 3.777-3.780.

## **PERFORMANCE REQUIREMENTS GENERAL**

§ 3.81 *Performance.* The following items of performance shall be determined and the airplane shall comply with the corresponding requirements in standard atmosphere and still air.

§ 3.82 *Definition of stalling speeds.*

(a)  $V_{so}$  denotes the true indicated stalling speed, if obtainable, or the minimum steady flight speed at which the airplane is controllable, in miles per hour, with:

- (1) Engines idling, throttles closed (or not more than sufficient power for zero thrust),
- (2) Propellers in position normally used for take-off,
- (3) Landing gear extended,
- (4) Wing flaps in the landing position,
- (5) Cowl flaps closed,
- (6) Center of gravity in the most unfavorable position within the allowable landing range,

(7) The weight of the airplane equal to the weight in connection with which  $V_{so}$  is being used as a factor to determine a required performance.

(b)  $V_{s1}$  denotes the true indicated stalling speed, if obtainable, otherwise the calculated value in miles per hour, with:

- (1) Engines idling, throttles closed (or not more than sufficient power for zero thrust),

(2) Propellers in position normally used for take-off, the airplane in all other respects (flaps, landing gear, etc.) in the particular condition existing in the particular test in connection with which  $V_{s1}$  is being used,

(3) The weight of the airplane equal to the weight in connection with which  $V_{s1}$  is being used as a factor to determine a required performance.

(c) These speeds shall be determined by flight tests using the procedure outlined in §3.120.

§ 3.83 *Stalling speed.*  $V_{so}$  at maximum weight shall not exceed 70 miles per hour for (1) single-engine airplanes and (2) multiengine airplanes which do not have the rate of climb with critical engine inoperative specified in §3.85 (b).

## **TAKE-OFF**

§ 3.84 Take-off.

(a) The distance required to take off and climb over a 50-foot obstacle shall be determined under the following conditions:

- (1) Most unfavorable combination of weight and center of gravity location,
- (2) Engines operating within the approved limitations,
- (3) Cowl flaps in the position normally used for take-off.

(b) Upon obtaining a height of 50 feet above the level take-off surface, the airplane shall have attained a speed of not less than  $1.3 V_{s1}$  unless a lower speed of not less than  $V_x$  plus 5 can be shown to be safe under all conditions, including turbulence and complete engine failure.

(c) The distance so obtained, the type of surface from which made, and the pertinent information with respect to the cowl flap position, the use of flight-path control devices and landing gear retraction system shall be entered in the Airplane Flight Manual. The take-off shall be made in such a manner that its reproduction shall not require an exceptional degree of skill on the part of the pilot or exceptionally favorable conditions.

## **CLIMB**

§ 3.85 *Climb*—

(a) Normal climb condition. The steady rate of climb at sea level shall be at least 300 feet per minute, and the steady angle of climb at least 1:12 for landplanes or 1:15 for seaplanes with:

- (1) Not more than maximum continuous power on all engines,

- (2) Landing gear fully retracted,
- (3) Wing flaps in take-off position,
- (4) Cowl flaps in the position used in cooling tests specified in §§ 3.581-3.596.

(b) Climb with inoperative engine. All multiengine airplanes having a stalling speed  $V_{so}$  greater than 70 miles per hour or a maximum weight greater than 6,000 pounds shall have a steady rate of climb of at least  $0.02 V_{so}$  in feet per minute at an altitude of 5,000 feet with the critical engine inoperative and:

- (1) The remaining engines operating at not more than maximum continuous power,
- (2) The inoperative propeller in the minimum drag position,
- (3) Landing gear retracted,
- (4) Wing flaps in the most favorable position,
- (5) Cowl flaps in the position used in cooling tests specified in §§ 3.581-3.596.

(c) Balked landing conditions. The steady angle of climb at sea level shall be at least 1:30 with:

- (1) Take-off power on all engines,
- (2) Landing gear extended,

(3) Wing flaps in landing position. If rapid retraction is possible with safety without loss of altitude and without requiring sudden changes of angle of attack or exceptional skill on the part of the pilot, wing flaps may be retracted.

## **LANDING**

### *§ 3.86 Landing*

(a) The horizontal distance required to land and to come to a complete stop (to a speed of approximately 3 miles per hour for seaplanes or float planes) from a point at a height of 50 feet above the landing surface shall be determined as follows:

(1) Immediately prior to reaching the 50-foot altitude, a steady gliding approach shall have been maintained, with a true indicated air speed of at least  $1.3 V_{so}$ .

(2) The landing shall be made in such a manner that there is no excessive vertical acceleration, no tendency to bounce, nose over, ground loop, porpoise, or water loop, and in such

a manner that its reproduction shall not require any exceptional degree of skill on the part of the pilot or exceptionally favorable conditions.

(b) The distance so obtained, the type of landing surface on which made and the pertinent information with respect of cowl flap position, and the use of flight path control devices shall be entered in the Airplane Flight Manual.

## FLIGHT CHARACTERISTICS

§ 3.105 Requirements. The airplane shall meet the requirements set forth in §§ 3.106 to 3.124 at all normally expected operating altitudes under all critical loading conditions within the range of center of gravity and, except as otherwise specified, at the maximum weight for which certification is sought.

## CONTROLLABILITY

§ 3.106 *General*. The airplane shall be satisfactorily controllable and maneuverable during take-off, climb, level flight, drive, and landing with or without power. It shall be possible to make a smooth transition from one flight condition to another, including turns and slips, without requiring an exceptional degree of skill, alertness, or strength on the part of the pilot, and without danger of exceeding the limit load factor under all conditions of operation probable for the type, including for multiengine airplanes those conditions normally encountered in the event of sudden failure of any engine. Compliance with "strength of pilots" limits need not be demonstrated by quantitative tests unless the Administrator finds the condition to be marginal. In the latter case they shall not exceed maximum values found by the Administrator to be appropriate for the type but in no case shall they exceed the following limits:

	Pitch	Roll	Yaw
(a) For temporary application:			
Stick	60	30	150
Wheel <sup>1</sup>	75	60	150
(b) For prolonged application.	10	5	20

<sup>1</sup>Applied to rim.

§ 3.107-U *Approved acrobatic maneuvers*. It shall be demonstrated that the approved acrobatic maneuvers can be performed safely. Safe entry speeds shall be determined for these maneuvers.

§ 3.108-A *Acrobatic maneuvers*. It shall be demonstrated that acrobatic maneuvers can be performed readily and safely. Safe entry speeds shall be determined for these maneuvers.

§ 3.109 *Longitudinal control.* The airplane shall be demonstrated to comply with the following requirements:

(a) It shall be possible at all speeds below  $V_x$  to pitch the nose downward so that the rate of increase in air speed is satisfactory for prompt acceleration of  $V_x$  with:

(1) Maximum continuous power on all engines, the airplane trimmed at  $V_x$ .

(2) Power off, the airplane trimmed at  $1.4 V_{s1}$ .

(3) (i) Wing flaps and landing gear extended and

(ii) Wing flaps and landing gear retracted.

(b) During each of the controllability demonstrations outlined below it shall not require a change in the trim control or the exertion of more control force than can be readily applied with one hand for a short period. Each maneuver shall be performed with the landing gear extended.

(1) With power off, flaps retracted, and the airplane trimmed at  $1.4 V_{s1}$ , the flaps shall be extended as rapidly as possible while maintaining the air speed at approximately 40 percent above the instantaneous value of the stalling speed.

(2) Same as subparagraph (1) of this paragraph, except the flaps shall be initially extended and the airplane trimmed at  $1.4 V_{s1}$ , then the flaps shall be retracted as rapidly as possible.

(3) Same as subparagraph (2) of this paragraph, except maximum continuous power shall be used.

(4) With power off, the flaps retracted, and the airplane trimmed at  $1.4 V_{s1}$ , take-off power shall be applied quickly while the same air speed is maintained.

(5) Same as subparagraph (4) of this paragraph, except with the flaps extended.

(6) With power off, flaps extended, and the airplane trimmed at  $1.4 V_{s1}$ , air speeds within the range of  $1.1 V_{s1}$  to  $1.7 V_{s1}$  or  $V_f$  whichever is the lesser, shall be obtained and maintained.

(c) It shall be possible without the use of exceptional piloting skill to maintain essentially level flight when flap retraction from any position is initiated during steady horizontal flight at  $1.1 V_{s1}$  with simultaneous application of not more than maximum continuous power.

§ 3.110 Lateral and directional control.

(a) It shall be possible with multiengine airplanes to execute 15-degree banked turns both with and against the inoperative engine from steady climb at 1.4  $V_{s1}$  or  $V_y$  for the condition with:

- (1) Maximum continuous power on the operating engines,
- (2) Rearmost center of gravity,
- (3) (i) Landing gear retracted and (ii) Landing gear extended.
- (4) Wing flaps in most favorable climb position,
- (5) Maximum weight,
- (6) The inoperative propeller in its minimum drag condition.

(b) It shall be possible with multiengine airplanes, while holding the wings level laterally within 5 degrees, to execute sudden changes in heading in both directions without dangerous characteristics being encountered. This shall be demonstrated at 1.4  $V_{s1}$  or  $V_y$  up to heading changes of 15 degrees, except that the heading change at which the rudder force corresponds to that specified in § 3.106 need not be exceeded, with:

- (1) The critical engine inoperative,
- (2) Maximum continuous power on the operating engine(s),
- (3) (i) Landing gear retracted and (ii) Landing gear extended,
- (4) Wing flaps in the most favorable climb position,
- (5) The inoperative propeller in its minimum drag condition,
- (6) The airplane center of gravity at its rearmost position.

### § 3.111 Minimum control speed ( $V_{mc}$ ).

(a) A minimum speed shall be determined under the conditions specified below, such that when any one engine is suddenly made inoperative at that speed, it shall be possible to recover control of the airplane, with the one engine still inoperative, and to maintain it in straight flight at that speed, either with zero yaw or, at the option of the applicant, with a bank not in excess of 5 degrees. Such speed shall not exceed 1.3  $V_{s1}$ , with:

- (1) Take-off or maximum available power on all engines,
- (2) Rearmost center of gravity,

(3) Flaps in take-off position,

(4) Landing gear retracted.

(b) In demonstrating this minimum speed, the rudder force required to maintain it shall not exceed forces specified in § 3.106, nor shall it be necessary to throttle the remaining engines. During recovery the airplane shall not assume any dangerous attitude, nor shall it require exceptional skill, strength, or alertness on the part of the pilot to prevent a change of heading in excess of 20 degrees before recovery is complete.

## **TRIM**

### § 3.112 Requirements.

(a) The means used for trimming the airplane shall be such that, after being trimmed and without further pressure upon or movement of either the primary control or its corresponding trim control by the pilot or the automatic pilot, the airplane will maintain:

(1) Lateral and directional trim in level flight at a speed of  $0.9 V_h$  or at  $V_c$ , if lower, with the landing gear and wing flaps retracted:

(2) Longitudinal trim under the following conditions:

(i) During a climb with maximum continuous power at a speed between  $V_x$  and  $1.4 V_{s1}$ ,

(a) With landing gear retracted and wing flaps retracted,

(b) With landing gear retracted and wing flaps in the take-off position.

(ii) During a glide with power off at a speed not in excess of  $1.4 V_{s1}$ ,

(a) With landing gear extended and wing flaps retracted,

(b) With landing gear extended and wing flaps extended under the forward center of gravity position approved with the maximum authorized weight.

(c) With landing gear extended and wing flaps extended under the most forward center of gravity position approved, regardless of weight.

(iii) During level flight at any speed from  $0.9 V_h$  to  $V_x$  or  $1.4 V_{s1}$  with landing gear and wing flaps retracted.

(b) In addition to the above, multiengine airplanes shall maintain longitudinal and directional trim at a speed between  $V_y$  and  $1.4 V_{s1}$  during climbing flight with the critical of two or more engines inoperative, with:

- (1) The other engine(s) operating at maximum continuous power.
- (2) The landing gear retracted,
- (3) Wing flaps retracted,
- (4) Bank not in excess of 5 degrees.

## **STABILITY**

§ 3.113 General. The airplane shall be longitudinally, directionally, and laterally stable in accordance with the following sections. Suitable stability and control "feel" (static stability) shall be required in other conditions normally encountered in service, if flight tests show such stability to be necessary for safe operation.

§ 3.114 Static longitudinal stability. In the configurations outlined in § 3.115 and with the airplane trimmed as indicated, the characteristics of the elevator control forces and the friction within the control system shall be such that:

(a) A pull shall be required to obtain and maintain speeds below the specified trim speed and a push to obtain and maintain speeds above the specified trim speed. This shall be so at any speed which can be obtained without excessive control force, except that such speeds need not be greater than the appropriate maximum permissible speed or less than the minimum speed in steady unstalled flight.

(b) The air speed shall return to within 10 percent of the original trim speed when the control force is slowly released from any speed within the limits defined in paragraph (a) of this section.

§ 3.115 Specific conditions. In conditions set forth in this section, within the speeds specified, the stable slope of stick force versus speed curve shall be such that any substantial change in speed is clearly perceptible to the pilot through a resulting change in stick force.

(a) Landing. The stick force curve shall have a stable slope and the stick force shall not exceed 40 lbs. at any speed between 1.1  $V_{s1}$  and 1.3  $V_{s1}$  with:

- (1) Wing flaps in the landing position,
- (2) The landing gear extended,
- (3) Maximum weight,
- (4) Throttles closed on all engines,
- (5) The airplane trimmed at 1.4  $V_{s1}$  with throttles closed.



(b) Climb. The stick force curve shall have a stable slope at all speeds between 1.2  $V_{s1}$  and 1.6  $V_{s1}$  with:

- (1) Wing flaps retracted,
- (2) Landing gear retracted,
- (3) Maximum weight,
- (4) 75 percent of maximum continuous power,
- (5) The airplane trimmed at 1.4  $V_{s1}$ .

(c) Cruising. (1) Between 1.3  $V_{s1}$  and the maximum permissible speed, the stick force curve shall have a stable slope at all speeds obtainable with a stick force not in excess of 40 pounds with:

- (i) Landing gear retracted,
- (ii) Wing flaps retracted,
- (iii) Maximum weight,
- (iv) 75 percent of maximum continuous power,
- (v) The airplane trimmed for level flight with 75 percent of the maximum continuous power.

(2) Same as subparagraph (1) of this paragraph, except that the landing gear shall be extended and the level flight trim speed need not be exceeded.

§ 3.116 Instrumented stick force measurements. Instrumented stick force measurements need not be made when changes in speed are clearly reflected by changes in stick forces and the maximum forces obtained in the above conditions are not excessive.

§ 3.117 Dynamic longitudinal stability. Any short period oscillation occurring between stalling speed and maximum permissible speed shall be heavily damped with the primary controls (1) free, and (2) in a fixed position.

§ 3.118 Directional and lateral stability—

- (a) Three-control airplanes.

(1) The static directional stability, as shown by the tendency to recover from a skid with rudder free, shall be positive for all flap positions and symmetrical power conditions, and for all speeds from 1.2  $V_{s1}$  up to the maximum permissible speed.

(2) The static lateral stability as shown by the tendency to raise the low wing in a sideslip, for all flap positions and symmetrical power conditions, shall:

(i) Be positive at the maximum permissible speed.

(ii) Not be negative at a speed equal to  $1.2 V_{s1}$ .

(3) In straight steady sideslips (unaccelerated forward slips), the aileron and rudder control movements and forces shall increase steadily, but not necessarily in constant proportion, as the angle of sideslip is increased; the rate of increase of the movements and forces shall lie between satisfactory limits up to sideslip angles considered appropriate to the operation of the type. At greater angles, up to that at which the full rudder control is employed or a rudder pedal force of 150 pounds is obtained, the rudder pedal forces shall not reverse and increased rudder deflection shall produce increased angles of sideslip. Sufficient bank shall accompany sideslipping to indicate adequately any departure from steady unyawed flight.

(4) Any short-period oscillation occurring between stalling speed and maximum permissible speed shall be heavily damped with the primary controls (i) free and (ii) in a fixed position.

(b) Two-control (or simplified) airplanes.

(1) The directional stability shall be shown to be adequate by demonstrating that the airplane in all configurations can be rapidly rolled from a 45-degree bank to a 45-degree bank in the opposite direction without exhibiting dangerous skidding characteristics.

(2) Lateral stability shall be shown to be adequate by demonstrating that the airplane will not assume a dangerous attitude or speed when all the controls are abandoned for a period of 2 minutes. This demonstration shall be made in moderately smooth air with the airplane trimmed for straight level flight at  $0.9 V_h$  (or at  $V_c$ , if lower), flaps and gear retracted, and with rearward center of gravity loading.

(3) Any short period oscillation occurring between the stalling speed and the maximum permissible speed shall be heavily damped with the primary controls (i) free and (ii) in a fixed position.

## **STALLS**

§ 3.120 Stalling demonstration.

(a) Stalls shall be demonstrated under two conditions:

(1) With power off.

(2) With the power setting not less than that required to show compliance with § 3.85 (a).

(b) In either condition it shall be possible, with flaps and landing gear in any position, with center of gravity in the position least favorable for recovery, and with appropriate airplane weights for: (1) Airplanes having independently controlled rolling and directional controls to produce and to correct roll by unreversed use of the rolling control and to produce and to correct yaw by unreversed use of the directional control during the maneuvers described below up to the time when the airplane pitches, (2) two-control airplanes having either interconnected lateral and directional controls or providing only one of these controls to produce and to correct roll by unreversed use of the rolling control without producing excessive yaw during the maneuvers described below up to the time the airplane pitches.

(c) During the recovery portions of the maneuver, pitch shall not exceed 30 degrees below level, there shall be no loss of altitude in excess of 100 feet, and not more than 15 degrees roll or yaw shall occur when controls are not used for 1 second after pitch starts and are used thereafter only in a normal manner.

(d) Where clear and distinctive stall warning is apparent to the pilot at a speed at least 5 percent above the stalling speed with flaps and landing gear in any position, both in straight and turning flight, these requirements are modified as follows:

(1) It shall be possible to prevent more than 15 degrees roll or yaw by the normal use of controls.

(2) Any loss of altitude in excess of 100 feet or any pitch in excess of 30 degrees below level shall be entered in the Airplane Flight Manual.

(e) In demonstrating the qualities set forth in paragraph (d) of this section, the order of events shall be:

(1) With trim controls adjusted for straight flight at a speed of approximately  $1.4 V_{s1}$ , reduce speed by means of the elevator control until the speed is steady at slightly above stalling speed, then

(2) Pull elevator control back at a rate such that the airplane speed reduction does not exceed 1 mile per hour per second until a stall is produced as evidenced by an uncontrollable downward pitching motion of the airplane, or until the control reaches the stop. Normal use of the elevator control for recovery may be made after such pitching motion is unmistakably developed.

§ 3.121 Climbing stalls. When stalled from an excessive climb attitude it shall be possible to recover from this maneuver without exceeding the limiting air speed or the allowable acceleration limit.

§ 3.122 Turning flight stalls. When stalled during a coordinated 30-degree banked turn with 75 percent maximum continuous power on all engines, flaps and landing gear retracted, it shall be possible to recover to normal level flight without encountering excessive loss of altitude, uncontrollable rolling characteristics, or uncontrollable spinning tendencies. These qualities shall

be demonstrated by performing the following maneuver: After a steady curvilinear level coordinated flight condition in a 30-degree bank is established and while maintaining the 30-degree bank, the airplane shall be stalled by steadily and progressively tightening the turn with the elevator control until the airplane is stalled or until the elevator has reached its stop. When the stall has fully developed, recovery to level flight shall be made with normal use of the controls.

§ 3.123 One-engine-inoperative stalls. Multiengine airplanes shall not display any undue spinning tendency and shall be safely recoverable without applying power to the inoperative engine when stalled with:

(a) The critical engine inoperative,

(b) Flaps and landing gear retracted,

(c) The remaining engines operating at up to 75 percent of maximum continuous power, except that the power need not be greater than that at which the use of maximum control travel just holds the wings laterally level in approaching the stall. The operating engines may be throttled back during the recovery from the stall.

## **SPINNING**

§ 3.124 Spinning—

(a) Category N. All airplanes of 4,000 pounds or less maximum weight shall recover from a one-turn spin with controls assisted to the extent necessary to overcome friction in not more than one and one-half additional turns and without exceeding either the limiting air speed or the limit positive maneuvering load factor for the airplane. It shall not be possible to obtain uncontrollable spins by means of any possible use of the controls. Compliance with the above shall be demonstrated at any permissible combination of weight and center of gravity positions obtainable with all or part of the design useful load. All airplanes in this category, regardless of weight, shall be placarded against spins or demonstrated to be "characteristically incapable of spinning" in which case they shall be so designated. (See paragraph (d) of this section.)

(b) Category U. Airplanes in this category shall comply with either the entire requirements of paragraph (a) of this section or the entire requirements of paragraph (c) of this section.

(c) Category A. All airplanes in this category must be capable of spinning and shall comply with the following:

(1) At any permissible combination of weight and center of gravity position obtainable with all or part of the design useful load, the airplane shall recover from a six-turn spin with controls free in not more than four additional turns after releasing the controls. If the airplane will not recover as prescribed with controls free but will recover with the controls assisted to the

extent necessary to overcome friction, the airplane may be certificated with the rearmost center of gravity position 2 percent forward of the position used in the test.

(2) It shall be possible to recover at any point in the spinning described above by using the controls in a normal manner for that purpose in not more than one and one-half additional turns, and without exceeding either the limiting air speed or the limit positive maneuvering load factor for the airplane. It shall not be possible to obtain uncontrollable spins by means of any possible use of the controls.

(d) Category NU. When it is desired to designate an airplane as a type "characteristically incapable of spinning," the flight tests to demonstrate this characteristic shall also be conducted with:

(1) A maximum weight 5 percent in excess of the weight for which approval is desired,

(2) A center of gravity at least 3 percent aft of the rearmost position for which approvals is desired,

(3) An available up-elevator travel 4 degrees in excess of that to which the elevator travel is to be limited by appropriate stops.

(4) An available rudder travel 7 degrees, in both directions, in excess of that to which the rudder travel is to be limited by appropriate stops.

## **GROUND AND WATER CHARACTERISTICS**

§ 3.143 Requirements. All airplanes shall comply with the requirements of §§ 3.144 to 3.147.

§ 3.144 Longitudinal stability and control. There shall be no uncontrollable tendency for landplanes to nose over in any operating condition reasonably expected for the type, or when rebound occurs during landing or take-off. Wheel brakes shall operate smoothly and shall exhibit no undue tendency to induce nosing over. Seaplanes shall exhibit no dangerous or uncontrollable proposing at any speed at which the airplane is normally operated on the water.

§ 3.145 Directional stability and control.

(a) There shall be no uncontrollable looping tendency in 90-degree cross winds up to a velocity equal to  $0.2 V_{so}$  at any speed at which the aircraft may be expected to be operated upon the ground or water.

(b) All landplanes shall be demonstrated to be satisfactorily controllable with no exceptional degree of skill or alternates on the part of the pilot in power-off landings at normal landing speed and during which brakes or engine power are not to maintain a straight path.

(c) Means shall be provided for adequate directional control during taxiing.

§ 3.146 Shock absorption. The shock absorbing mechanism shall not produce damage to the structure when the airplane is taxied on the roughest ground which it is reasonable to expect the airplane to encounter in normal operation.

§ 3.147 Spray characteristics. For seaplanes, spray during taxiing, take-off, and landing shall at no time dangerously obscure the vision of the pilots nor produce damage to the propeller or other parts of the airplane.

## **FLUTTER AND VIBRATION**

§ 3.159 Flutter and vibration. All parts of the airplane shall be demonstrated to be free from flutter and excessive vibration under all speed and power conditions appropriate to the operation of the airplane up to at least the minimum value permitted for  $V_d$  in § 3.184. There shall also be no buffeting condition in any normal flight condition severe enough to interfere with the satisfactory control of the airplane or to cause excessive fatigue to the crew or result in structural damage. However, buffeting as stall warning is considered desirable and discouragement of this type of buffeting is not intended.

## **SUBPART C—STRENGTH REQUIREMENTS GENERAL**

§ 3.171 Loads.

(a) Strength requirements are specified in terms of limit and ultimate loads. Limit loads are the maximum loads anticipated in service. Ultimate loads are equal to the limit loads multiplied by the factor of safety. Unless otherwise described, loads specified are limit loads.

(b) Unless otherwise provided, the specified air, ground, and water loads shall be placed in equilibrium with inertia forces, considering all items of mass in the airplane. All such loads shall be distributed in a manner conservatively approximating or closely representing actual conditions. If deflections under load would change significantly the distribution of external or internal loads, such redistribution shall be taken into account.

§ 3.172 Factor of safety. The factor of safety shall be 1.5 unless otherwise specified.

§ 3.173 Strength and deformations. The structure shall be capable of supporting limit loads without suffering detrimental permanent deformations. At all loads up to limit loads, the deformation shall be such as not to interfere with safe operation of the airplane. The structure shall be capable of supporting ultimate loads without failure for at least 3 seconds, except that when proof of strength is demonstrated by dynamic tests simulating actual conditions of load application, the 3-second limit does not apply.

§ 3.174 Proof of structure. Proof of compliance of the structure with the strength and deformation requirements of § 3.173 shall be made for all critical loading conditions. Proof of compliance by means of structural analysis will be accepted only when the structure conforms with types for which experience has shown such methods to be reliable. In all other cases

substantiating load tests are required. In all cases certain portions of the structure must be subjected to tests as specified in Subpart D.

## **FLIGHT LOADS**

§ 3.181 General. Flight load requirements shall be complied with at critical altitudes within the range in which the airplane may be expected to operate and at all weights between the minimum design weight and the maximum design weight, with any practicable distribution of disposable load within prescribed operating limitations stated in § 3.777-3.780.

§ 3.182 Definition of flight load factor. The flight load factors specified represent the acceleration component (in terms of the gravitational constant g) normal to the assumed longitudinal axis of the airplane, and equal in magnitude and opposite in direction to the airplane inertia load factor at the center of gravity.

## **SYMMETRICAL FLIGHT CONDITIONS (FLAPS RETRACTED)**

§ 3.183 General. The strength requirements shall be met at all combinations of air speed and load factor on and within the boundaries of a pertinent V-n diagram, constructed similarly to the one shown in Figure 3-1, which represents the envelope of the flight loading conditions specified by the maneuvering and gust criteria of §§ 3.185 and 3.187. This diagram will also be used in determining the airplane structural operating limitations as specified in Subpart G.

§ 3.184 Design air speeds. The design air speeds shall be chosen by the designer except that they shall not be less than the following values:

$$\begin{aligned} V_c \text{ (design cruising speed)} \\ = 38 \sqrt{\frac{W}{S}} \quad (\text{N, U}) \\ = 42 \sqrt{\frac{W}{S}} \quad (\text{A}) \end{aligned}$$

except that for values of W/S greater than 20, the above numerical multiplying factors shall be decreased linearly with W/S to a value of 33 at W/S=100: And further provided, That the required minimum value need be no greater than 0.9 Vh actually obtained at sea level.

$$\begin{aligned} V_d \text{ (design dive speed)} \\ = 1.40 V_c \text{ min (N)} \\ = 1.50 V_c \text{ min (U)} \\ = 1.55 V_c \text{ min (A)} \end{aligned}$$

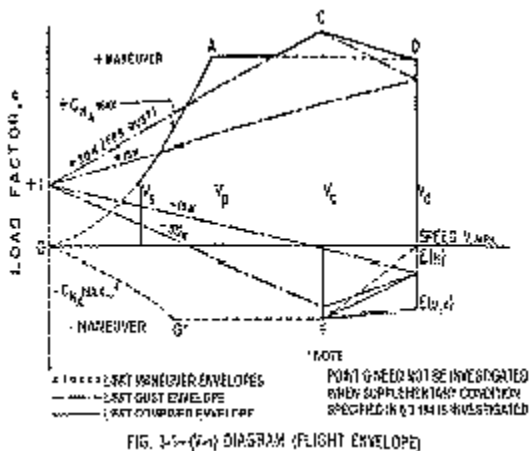
except that for values of W/S greater than 20, the above numerical multiplying factors shall be decreased linearly with W/S to a value of 1.35 at W/S=100. (Vc min is the required minimum value of design cruising speed specified above.)

- $V_p$  (design maneuvering speed)
- $= V_s \sqrt{n}$  where:
- $V_s$  = computed stalling speed with flaps fully retracted at the design weight, normally based on the maximum airplane normal force coefficient,  $C_{NA}$ .
  - $N$  = limit maneuvering load factor used in design,

except that the value of  $V_p$  need not exceed the value of  $V_c$  used in design.

§ 3.185 Maneuvering envelope. The airplane shall be assumed to subjected to symmetrical maneuvers resulting in the following limit load factors, except where limited by maximum (static) lift coefficients:

- (a) The positive maneuvering load factor specified in § 3.186 at all speeds up to  $V_d$ ,



- (b) The negative maneuvering load factor specified in § 3.188 at speed  $V_c$ ; and factors varying linearly with speed from the specified value at  $V_c$  to 0.0 at  $V_d$  for the N category and -1.0 at  $V_d$  for the A and U categories.

§ 3.186 Maneuvering load factors.

- (a) The positive limit maneuvering load factors shall not be less than the following values (see Fig. 3-2):

$$n = 2.1 + \frac{24,000}{W + 10,000} \text{ ----- Category N}$$

except that  $n$  need not be greater than 3.8 and shall not be less than 2.5. For airplanes certificated as characteristically incapable of spinning,  $n$  need not exceed 3.5.



n = 4.4-----Category U  
 n = 6.0-----Category A

(b) The negative limit maneuvering load factors shall not be less than -0.4 times the positive load factor for the N and U categories, and shall not be less than -0.5 times the positive load factor for the A category.

(c) Lower values of maneuvering load factor may be employed only if it be proven that the airplane embodies features of design which make it impossible to exceed such values in flight. (See also § 3.106.)

§ 3.187 Gust envelope. The airplane shall be assumed to encounter symmetrical vertical gusts as specified below while in level flight and the resulting loads shall be considered limit loads:

(a) Positive (up) and negative (down) gusts of 30 feet per second nominal intensity at all speeds up to  $V_c$ ,

(b) Positive and negative 15 feet per second gusts at  $V_d$ . Gust load factors shall be assumed to vary linearly between  $V_c$  and  $V_d$ .

§ 3.188 Gust load factors. In applying the gust requirements, the gust load factors shall be computed by the following formula:

$$n = 1 + \frac{KUV_m}{575(W/S)}$$

where:  $K = \frac{1}{2}(W/S)^{1/4}$  (for  $W/S < 16$  p.s.f.)  
 $= 1.33 - \frac{2.67}{(W/S)^{1/4}}$  (for  $W/S > 16$  p.s.f.)

U = nominal gust velocity, f.p.s.

(Note that the "effective sharp-edged gust" equals KU.)

V = airplane speed, m.p.h.

m = slope of lift curve, CL per radian, corrected for aspect ratio.

W/S = wing loading, p.s.f.

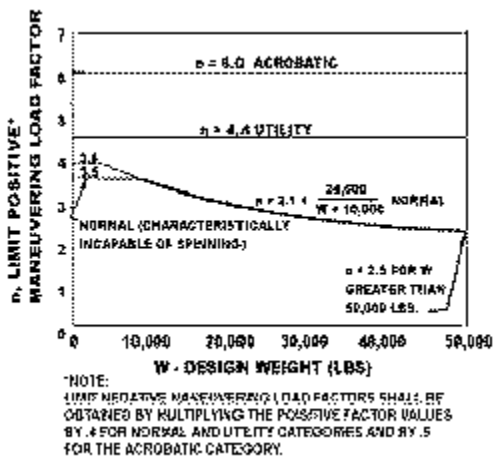


FIG. 3-2—LIMIT MANEUVERING LOAD FACTORS

§ 3.189 Airplane equilibrium. In determining the wing loads and linear inertia loads corresponding to any of the above specified flight conditions, the appropriate balancing horizontal tail load (see § 3.215) shall be taken into account in a rational or conservative manner. Incremental horizontal tail loads due to maneuvering and gusts (see §§ 3.216 and 3.217) shall be reacted by angular inertia of the complete airplane in a rational or conservative manner.

### FLAPS EXTENDED FLIGHT CONDITIONS

§ 3.190 Flaps extended flight conditions.

(a) When flaps or similar high lift devices intended for use at the relatively low air speeds of approach, landing, and take-off are installed, the airplane shall be assumed to be subjected to symmetrical maneuvers and gusts with the flaps fully deflected at the design flap speed  $V_f$  resulting in limit load factors within the range determined by the following conditions:

(1) Maneuvering, to a positive limit load factor of 2.0.

(2) Positive and negative 15-feet-per-second gusts acting normal to the flight path in level flight. The gust load factors shall be computed by the formula of § 3.188.

$V_f$  shall be assumed not less than 1.4  $V_s$  or 1.8  $V_{sf}$  whichever is greater, where:

$V_s$  = the computed stalling speed with flaps fully retracted at the design weight

$V_{sf}$  = the computed stalling speed with flaps fully extended at the design weight except that when an automatic flap load limiting device is employed, the airplane may be designed for critical combinations of air speed and flap position permitted by the device. (See also § 3.338.)

(b) In designing the flaps and supporting structure, slipstream effects shall be taken into account as specified in § 3.223.

Note: In determining the external loads on the airplane as a whole, the thrust, slip-stream, and pitching acceleration may be assumed equal to zero.

## UNSYMMETRICAL FLIGHT CONDITIONS

§ 3.191 Unsymmetrical flight conditions. The airplane shall be assumed to be subjected to rolling and yawing maneuvers as described in the following conditions. Unbalanced aerodynamic moments about the center of gravity shall be reacted in a rational or conservative manner considering the principal masses furnishing the reacting inertia forces.

(a) Rolling conditions. The airplane shall be designed for (1) unsymmetrical wing loads appropriate to the category, and (2) the loads resulting from the aileron deflections and speeds specified in § 3.222, in combination with an airplane load factor of at least two-thirds of the positive maneuvering factor used in the design of the airplane. Only the wing and wing bracing need be investigated for this condition.

Note: These conditions may be covered as noted below:

(a) Rolling accelerations may be obtained by modifying the symmetrical flight conditions shown in Figure 3-1 as follows:

(1) Acrobatic category. In conditions A and F assume 100 percent of the wing air load acting on one side of the plane of symmetry and 60 percent on the other.

(2) Normal and utility categories. In condition A, assume 100 percent of the wing air load acting on one side of the airplane and 70 percent on the other. For airplanes over 1,000 pounds design weight, the latter percentage may be increased linearly with weight up to 80 percent at 25,000 pounds.

(b) The effect of aileron displacement on wing torsion may be accounted for by adding the following increment to the basic airfoil moment coefficient over the aileron portion of the span in the critical condition as determined by the note under § 3.222:

$$\Delta_{cm} = -0.1\delta$$

where:

$\Delta_{cm}$  = moment coefficient increment

$\delta$  = down aileron deflection in degrees in critical condition

(b) Yawing conditions. The airplane shall be designed for the yawing loads resulting from the vertical surface loads specified in §§ 3.219 to 3.221.

## SUPPLEMENTARY CONDITIONS

§ 3.194 Special condition for rear lift truss. When a rear lift truss is employed, it shall be designed for conditions of reversed airflow at a design speed of:

$$V = 10 \sqrt{\overline{W/S}} + 10 \text{ (m.p.h.)}$$

Note: It may be assumed that the value of CL is equal to -0.8 and the chordwise distribution is triangular between a peak at the trailing edge and zero at the leading edge.

§ 3.195 Engine torque effects.

(a) Engine mounts and their supporting structures shall be designed for engine torque effects combined with certain basic flight conditions as described in subparagraphs (1) and (2) of this paragraph. Engine torque may be neglected in the other flight conditions.

(1) The limit torque corresponding to takeoff power and propeller speed acting simultaneously with 75 percent of the limit loads from flight condition A. (See Fig. 3-1.)

(2) The limit torque corresponding to maximum continuous power and propeller speed, acting simultaneously with the limit loads from flight condition A. (See Fig. 3-1.)

(b) The limit torque shall be obtained by multiplying the mean torque by a factor of 1.33 in the case of engines having 5 or more cylinders. For 4-, 3-, and 2-cylinder engines, the factor shall be 2, 3, and 4, respectively.

§ 3.196 Side load on engine mount. The limit load factor in a lateral direction for this condition shall be at least equal to one-third of the limit load factor for flight condition A (see Fig. 3-1) except that it shall not be less than 1.33. Engine mounts and their supporting structure shall be designed for this condition which may be assumed independent of other flight conditions.

## **CONTROL SURFACE LOADS**

§ 3.211 General. The control surface loads specified in the following sections shall be assumed to occur in the symmetrical and unsymmetrical flight conditions as described in §§ 3.189-3.191. See Figures 3-3 to 3-10 for acceptable values of control surface loadings which are considered as conforming to the following detailed rational requirements.

§ 3.212 Pilot effort. In the control surface loading conditions described, the airloads on the movable surfaces and the corresponding deflections need not exceed those which could be obtained in flight by employing the maximum pilot control forces specified in Figure 3-11. In applying this criterion, proper consideration shall be given to the effects of control system boost and servo mechanisms, tabs, and automatic pilot systems in assisting the pilot.

§ 3.213 Trim tab effects. The effects of trim tabs on the control surface design conditions need be taken into account only in cases where the surface loads are limited on the basis of maximum pilot effort. In such cases the tabs shall be considered to be deflected in the direction which

would assist the pilot and the deflection shall correspond to the maximum expected degree of "out of trim" at the speed for the condition under consideration.

## HORIZONTAL TAIL SURFACES

§ 3.214 Horizontal tail surfaces. The horizontal tail surfaces shall be designed for the conditions set forth in §§ 3.215-3.218.

§ 3.215 Balancing loads. A horizontal tail balancing load is defined as that necessary to maintain the airplane in equilibrium in a specified flight condition with zero pitching acceleration. The horizontal tail surfaces shall be designed for the balancing loads occurring at any point on the limit maneuvering envelope, Figure 3-1, and in the flap conditions. (See § 3.190.)

Note: The distribution of Figure 3-7 may be used.

§ 3.216 Maneuvering loads.

(a) At maneuvering speed  $V_p$  assume a sudden deflection of the elevator control to the maximum upward deflection as limited by the control stops or pilot effort, whichever is critical.

Note: The average loading of Figure 3-3 and the distribution of Figure 3-8 may be used. In determining the resultant normal force coefficient for the tail under these conditions, it will be permissible to assume that the angle of attack of the stabilizer with respect to the resultant direction of air flow is equal to that which occurs when the airplane is in steady unaccelerated flight at a flight speed equal to  $V_p$ . The maximum elevator deflection can then be determined from the above criteria and the tail normal force coefficient can be obtained from the data given in NACA Report No. 688, "Aerodynamic Characteristics of Horizontal Tail Surfaces," or other applicable NACA reports.

(b) Same as case (a) except that the elevator deflection is downward.

Note: The average loading of Figure 3-3 and the distribution of Figure 3-8 may be used.

(c) At all speeds above  $V_p$  the horizontal tail shall be designed for the maneuvering loads resulting from a sudden upward deflection of the elevator, followed by a downair deflection of the elevator such that the following combinations of normal acceleration and angular acceleration are obtained:

Condition	Airplane normal acceleration $n$	Angular acceleration radian/sec. <sup>2</sup>
Down load	1.0	$+\frac{g}{V} \frac{r}{m}$
Up load	$nm$	$-\frac{g}{V} \frac{r}{m}$

Acceptable values of limit average maneuvering control surface loadings can be obtained from Figure 3-3 (b) as follows:

### **HORIZONTAL TAIL SURFACES**

(1) Condition § 3.216 (a):

Obtain  $\bar{w}$  as function of W/S and surface deflection;

Use Curve C for deflection 10° or less;

Use Curve B for deflection 20°;

Use Curve A for deflection 30° or more;

(Interpolate for other deflections);

Use distribution of Figure 3-8.

(2) Condition § 3.216 (b):

Obtain  $\bar{w}$  from Curve B. Use distribution of Figure 3-8.

### **VERTICAL TAIL SURFACES**

(3) Condition § 3.219 (a):

Obtain  $\bar{w}$  as function of W/S and surface deflection in same manner as outlined in (1) above, use distribution of Figure 3-8;

(4) Condition § 3.219 (b):

Obtain  $\bar{w}$  from Curve C, use distribution of Figure 3-7;

(5) Condition § 3.219 (c):

Obtain  $\bar{w}$  from Curve A, use distribution of Figure 3-9. (Note that condition § 3.220 generally will be more critical than this condition.)

### **AILERONS**

(6) In lieu of conditions § 3.222 (b):

Obtain  $\bar{w}$  from Curve B, acting in both up and down directions. Use distribution of Figure 3-10.

where:

$n_m$  = positive limit maneuvering load factor used in the design of the airplane.  
 $V$  = initial speed in miles per hour.

FIG. 3-3(a)---LIMIT AVERAGE MANEUVERING CONTROL SURFACE LOADINGS

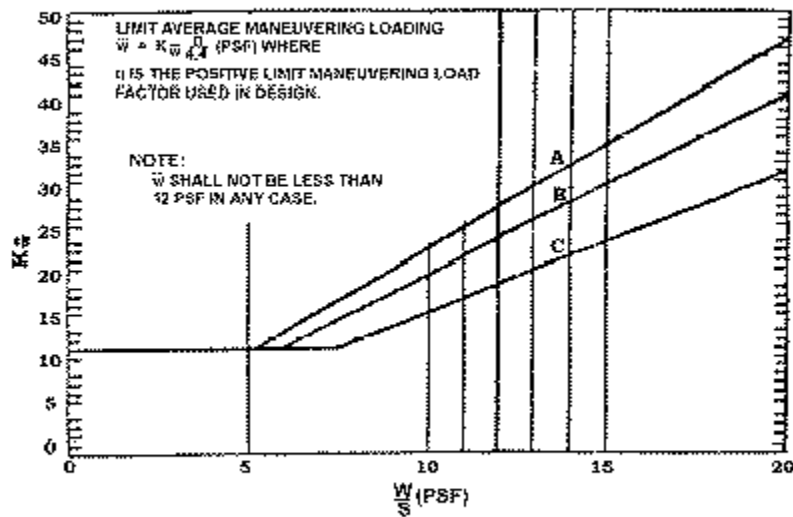


FIGURE 3-3(b) —LIMIT AVERAGE MANEUVERING CONTROL SURFACE LOADING

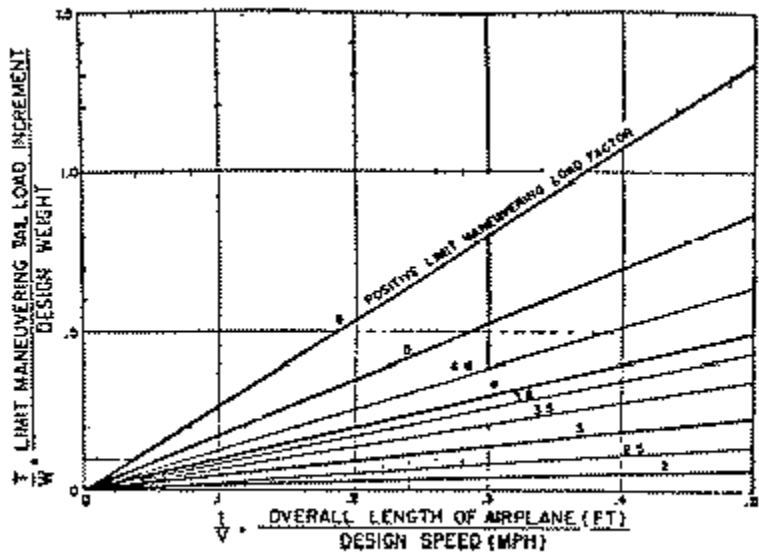


FIG. 3-4 — MANEUVERING TAIL LOAD INCREMENT (UP OR DOWN)



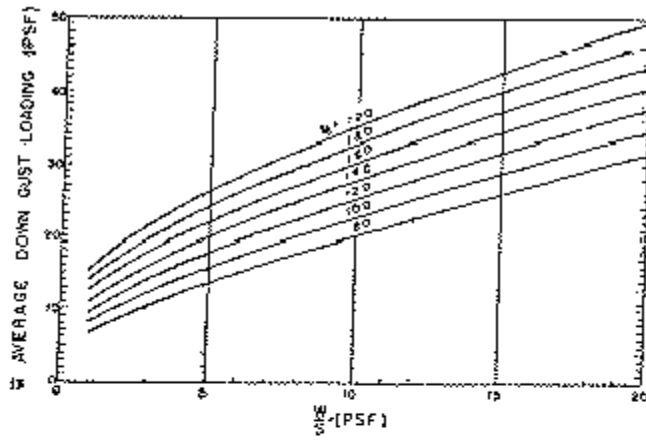


FIG. 3-5(a)—DOWN GUST LOADING ON HORIZONTAL TAIL SURFACE

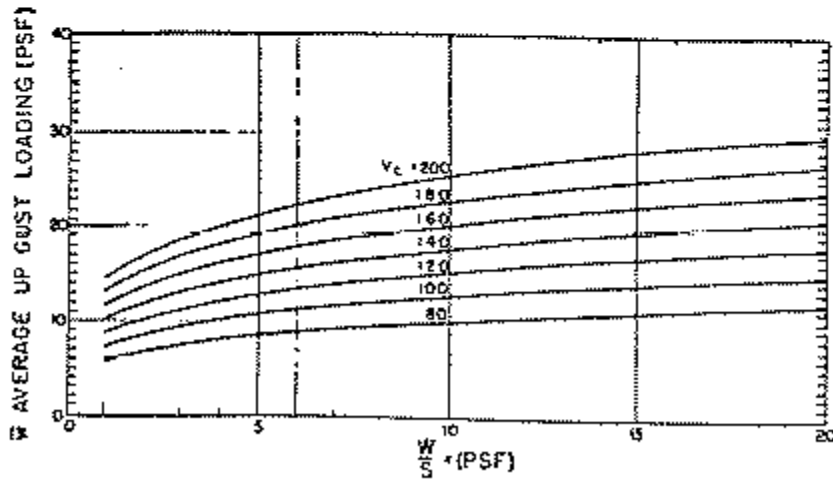
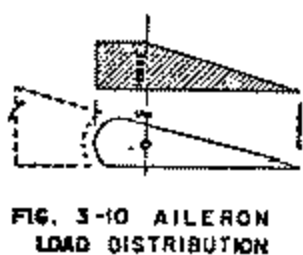
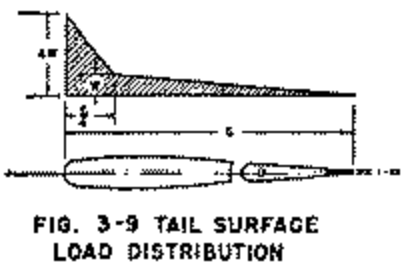
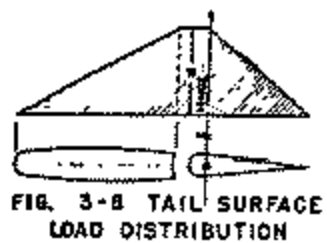
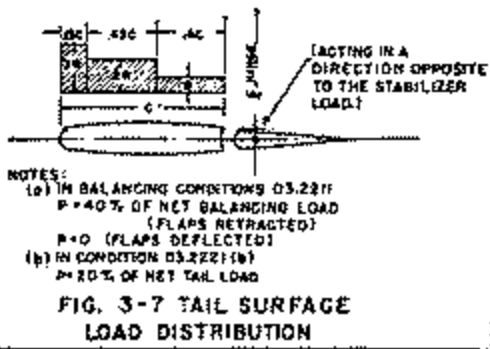
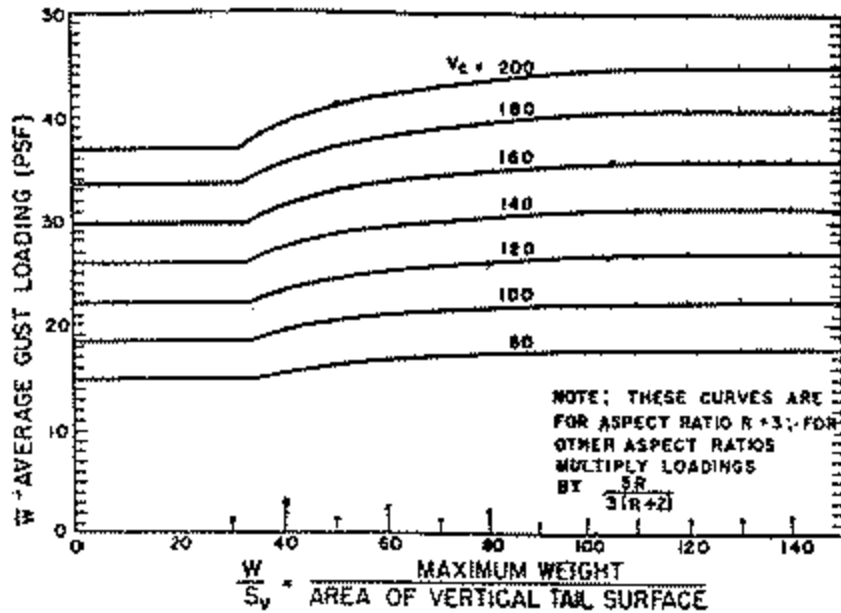


FIG. 3-5(b)—UP GUST LOADING ON HORIZONTAL TAIL SURFACE



(d) The total tail load for the conditions specified in (c) shall be the sum of: (1) The balancing tail load corresponding with the condition at speed  $V$  and the specified value of the normal load factor  $n$ , plus (2) the maneuvering load increment due to the specified value of the angular acceleration.

NOTE: The maneuvering load increment of Figure 3-4 and the distributions of Figure 3-8 (for downloads) and Figure 3-9 (for uploads) may be used. These distributions apply to the total tail load.

§ 3.217 Gust loads. The horizontal tail surfaces shall be designed for loads occurring in the following conditions:

(a) Positive and negative gusts of 30 feet per second nominal intensity at speed  $V_c$ , corresponding to flight condition § 3.187 (a) with flaps retracted.

NOTE: The average loadings of Figures 3-5 (a) and 3-5 (b) and the distribution of Figure 3-9 may be used for the total tail loading in this condition.

(b) Positive and negative gusts of 15 feet per second nominal intensity at speed  $V_t$ , corresponding to flight condition § 3.190 (b) with flaps extended. In determining the total load on the horizontal tail for these conditions, the initial balancing tail loads shall first be determined for steady unaccelerated flight at the pertinent design speeds  $V_c$  and  $V_t$ . The incremental tail load resulting from the gust shall then be added to the initial balancing tail load to obtain the total tail load.

Note: The incremental tail load due to the gust may be computed by the following formula:

$$\Delta^t = 0.1 K U V S_t a_t \left( 1 - \frac{a_w}{R_w} \right)$$

where:

$\Delta^t$  = the limit gust load increment on the tail in pounds;  
 $K$  = gust coefficient  $K$  in § 3.188,  
 $U$  = nominal gust intensity in feet per second,  
 $V$  = airplane speed in miles per hour,  
 $S_t$  = tail surface area in square feet,  
 $a_t$  = slope of lift curve of tail surface,  
 CL per degree, corrected for aspect ratio,  
 $a_w$  = slope of lift curve of wing, CL per degree,  
 $R_w$  = aspect ratio of the wing.

§ 3.218 Unsymmetrical loads. The maximum horizontal tail surface loading (load per unit area), as determined by the preceding sections, shall be applied to the horizontal surfaces on one side of the plane of symmetry and the following percentage of that loading shall be applied on the opposite side:

% =  $100 - 10(n - 1)$  where:

$n$  is the specified positive maneuvering load factor.

In any case the above value shall not be greater than 80 percent.

## VERTICAL TAIL SURFACES

§ 3.219 Maneuvering loads. At all speeds up to  $V_p$ :

(a) With the airplane in unaccelerated flight at zero yaw, a sudden displacement of the rudder control to the maximum deflection as limited by the control stops or pilot effort, whichever is critical, shall be assumed.

Note: The average loading of Figure 3-3 and the distribution of Figure 3-8 may be used.

(b) The airplane shall be assumed to be yawed to a sideslip angle of 15 degrees while the rudder control is maintained at full deflection (except as limited by pilot effort) in the direction tending to increase the sideslip.

Note: The average loading of Figure 3-3 and the distribution of Figure 3-7 may be used.

(c) The airplane shall be assumed to be yawed to a sideslip angle of 15 degrees while the rudder control is maintained in the neutral position (except as limited by pilot effort). The assumed sideslip angles may be reduced if it is shown that the value chosen for a particular speed cannot be exceeded in the cases of steady slips, uncoordinated rolls from a steep bank, and sudden failure of the critical engine with delayed corrective action.

Note: The average loading of Figure 3-3 and the distribution of Figure 3-9 may be used.

§ 3.220 Gust loads.

(a) The airplane shall be assumed to encounter a gust of 30 feet per second nominal intensity, normal to the plane of symmetry while in unaccelerated flight at speed  $V_c$ .

(b) The gust loading shall be computed by the following formula:

$$\bar{w} = \frac{K U^3 V_c}{575}$$

where:

$\bar{w}$  = average limit unit pressure in pounds per square foot,

$K = \frac{1.33 - \frac{4.5}{(V/S)^{1/4}}}{1.33}$  except that  $K$  shall not be less than 1.0. A value of  $K$  obtained by rational determination may be used.

$U$  = nominal gust intensity in feet per second,

$V$  = airplane speed in miles per hour,

$m$  = slope of lift curve of vertical surface, CL per radian, corrected for aspect ratio,

$W$  = design weight in pounds,

$S_v$  = vertical surface area in square feet.

(c) This loading applies only to that portion of the vertical surfaces having a well-defined leading edge.

Note: The average loading of Figure 3-6 and the distribution of Figure 3-9 may be used.

§ 3.221 Outboard fins. When outboard fins are carried on the horizontal tail surface, the tail surfaces shall be designed for the maximum horizontal surface load in combination with the corresponding loads induced on the vertical surfaces by end plate effects. Such induced effects need not be combined with other vertical surface loads. When outboard fins extend above and below the horizontal surface, the critical vertical surface loading (load per unit area) as determined by §§ 3.219 and 3.220 shall be applied:

(a) To the portion of the vertical surfaces above the horizontal surface, and 80 percent of that loading applied to the portion below the horizontal surface,

(b) To the portion of the vertical surfaces below the horizontal surface, and 80 percent of that loading applied to the portion above the horizontal surface.

#### **AILERONS, WING FLAPS, TABS, ETC.**

§ 3.222 Ailerons.

(a) In the symmetrical flight conditions (see §§ 3.183-3.189), the ailerons shall be designed for all loads to which they are subjected while in the neutral position.

(b) In unsymmetrical flight conditions (see § 3.191 (a)), the ailerons shall be designed for the loads resulting from the following deflections except as limited by pilot effort:

(1) At speed  $V_p$  it shall be assumed that there occurs a sudden maximum displacement of the aileron control. (Suitable allowance may be made for control system deflections.)

(2) When  $V_c$  is greater than  $V_p$ , the aileron deflection at  $V_c$  shall be that required to produce a rate of roll not less than that obtained in condition (1).

(3) At speed  $V_d$  the aileron deflection shall be that required to produce a rate of roll not less than one-third of that which would be obtained at the speed and aileron deflection specified in condition (1).

Note: For conventional ailerons, the deflections for conditions (2) and (3) may be computed from:

$$\delta_2 = \frac{1}{2} \delta_1 \quad \text{and} \quad \delta_3 = \frac{0.5V_d}{V_c} \delta_1$$

where:

$\delta_1$  = total aileron deflection (sum of both aileron deflections) in condition (1).

$\delta_2$  = total aileron deflection in condition (2).

$\delta_3$  = total deflection in condition (3). In the equation for  $\delta_3$ , the 0.5 factor is used instead of 0.33 to allow for wing torsional flexibility.

(c) The critical loading on the ailerons should occur in condition (2) if  $V_d$  is less than  $2V_c$  and the wing meets the torsional stiffness criteria. The normal force coefficient  $C_N$  for the ailerons may be taken as  $0.04\delta$ , where  $\delta$  is the deflection of the individual aileron in degrees. The critical condition for wing torsional loads will depend upon the basic airfoil moment coefficient as well as the speed, and may be determined as follows:

$$\frac{T_3}{T_2} = \frac{(C_{m-D1} \delta_{3i}) V_d^2}{(C_{m-D1} \delta_{2i}) V_c^2}$$

where:

$T_3/T_2$  is the ratio of wing torsion in condition (b) (3) to that in condition (b) (2).

$\delta_2$  and  $\delta_3$  are the down deflections of the individual aileron in conditions (b) (2) and (3) respectively.

(d) When  $T_3/T_2$  is greater than 1.0 condition (b) (3) is critical; when  $T_3/T_2$  is less than 1.0 condition (b) (2) is critical.

(e) In lieu of the above rational conditions the average loading of Figure 3-3 and the distribution of Figure 3-10 may be used.

§ 3.223 Wing flaps. Wing flaps, their operating mechanism, and supporting structure shall be designed for critical loads occurring in the flap-extended flight conditions (see § 3.190) with the flaps extended to any position from fully retracted to fully extended; except that when an automatic flap load limiting device is employed these parts may be designed for critical combinations of air speed and flap position permitted by the device. (Also see §§ 3.338 and 3.339.) The effects of propeller slipstream corresponding to take-off power shall be taken into account at an airplane speed of not less than  $1.4 V_s$  where  $V_s$  is the computed stalling speed with flaps fully retracted at the design weight.

For investigation of the slipstream condition, the airplane load factor may be assumed to be 1.0.

§ 3.224 Tabs. Control surface tabs shall be designed for the most severe combination of air speed and tab deflection likely to be obtained within the limit V-n diagram (Fig. 3-1) for any usable loading condition of the airplane.

§ 3.225 Special devices. The loading for special devices employing aerodynamic surfaces, such as slots and spoilers, shall be based on test data.

## **CONTROL SYSTEM LOADS**

§ 3.231 Primary flight controls and systems.

(a) Flight control systems and supporting structure shall be designed for loads corresponding to 125 percent of the computed hinge moments of the movable control surface in the conditions prescribed in §§ 3.211 to 3.225, subject to the following maxima and minima:

(1) The system limit loads need not exceed those which can be produced by the pilot and automatic devices operating the controls.

(2) The loads shall in any case be sufficient to provide a rugged system for service use, including consideration of jamming, ground gusts, taxiing tail to wind, control inertia, and friction.

(b) Acceptable maximum and minimum pilot loads for elevator, aileron, and rudder controls are shown in Figure 3-11. These pilot loads shall be assumed to act at the appropriate control grips or pads in a manner simulating flight conditions and to be reacted at the attachments of the control system to the control surface horn.

§ 3.232 Dual controls. When dual controls are provided, the systems shall be designed for the pilots operating in opposition, using individual pilot loads equal to 75 percent of those obtained in accordance with § 3.231, except that the individual pilot loads shall not be less than the minimum loads specified in Figure 3-11.

§ 3.233 Ground gust conditions.

(a) The following ground gust conditions shall be investigated in cases where a deviation from the specific values for minimum control forces listed in Figure 3-11 is applicable. The following conditions are intended to simulate the loadings on control surfaces due to ground gusts and when taxiing with the wind.

(b) The limit hinge moment H shall be obtained from the following formula:

$$H = KcSq$$

where:

H = limit hinge moment (foot-pounds).

c = mean chord of the control surface aft of the hinge line (feet).

S = area of control surface aft of the hinge line (square feet).

q = dynamic pressure (pounds per square foot) to be based on a design speed not less than  $10\sqrt{W/S} + 10$  miles per hour, except that the design speed need not exceed 60 miles per hour.

K = factor as specified below:

Surface	K
(a) Aileron---Control column locked or lashed in midposition.	+ 0.75
(b) Aileron---Ailerons at full throw; + moment on one aileron, - moment on the other.	$\pm 0.50$
(c) (d) Elevator---Elevator (c) full up (-), and (d) full down(+).	$\pm 0.75$
(e) (f) Rudder---Rudder (e) in neutral, and (f) at full throw.	$\pm 0.75$

(c) As used in paragraph (b) in connection with ailerons and elevators, a positive value of K indicates a moment tending to depress the surface while a negative value of K indicates a moment tending to raise the surface.

§ 3.234 Secondary controls and systems. Secondary controls, such as wheel brakes, spoilers, and tab controls, shall be designed for the loads based on the maximum which a pilot is likely to apply to the control in question.

## GROUND LOADS

§ 3.241 Ground loads. The loads specified in the following conditions shall be considered as the external loads and inertia forces which would occur in an airplane structure if it were acting as a rigid body. In each of the ground load conditions specified the external reactions shall be placed in equilibrium with the linear and angular inertia forces in a rational or conservative manner.

§ 3.242 Design weight. The design weight used in the landing conditions shall not be less than the maximum weight for which certification is desired: Provided, however, That for multiengine airplanes meeting the one-engine inoperative climb requirement of § 3.85 (b), the airplane may be designed for a design landing weight which is less than the maximum design weight, if compliance is shown with the following sections of Part 4b in lieu of the corresponding requirements of this part: the ground load requirements of § 4b.241, and shock absorption requirements of § 4b.371 and its related sections, the wheel and tire requirements of §§ 4b.391 and 4b.392, and the fuel jettisoning system requirements of § 4b.536.



§ 3.243 Load factor for landing conditions. In the following landing conditions the limit vertical inertia load factor at the center of gravity of the airplane shall be chosen by the designer but shall not be less than the value which would be obtained when landing the airplane with a descent velocity, in feet per second, equal to the following value:

$$V = 4.4 (W/S)^{1/4}$$

except that the descent velocity need not exceed 10 feet per second and shall not be less than 7 feet per second. Wing lift not exceeding two thirds of the weight of the airplane may be assumed to exist throughout the landing impact and may be assumed to act through the airplane center of gravity. When such wing lift is assumed, the ground reaction load factor may be taken equal to the inertia load factor minus the ratio of the assumed wing lift to the airplane weight. (See § 3.354 for requirements concerning the energy absorption tests which determine the limit load factor corresponding to the required limit descent velocities.) In no case, however, shall the inertia load factor used for design purposes be less than 2.67, nor shall the limit ground reaction load factor be less than 2.0, unless it is demonstrated that lower values of limit load factor will not be exceeded in taxiing the airplane over terrain having the maximum degree of roughness to be expected under intended service use at all speeds up to take-off speed.

## **LANDING CASES AND ATTITUDES**

§ 3.244 Landing cases and attitudes. For conventional arrangements of main and nose, or main and tail wheels, the airplane shall be assumed to contact the ground at the specified limit vertical velocity in the attitudes described in

§§ 3.245-3.247. (See Figs. 3-12 (a) and 3-12 (b) for acceptable landing conditions which are considered to conform with §§ 3.245-3.247.)

§ 3.245 Level landing—

(a) Tail wheel type. Normal level flight attitude.

(b) Nose wheel type. Two cases shall be considered:

(1) Nose and main wheels contacting the ground simultaneously,

(2) Main wheels contacting the ground, nose wheel just clear of the ground. (The angular attitude may be assumed the same as in subparagraph (1) of this paragraph for purposes of analysis.)

(c) Drag components. In this condition, drag components simulating the forces required to accelerate the tires and wheels up to the landing speed shall be properly combined with the corresponding instantaneous vertical ground

reactions. The wheel spin-up drag loads may be based on vertical ground reactions, assuming wing lift and a tire-sliding coefficient of friction of 0.8, but in any case the drag loads shall not be less than 25 percent of the maximum vertical ground reactions neglecting wing lift.

LIMIT PILOT LOADS		
Control	Maximum loads for design weight W equal to or less than 5,000 lbs. <sup>1</sup>	Minimum loads. <sup>2</sup>
<b>Aileron:</b>		
Stick	67 pounds	40 pounds.
Wheel <sup>3</sup>	53 D in-pounds <sup>4</sup>	40 D in-pounds
<b>Elevator:</b>		
Stick	167 pounds	100 pounds.
Wheel	200 pounds	100 pounds.
<b>Rudder</b>		
	200 pounds	130 pounds.

<sup>1</sup>For design weight W greater than 5,000 pounds the above specified maximum values shall be increased linearly with weight to 1.5 times the specified values at a design weight of 25,000 pounds.

<sup>2</sup>If the design of any individual set of control systems or surfaces is such as to make these specified minimum loads inapplicable, values corresponding to the pertinent hinge moments obtained according to § 3.233 may be used instead, except that in any case values less than 0.6 of the specified minimum loads shall not be employed.

<sup>3</sup>The critical portions of the aileron control system shall also be designed for a single tangential force having a limit value equal to 1.25 times the couple force determined from the above criteria.

<sup>4</sup>D = wheel diameter.

**FIG. 3-11 —PILOT CONTROL FORCE LIMITS**

§ 3.246 Tail down—

(a) Tail wheel type. Main and tail wheels contacting ground simultaneously.

(b) Nose wheel type. Stalling attitude or the maximum angle permitting clearance of the ground by all parts of the airplane, whichever is the lesser.

(c) Vertical ground reactions. In this condition, it shall be assumed that the ground reactions are vertical, the wheels having been brought up to speed before the maximum vertical load is attained.

§ 3.247 One-wheel landing. One side of the main gear shall contact the ground with the airplane in the level attitude. The ground reactions shall be the same as those obtained on the one side in the level attitude. (See § 3.245.)

**GROUND ROLL CONDITIONS**

§ 3.248 Braked roll. The limit vertical load factor shall be 1.33. The attitude and ground contacts shall be those described for level landings in § 3.245, with the shock absorbers and tires deflected to their static positions. A drag reaction equal to the vertical reaction at the wheel multiplied by a coefficient of friction of 0.8 shall be applied at the ground contact point of each wheel having brakes, except that the drag reaction need not exceed the maximum value based on limiting brake torque.

§ 3.249 Side load. Level attitude with main wheels only contacting the ground, with the shock absorbers and tires deflected to their static positions. The limit vertical load factor shall be 1.33 with the vertical ground reaction divided equally between main wheels. The limit side inertia factor shall be 0.83 with the side ground reaction divided between main wheels as follows:  
0.5 W acting inboard on one side.  
0.33 W acting outboard on the other side.

## **TAIL WHEELS**

§ 3.250 Supplementary conditions for tail wheels. The conditions in §§ 3.251 and 3.252 apply to tail wheels and affected supporting structure.

§ 3.251 Obstruction load. The limit ground reaction obtained in the tail down landing condition shall be assumed to act up and aft through the axle at 45 degrees. The shock absorber and tire may be assumed deflected to their static positions.

§ 3.252 Side load. A limit vertical ground reaction equal to the static load on the tail wheel, in combination with a side component of equal magnitude. When a swivel is provided, the tail wheel shall be assumed swiveled 90 degrees to the airplane longitudinal axis, the resultant ground load passing through the axle. When a lock steering device or shimmy damper is provided, the tail wheel shall also be assumed in the trailing position with the side load acting at the ground contact point. The shock absorber and tire shall be assumed deflected to their static positions.

## **NOSE WHEELS**

§ 3.253 Supplementary conditions for nose wheels. The conditions set forth in §§ 3.254-3.256 apply to nose wheels and affected supporting structure. The shock absorbers and tires shall be assumed deflected to their static positions.

§ 3.254 Aft load. Limit force components at axle:

Vertical, 2.25 times static load on wheel, Drag, 0.8 times vertical load.

§ 3.255 Forward load. Limit force components at axle:

Vertical, 2.25 times static load on wheel,  
Forward, 0.4 times vertical load.

§ 3.256 Side load. Limit force components at ground contact:

Vertical, 2.25 times static load on wheel, Side, 0.7 times vertical load.

## SKIPLANES

§ 3.257 Supplementary conditions for skiplanes. The airplane shall be assumed resting on the ground with one main ski frozen in the snow and the other main ski and the tail ski free to slide. A limit side force equal to  $P/3$  shall be applied at the most convenient point near the tail assembly, where  $P$  is the static ground reaction on the tail ski. For this condition the factor of safety shall be assumed equal to 1.0.

## WATER LOADS

§ 3.265 General. The requirements set forth in §§ 3.266-3.282 shall apply to the entire airplane, but have particular reference to hull structure, wing, nacelles, and float supporting structure.

## DESIGN WEIGHT

§ 3.266 Design weight. The design weight used in the water landing conditions shall not be less than the maximum weight for which certification is desired for any operation.

## BOAT SEAPLANES

§ 3.267 Local bottom pressures—

(a) Maximum local pressure. The maximum value of the limit local pressure shall be determined from the following equation:

$$P_{\text{limit}} = 0.055 \rho V_{S0}^2 \left( 1.4 \left( 0 + \frac{W}{60000} \right) \right)^{1/4}$$

where

$P$  = pressure in pound per square inch.

$V_{S0}$  = stalling speed, flaps down, power off, in miles per hour (to be calculated on the basis of wind tunnel data or flight tests on previous airplanes).

$W$  = design weight.

(b) Variation in local pressure. The local pressures to be applied to the hull bottom shall vary in accordance with Figure 3-13. No variation from keel to chine (beamwise) shall be assumed, except when the chine flare indicates the advisability of higher pressures at the chine.

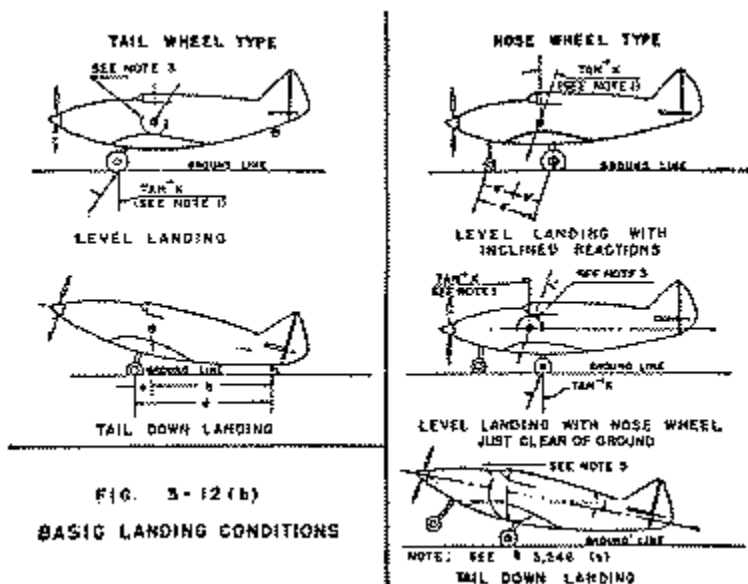
Condition	Tail wheel type		Nose wheel type		
	Level landing	Tail-down landing	Level landing with inclined reactions	Level landing with nose wheel just clear of ground	Tail-down landing
Reference section----	§ 3.245(a)	§ 3.246(a)	§ 3.245 (b) (1)	§ 3.245 (b) (2)	§ 3.246 (b) (c)
Vertical component at c.g.-----	$nW$	$nW$	$nW$	$nW$	$nW$
Fore and aft component at c.g.-----	$KnW$	0	$KnW$	$KnW$	0
Lateral component in either direction at c.g.	0	0	0	0	0
Shock absorber extension (hydraulic shock absorber)-----	Note (2)	Note (2)	Note (2)	Note (2)	Note (2)
Shock absorber deflection (rubber or spring shock absorber)-----	100% Static	100% Static	100% Static	100% Static	100% Static
Tire deflection-----	100% Static	100% Static	100% Static	100% Static	100% Static
Main wheel loads (both wheels)----- (N <sub>1</sub> )	$nW/d$	$nW/d$	$nW/d$	$nW$	$nW$
----- (D <sub>1</sub> )	$Kn$	0	$Kn$	$Kn$	0
Tail (nose) wheel loads ----- (N <sub>2</sub> )	0	$nW/d$	$nW/d$	0	0
----- (D <sub>2</sub> )	0	0	$Kn$	0	0
Notes-----	(1) and (3)	-----	(1)	(1) and (3)	(3)

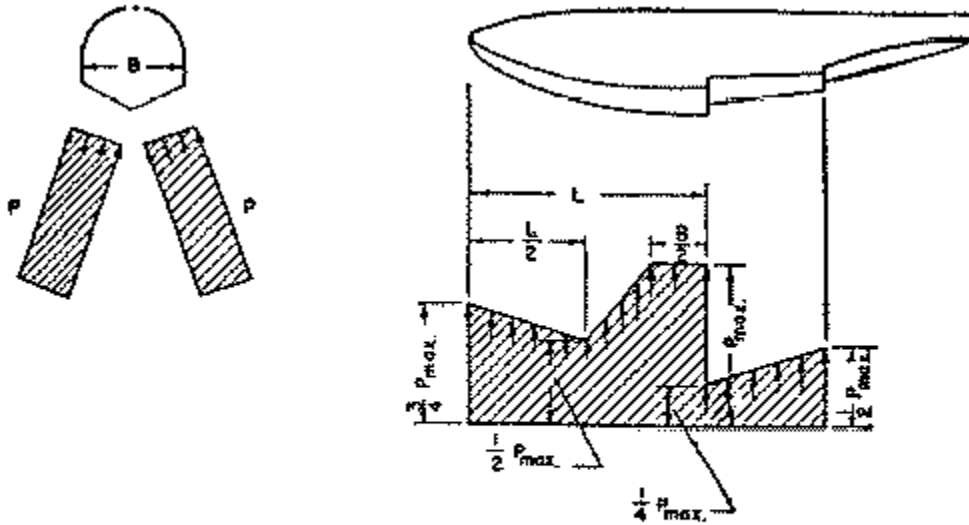
Note (1).— $K$  may be determined as follows:  $K=0.25$  for  $W\leq 3,000$  pounds or less;  $K=0.33$  for  $W\geq 6,000$  pounds or greater with linear variation of  $K$  between these weights.

Note (2).—For the purpose of design, the maximum load factor shall be assumed to occur throughout the shock absorber stroke from 25 percent deflection to 100 percent deflection unless demonstrated otherwise, and the load factor shall be used with whatever shock absorber extension is most critical for each element of the landing gear.

Note (3).—Unbalanced moments shall be balanced by a rational or conservative method.

FIG. 3-12(a)—BASIC LANDING CONDITIONS





**FIG. 3-13 DISTRIBUTION OF LOCAL PRESSURES  
(BOAT SEAPLANES)**

consideration of the inertia loads which resist the linear and angular accelerations involved. To avoid excessive local shear loads, the water reaction may be distributed over the hull bottom, using pressures not less than those specified in § 3.268.

§ 3.271 Stern loading condition—

(a) Application of load. The resultant water load shall be applied vertically in the plane of symmetry and shall be distributed over the hull bottom from the second step forward with an intensity equal to the pressures specified in §§ 3.267-3.272.

(b) Magnitude of load. The limit resultant load shall equal three-fourths of the maximum design weight of the airplane.

(c) Hull shear and bending loads. The hull shear and bending loads shall be determined by assuming the hull structure to be supported at the wing attachment fittings and neglecting internal inertia loads. This condition need not be applied to the fittings or to the portion of the hull ahead of the rear attachment fittings.

§ 3.272 Side loading condition—

(a) Application of load. The resultant water load shall be applied in a vertical plane through the center of gravity. The vertical component shall be assumed to act in the plane of symmetry and horizontal component at a point halfway between the bottom of the keel and the load water line at design weight (at rest).

(b) Magnitude of load. The limit vertical component of acceleration shall be 3.25 and the side component shall be equal to 15 percent of the vertical component.

(c) Hull shear and bending loads. The hull shear and bending loads shall be determined by proper consideration of the inertia loads or by introducing couples at the wing attachment points. To avoid excessive local shear loads, the water reaction may be distributed over the hull bottom, using pressures not less than those specified by § 3.268.