

**PART 31—AIRWORTHINESS STANDARDS: MANNED FREE BALLOONS****Subpart A—General****Subpart A—General**

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**APPENDIX A TO PART 31—INSTRUCTIONS FOR CONTINUED AIRWORTHINESS**

AUTHORITY: 49 U.S.C. 106(g), 40113, 44701–44702, 44704.

SOURCE: Docket No. 1437, 29 FR 8258, July 1, 1964, as amended by Amdt. 31-1, 29 FR 14563, Oct. 24, 1964, unless otherwise noted.

**§ 31.1 Applicability.**

(a) This part prescribes airworthiness standards for the issue of type certificates and changes to those certificates, for manned free balloons.

(b) Each person who applies under Part 21 for such a certificate or change must show compliance with the applicable requirements of this part.

(c) For purposes of this part—

(1) A captive gas balloon is a balloon that derives its lift from a captive lighter-than-air gas;

(2) A hot air balloon is a balloon that derives its lift from heated air;

(3) The envelope is the enclosure in which the lifting means is contained;

(4) The basket is the container, suspended beneath the envelope, for the balloon occupants;

(5) The trapeze is a harness or is a seat consisting of a horizontal bar or platform suspended beneath the envelope for the balloon occupants; and

(6) The design maximum weight is the maximum total weight of the balloon, less the lifting gas or air.

[Doc. No. 1437, 29 FR 8258, July 1, 1964, as amended by Amdt. 31-3, 41 FR 55474, Dec. 20, 1976]

**Subpart B—Flight Requirements****§ 31.12 Proof of compliance.**

(a) Each requirement of this subpart must be met at each weight within the range of loading conditions for which certification is requested. This must be shown by—

(1) Tests upon a balloon of the type for which certification is requested or by calculations based on, and equal in accuracy to, the results of testing; and

(2) Systematic investigation of each weight if compliance cannot be reasonably inferred from the weights investigated.

(b) Except as provided in § 31.17(b), allowable weight tolerances during flight testing are +5 percent and –10 percent.

[Amdt. 31-4, 45 FR 60179, Sept. 11, 1980]

**§ 31.14 Weight limits.**

(a) The range of weights over which the balloon may be safely operated must be established.

## § 31.16

(b) *Maximum weight.* The maximum weight is the highest weight at which compliance with each applicable requirement of this part is shown. The maximum weight must be established so that it is not more than—

(1) The highest weight selected by the applicant;

(2) The design maximum weight which is the highest weight at which compliance with each applicable structural loading condition of this part is shown; or

(3) The highest weight at which compliance with each applicable flight requirement of this part is shown.

(c) The information established under paragraphs (a) and (b) of this section must be made available to the pilot in accordance with § 31.81.

[Amdt. 31-3, 41 FR 55474, Dec. 20, 1976]

### § 31.16 Empty weight.

The empty weight must be determined by weighing the balloon with installed equipment but without lifting gas or heater fuel.

[Amdt. 31-4, 45 FR 60179, Sept. 11, 1980]

### § 31.17 Performance: Climb.

(a) Each balloon must be capable of climbing at least 300 feet in the first minute after takeoff with a steady rate of climb. Compliance with the requirements of this section must be shown at each altitude and ambient temperature for which approval is sought.

(b) Compliance with the requirements of paragraph (a) of this section must be shown at the maximum weight with a weight tolerance of +5 percent.

[Amdt. 31-4, 45 FR 60179, Sept. 11, 1980]

### § 31.19 Performance: Uncontrolled descent.

(a) The following must be determined for the most critical uncontrolled descent that can result from any single failure of the heater assembly, fuel cell system, gas valve system, or maneuvering vent system, or from any single tear in the balloon envelope between tear stoppers:

(1) The maximum vertical velocity attained.

(2) The altitude loss from the point of failure to the point at which maximum vertical velocity is attained.

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(3) The altitude required to achieve level flight after corrective action is initiated, with the balloon descending at the maximum vertical velocity determined in paragraph (a)(1) of this section.

(b) Procedures must be established for landing at the maximum vertical velocity determined in paragraph (a)(1) of this section and for arresting that descent rate in accordance with paragraph (a)(3) of this section.

[Amdt. 31-4, 45 FR 60179, Sept. 11, 1980]

### § 31.20 Controllability.

The applicant must show that the balloon is safely controllable and maneuverable during takeoff, ascent, descent, and landing without requiring exceptional piloting skill.

[Amdt. 31-3, 41 FR 55474, Dec. 20, 1976]

## Subpart C—Strength Requirements

### § 31.21 Loads.

Strength requirements are specified in terms of limit loads, that are the maximum load to be expected in service, and ultimate loads, that are limit loads multiplied by prescribed factors of safety. Unless otherwise specified, all prescribed loads are limit loads.

### § 31.23 Flight load factor.

In determining limit load, the limit flight load factor must be at least 1.4.

### § 31.25 Factor of safety.

(a) Except as specified in paragraphs (b) and (c) of this section, the factor of safety is 1.5.

(b) A factor of safety of at least five must be used in envelope design. A reduced factor of safety of at least two may be used if it is shown that the selected factor will preclude failure due to creep or instantaneous rupture from lack of rip stoppers. The selected factor must be applied to the more critical of the maximum operating pressure or envelope stress.

(c) A factor of safety of at least five must be used in the design of all fibrous or non-metallic parts of the rigging and related attachments of the envelope to basket, trapeze, or other means provided for carrying occupants.

The primary attachments of the envelope to the basket, trapeze, or other means provided for carrying occupants must be designed so that failure is extremely remote or so that any single failure will not jeopardize safety of flight.

(d) In applying factors of safety, the effect of temperature, and other operating characteristics, or both, that may affect strength of the balloon must be accounted for.

(e) For design purposes, an occupant weight of at least 170 pounds must be assumed.

[Doc. No. 1437, 29 FR 8258, July 1, 1964, as amended by Amdt. 31-2, 30 FR 3377, Mar. 13, 1965]

#### § 31.27 Strength.

(a) The structure must be able to support limit loads without detrimental effect.

(b) The structure must be substantiated by test to be able to withstand the ultimate loads for at least three seconds without failure. For the envelope, a test of a representative part is acceptable, if the part tested is large enough to include critical seams, joints, and load attachment points and members.

(c) An ultimate free-fall drop test must be made of the basket, trapeze, or other place provided for occupants. The test must be made at design maximum weight on a horizontal surface, with the basket, trapeze, or other means provided for carrying occupants, striking the surface at angles of 0, 15, and 30 degrees. The weight may be distributed to simulate actual conditions. There must be no distortion or failure that is likely to cause serious injury to the occupants. A drop test height of 36 inches, or a drop test height that produces, upon impact, a velocity equal to the maximum vertical velocity determined in accordance with § 31.19, whichever is higher, must be used.

[Doc. No. 1437, 29 FR 8258, July 1, 1964, as amended by Amdt. 31-4, 45 FR 60179, Sept. 11, 1980]

### Subpart D—Design Construction

#### § 31.31 General.

The suitability of each design detail or part that bears on safety must be established by tests or analysis.

#### § 31.33 Materials.

(a) The suitability and durability of all materials must be established on the basis of experience or tests. Materials must conform to approved specifications that will ensure that they have the strength and other properties assumed in the design data.

(b) Material strength properties must be based on enough tests of material conforming to specifications so as to establish design values on a statistical basis.

#### § 31.35 Fabrication methods.

The methods of fabrication used must produce a consistently sound structure. If a fabrication process requires close control to reach this objective, the process must be performed in accordance with an approved process specification.

#### § 31.37 Fastenings.

Only approved bolts, pins, screws, and rivets may be used in the structure. Approved locking devices or methods must be used for all these bolts, pins, and screws, unless the installation is shown to be free from vibration. Self-locking nuts may not be used on bolts that are subject to rotation in service.

#### § 31.39 Protection.

Each part of the balloon must be suitably protected against deterioration or loss of strength in service due to weathering, corrosion, or other causes.

#### § 31.41 Inspection provisions.

There must be a means to allow close examination of each part that require repeated inspection and adjustment.

## § 31.43

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### § 31.43 Fitting factor.

(a) A fitting factor of at least 1.15 must be used in the analysis of each fitting the strength of which is not proven by limit and ultimate load tests in which the actual stress conditions are simulated in the fitting and surrounding structure. This factor applies to all parts of the fitting, the means of attachment, and the bearing on the members joined.

(b) Each part with an integral fitting must be treated as a fitting up to the point where the section properties become typical of the member.

(c) The fitting factor need not be used if the joint design is made in accordance with approved practices and is based on comprehensive test data.

### § 31.45 Fuel cells.

If fuel cells are used, the fuel cells, their attachments, and related supporting structure must be shown by tests to be capable of withstanding, without detrimental distortion or failure, any inertia loads to which the installation may be subjected, including the drop tests prescribed in § 31.27(c). In the tests, the fuel cells must be loaded to the weight and pressure equivalent to the full fuel quantity condition.

[Amdt. 31-3, 41 FR 55474, Dec. 20, 1976]

### § 31.46 Pressurized fuel systems.

For pressurized fuel systems, each element and its connecting fittings and lines must be tested to an ultimate pressure of at least twice the maximum pressure to which the system will be subjected in normal operation. No part of the system may fail or malfunction during the test. The test configuration must be representative of the normal fuel system installation and balloon configuration.

[Amdt. 31-3, 41 FR 55474, Dec. 20, 1976]

### § 31.47 Burners.

(a) If a burner is used to provide the lifting means, the system must be designed and installed so as not to create a fire hazard.

(b) There must be shielding to protect parts adjacent to the burner

flame, and the occupants, from heat effects.

(c) There must be controls, instruments, or other equipment essential to the safe control and operation of the heater. They must be shown to be able to perform their intended functions during normal and emergency operation.

(d) The burner system (including the burner unit, controls, fuel lines, fuel cells, regulators, control valves, and other related elements) must be substantiated by an endurance test of at least 40 hours. Each element of the system must be installed and tested to simulate actual balloon installation and use.

(1) The test program for the main blast valve operation of the burner must include:

(i) Five hours at the maximum fuel pressure for which approval is sought, with a burn time for each one minute cycle of three to ten seconds. The burn time must be established so that each burner is subjected to the maximum thermal shock for temperature affected elements;

(ii) Seven and one-half hours at an intermediate fuel pressure, with a burn time for each one minute cycle of three to ten seconds. An intermediate fuel pressure is 40 to 60 percent of the range between the maximum fuel pressure referenced in paragraph (d)(1)(i) of this section and minimum fuel pressure referenced in paragraph (d)(1)(iii);

(iii) Six hours and fifteen minutes at the minimum fuel pressure for which approval is sought, with a burn time for each one minute cycle of three to ten seconds;

(iv) Fifteen minutes of operation on vapor, with a burn time for each one minute cycle of at least 30 seconds; and

(v) Fifteen hours of normal flight operation.

(2) The test program for the secondary or backup operation of the burner must include six hours of operation with a burn time for each five minute cycle of one minute at an intermediate fuel pressure.

(e) The test must also include at least three flameouts and restarts.

(f) Each element of the system must be serviceable at the end of the test.

[Doc. No. 1437, 29 FR 8258, July 1, 1964, as amended by Amdt. 31-2, 30 FR 3377, Mar. 13, 1965; Amdt. 31-7, 61 FR 18223, Apr. 24, 1996; 61 FR 20877, May 8, 1996]

#### § 31.49 Control systems.

(a) Each control must operate easily, smoothly, and positively enough to allow proper performance of its functions. Controls must be arranged and identified to provide for convenience of operation and to prevent the possibility of confusion and subsequent inadvertent operation.

(b) Each control system and operating device must be designed and installed in a manner that will prevent jamming, chafing, or interference from passengers, cargo, or loose objects. Precaution must be taken to prevent foreign objects from jamming the controls. The elements of the control system must have design features or must be distinctly and permanently marked to minimize the possibility of incorrect assembly that could result in malfunctioning of the control system.

(c) Each balloon using a captive gas as the lifting means must have an automatic valve or appendix that is able to release gas automatically at the rate of at least three percent of the total volume per minute when the balloon is at its maximum operating pressure.

(d) Each hot air balloon must have a means to allow the controlled release of hot air during flight.

(e) Each hot air balloon must have a means to indicate the maximum envelope skin temperatures occurring during operation. The indicator must be readily visible to the pilot and marked to indicate the limiting safe temperature of the envelope material. If the markings are on the cover glass of the instrument, there must be provisions to maintain the correct alignment of the glass cover with the face of the dial.

[Doc. No. 1437, 29 FR 8258, July 1, 1964, as amended by Amdt. 31-2, 30 FR 3377, Mar. 13, 1965]

#### § 31.51 Ballast.

Each captive gas balloon must have a means for the safe storage and con-

trolled release of ballast. The ballast must consist of material that, if released during flight, is not hazardous to persons on the ground.

#### § 31.53 Drag rope.

If a drag rope is used, the end that is released overboard must be stiffened to preclude the probability of the rope becoming entangled with trees, wires, or other objects on the ground.

#### § 31.55 Deflation means.

There must be a means to allow emergency deflation of the envelope so as to allow a safe emergency landing. If a system other than a manual system is used, the reliability of the system used must be substantiated.

[Amdt. 31-2, 30 FR 3377, Mar. 13, 1965]

#### § 31.57 Rip cords.

(a) If a rip cord is used for emergency deflation, it must be designed and installed to preclude entanglement.

(b) The force required to operate the rip cord may not be less than 25, or more than 75, pounds.

(c) The end of the rip cord to be operated by the pilot must be colored red.

(d) The rip cord must be long enough to allow an increase of at least 10 percent in the vertical dimension of the envelope.

#### § 31.59 Trapeze, basket, or other means provided for occupants.

(a) The trapeze, basket, or other means provided for carrying occupants may not rotate independently of the envelope.

(b) Each projecting object on the trapeze, basket, or other means provided for carrying occupants, that could cause injury to the occupants, must be padded.

#### § 31.61 Static discharge.

Unless shown not to be necessary for safety, there must be appropriate bonding means in the design of each balloon using flammable gas as a lifting means to ensure that the effects of static discharges will not create a hazard.

[Amdt. 31-2, 30 FR 3377, Mar. 13, 1965]

**§ 31.63**

**§ 31.63 Safety belts.**

(a) There must be a safety belt, harness, or other restraining means for each occupant, unless the Administrator finds it unnecessary. If installed, the belt, harness, or other restraining means and its supporting structure must meet the strength requirements of Subpart C of this part.

(b) This section does not apply to balloons that incorporate a basket or gondola.

[Amdt. 31-2, 30 FR 3377, Mar. 13, 1965, as amended by Amdt. 31-3, 41 FR 55474, Dec. 20, 1976]

**§ 31.65 Position lights.**

(a) If position lights are installed, there must be one steady aviation white position light and one flashing aviation red (or flashing aviation white) position light with an effective flash frequency of at least 40, but not more than 100, cycles per minute.

(b) Each light must provide 360° horizontal coverage at the intensities prescribed in this paragraph. The following light intensities must be determined with the light source operating at a steady state and with all light covers and color filters in place and at the manufacturer's rated minimum voltage. For the flashing aviation red light, the measured values must be adjusted to correspond to a red filter temperature of at least 130° F:

(1) The intensities in the horizontal plane passing through the light unit must equal or exceed the following values:

Position light	Minimum intensity (candles)
Steady white .....	20
Flashing red or white .....	40

(2) The intensities in vertical planes must equal or exceed the following values. An intensity of one unit corresponds to the applicable horizontal plane intensity specified in paragraph (b)(1) of this section.

Angles above and below the horizontal in any vertical plane (degrees)	Minimum intensity (units)
0 .....	1.00
0 to 5 .....	0.90
5 to 10 .....	0.80
10 to 15 .....	0.70

Angles above and below the horizontal in any vertical plane (degrees)	Minimum intensity (units)
15 to 20 .....	0.50
20 to 30 .....	0.30
30 to 40 .....	0.10
40 to 60 .....	0.05

(c) The steady white light must be located not more than 20 feet below the basket, trapeze, or other means for carrying occupants. The flashing red or white light must be located not less than 7, nor more than 10, feet below the steady white light.

(d) There must be a means to retract and store the lights.

(e) Each position light color must have the applicable International Commission on Illumination chromaticity coordinates as follows:

(1) *Aviation red*—  
 “y” is not greater than 0.335; and “z” is not greater than 0.002.

(2) *Aviation white*—  
 “x” is not less than 0.300 and not greater than 0.540;  
 “y” is not less than “x”-0.040” or “y<sub>0</sub>-0.010”, whichever is the smaller; and  
 “y” is not greater than “x+0.020” nor “0.636-0.0400 x”;

Where “y<sub>0</sub>” is the “y” coordinate of the Planckian radiator for the value of “x” considered.

[Doc. No. 1437, 29 FR 8258, July 1, 1964, as amended by Amdt. 31-1, 29 FR 14563, Oct. 24, 1964; Amdt. 31-4, 45 FR 60179, Sept. 11, 1980]

**Subpart E—Equipment**

**§ 31.71 Function and installation.**

(a) Each item of installed equipment must—

(1) Be of a kind and design appropriate to its intended function;

(2) Be permanently and legibly marked or, if the item is too small to mark, tagged as to its identification, function, or operating limitations, or any applicable combination of those factors;

(3) Be installed according to limitations specified for that equipment; and

(4) Function properly when installed.

(b) No item of installed equipment, when performing its function, may affect the function of any other equipment so as to create an unsafe condition.

(c) The equipment, systems, and installations must be designed to prevent hazards to the balloon in the event of a probable malfunction or failure.

[Amdt. 31-4, 45 FR 60180, Sept. 11, 1980]

### Subpart F—Operating Limitations and Information

#### § 31.81 General.

(a) The following information must be established:

(1) Each operating limitation, including the maximum weight determined under § 31.14.

(2) The normal and emergency procedures.

(3) Other information necessary for safe operation, including—

(i) The empty weight determined under § 31.16;

(ii) The rate of climb determined under § 31.17, and the procedures and conditions used to determine performance;

(iii) The maximum vertical velocity, the altitude drop required to attain that velocity, and altitude drop required to recover from a descent at that velocity, determined under § 31.19, and the procedures and conditions used to determine performance; and

(iv) Pertinent information peculiar to the balloon's operating characteristics.

(b) The information established in compliance with paragraph (a) of this section must be furnished by means of—

(1) A Balloon Flight Manual; or

(2) A placard on the balloon that is clearly visible to the pilot.

[Amdt. 31-4, 45 FR 60180, Sept. 11, 1980]

#### § 31.82 Instructions for Continued Airworthiness.

The applicant must prepare Instructions for Continued Airworthiness in accordance with appendix A to this part that are acceptable to the Administrator. The instructions may be incomplete at type certification if a program exists to ensure their completion

prior to delivery of the first balloon or issuance of a standard certificate of airworthiness, whichever occurs later.

[Amdt. 31-4, 45 FR 60180, Sept. 11, 1980]

#### § 31.83 Conspicuity.

The exterior surface of the envelope must be of a contrasting color or colors so that it will be conspicuous during operation. However, multicolored banners or streamers are acceptable if it can be shown that they are large enough, and there are enough of them of contrasting color, to make the balloon conspicuous during flight.

#### § 31.85 Required basic equipment.

In addition to any equipment required by this subchapter for a specific kind of operation, the following equipment is required:

(a) For all balloons:

(1) [Reserved]

(2) An altimeter.

(3) A rate of climb indicator.

(b) For hot air balloons:

(1) A fuel quantity gauge. If fuel cells are used, means must be incorporated to indicate to the crew the quantity of fuel in each cell during flight. The means must be calibrated in appropriate units or in percent of fuel cell capacity.

(2) An envelope temperature indicator.

(c) For captive gas balloons, a compass.

[Amdt. 31-2, 30 FR 3377, Mar. 13, 1965, as amended by Amdt. 31-3, 41 FR 55474, Dec. 20, 1976; Amdt. 31-4, 45 FR 60180, Sept. 11, 1980]

#### APPENDIX A TO PART 31—INSTRUCTIONS FOR CONTINUED AIRWORTHINESS

##### A31.1 GENERAL

(a) This appendix specifies requirements for the preparation of Instructions for Continued Airworthiness as required by § 31.82.

(b) The Instructions for Continued Airworthiness for each balloon must include the Instructions for Continued Airworthiness for all balloon parts required by this chapter and any required information relating to the interface of those parts with the balloon. If Instructions for Continued Airworthiness are not supplied by the part manufacturer for a balloon part, the Instructions for Continued Airworthiness for the balloon must include the information essential to the continued airworthiness of the balloon.

(c) The applicant must submit to the FAA a program to show how changes to the Instructions for Continued Airworthiness made by the applicant or by the manufacturers of balloon parts will be distributed.

#### A31.2 FORMAT

(a) The Instructions for Continued Airworthiness must be in the form of a manual or manuals as appropriate for the quantity of data to be provided.

(b) The format of the manual or manuals must provide for a practical arrangement.

#### A31.3 CONTENT

The contents of the manual or manuals must be prepared in the English language. The Instructions for Continued Airworthiness must contain the following information:

(a) Introduction information that includes an explanation of the balloon's features and data to the extent necessary for maintenance or preventive maintenance.

(b) A description of the balloon and its systems and installations.

(c) Basic control and operation information for the balloon and its components and systems.

(d) Servicing information that covers details regarding servicing of balloon components, including burner nozzles, fuel tanks, and valves during operations.

(e) Maintenance information for each part of the balloon and its envelope, controls, rigging, basket structure, fuel systems, instruments, and heater assembly that provides the recommended periods at which they should be cleaned, adjusted, tested, and lubricated, the applicable wear tolerances, and the degree of work recommended at these periods. However, the applicant may refer to an accessory, instrument, or equipment manufacturer as the source of this information if the applicant shows that the item has an exceptionally high degree of complexity requiring specialized maintenance techniques, test equipment, or expertise. The recommended overhaul periods and necessary cross references to the Airworthiness Limitations section of the manual must also be included. In addition, the applicant must include an inspection program that includes the frequency and extent of the inspections necessary to provide for the continued airworthiness of the balloon.

(f) Troubleshooting information describing probable malfunctions, how to recognize those malfunctions, and the remedial action for those malfunctions.

(g) Details of what, and how, to inspect after a hard landing.

(h) Instructions for storage preparation including any storage limits.

(i) Instructions for repair on the balloon envelope and its basket or trapeze.

#### A31.4 AIRWORTHINESS LIMITATIONS SECTION

The Instructions for Continued Airworthiness must contain a section titled Airworthiness Limitations that is segregated and clearly distinguishable from the rest of the document. This section must set forth each mandatory replacement time, structural inspection interval, and related structural inspection procedure, including envelope structural integrity, required for type certification. If the Instructions for Continued Airworthiness consist of multiple documents, the section required by this paragraph must be included in the principal manual. This section must contain a legible statement in a prominent location that reads: "The Airworthiness Limitations section is FAA approved and specifies maintenance required under §§43.16 and 91.403 of the Federal Aviation Regulations."

[Amdt. 31-4, 45 FR 60180, Sept. 11, 1980, as amended by Amdt. 31-5, 54 FR 34330, Aug. 18, 1989]

## PART 33—AIRWORTHINESS STANDARDS: AIRCRAFT ENGINES

### Subpart A—General

#### Sec.

33.1 Applicability.

33.3 General.

33.4 Instructions for Continued Airworthiness.

33.5 Instruction manual for installing and operating the engine.

33.7 Engine ratings and operating limitations.

33.8 Selection of engine power and thrust ratings.

### Subpart B—Design and Construction; General

33.11 Applicability.

33.13 [Reserved]

33.14 Start-stop cyclic stress (low-cycle fatigue).

33.15 Materials.

33.17 Fire prevention.

33.19 Durability.

33.21 Engine cooling.

33.23 Engine mounting attachments and structure.

33.25 Accessory attachments.

33.27 Turbine, compressor, fan, and turbo-supercharger rotors.

33.28 Electrical and electronic engine control systems.

33.29 Instrument connection.

### Subpart C—Design and Construction; Reciprocating Aircraft Engines

33.31 Applicability.