

**NOTICE OF PROPOSED AMENDMENT (NPA) No 07/2006
DRAFT DECISION OF THE EXECUTIVE DIRECTOR OF THE AGENCY,
on Certification Specifications**

for

Hot Air Balloons (CS-31HB)

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A Explanatory Note

I. General

1. The purpose of this Notice of Proposed Amendment (NPA) is to propose introduction of certification specifications for Hot-Air balloons. The scope of this rulemaking activity is outlined in ToR 31.001 and is described in more detail below.
2. The Agency is directly involved in the rule-shaping process. It assists the Commission in its executive tasks by preparing draft regulations, and amendments thereof, for the implementation of Regulation (EC) No 1592/2002¹ (hereafter referred to as the Basic Regulation) which are adopted as “Opinions” (Article 14.1). It also adopts Certification Specifications, including Airworthiness Codes and Acceptable Means of Compliance and Guidance Material to be used in the certification process (Article 14.2).
3. When developing rules, the Agency is bound to following a structured process as required by article 43.1 of the Basic Regulation. Such process has been adopted by the Agency’s Management Board and is referred to as “The Rulemaking Procedure”².
4. This rulemaking activity will be part of the Agency’s rulemaking programme for 2007. It implements the rulemaking task 31.001 Balloons, development of the Certification Specifications for Hot-Air balloons (CS-31HB).
5. The text of this NPA has been developed by the Agency. It is submitted for consultation of all interested parties in accordance with Article 43 of the Basic Regulation and Articles 5(3) and 6 of the EASA rulemaking procedure.

II. Consultation

6. To achieve optimal consultation, the Agency is publishing the draft decision of the Executive Director on its internet site. Comments should be provided within 3 months in accordance with Article 6(4) of the EASA rulemaking procedure. Comments on this proposal may be forwarded (*preferably by e-mail*), using the attached comment form, to:

By e-mail: NPA@easa.europa.eu

By correspondence: Process Support
Rulemaking Directorate
EASA
Ref: NPA-07-2006
Postfach 10 12 53
D-50452 Cologne
Germany

Comments should be received by the Agency before Thursday 21st September 2006. If received after this deadline they might not be treated. Comments may not be considered if the form provided for this purpose is not used.

¹ Regulation (EC) No 1592/2002 of the European Parliament and of the Council of 15 July 2002 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency. *OJ L 240, 7.9.2002, p.1.*

² Management Board decision concerning the procedure to be applied by the Agency for the issuing of opinions, certification specifications and guidance material (“rulemaking procedure”), EASA MB/7/03, 27.6.2003

III. Comment response document

7. All comments received will be responded to and incorporated in a Comment Response Document (CRD). This will contain a list of all persons and/or organisations that have provided comments. The CRD will be widely available ultimately before the Agency adopts its final decision.

IV. Content of the draft decision

8. Background

As part of the legislative process leading to Agency establishment, the Basic Regulation requires the Commission to adopt a comprehensive framework of rules for the implementation of the essential airworthiness and environmental protection requirements. In the field of initial airworthiness the implementing rules are contained in the Commission Regulation (EC) No 1702/2003³, (hereinafter referred to as “Part 21”).

Pursuant to the Basic Regulation the Agency shall, where appropriate issue certification specifications, including airworthiness codes and acceptable means of compliance, as well as guidance material for the application of the Basic Regulation and its implementing rules.

Certification specifications (CS) are the Agency’s suggestions on best practices to be used to demonstrate compliance with the Basic Regulation and its implementing rules. These include, in particular:

- airworthiness codes, which are standard technical interpretations of the airworthiness essential requirements contained in Annex 1 to the Basic Regulation; and
- acceptable means of compliance, which are non-exclusive means of demonstrating compliance with airworthiness codes or implementing rules.

9. Background of Certification Specifications for Hot-Air Balloons

The proposal for this new EASA CS 31HB is based on the draft CS 31HB (EASA Core Group 9 final CG9 draft 27 February 2003/ Draft C text), which was developed as follows:

- o The starting point was based on:
 - BCAR Part 31 (CAP 494) Manned Free Balloons, which has been effective in the United Kingdom since 1984 and,
 - The LFHB (Lufttüchtigkeitsforderungen für Heißluftballone), which has been effective in Germany since 1982.
- o Changes were made; according to EASA CG9 Paper „Airworthiness JARs to EASA CS conversion, general guidelines, Issue 24.09.2002“ (Draft A)
- o Recommendations from the conference of European Balloon Manufacturers held in December 2002 where incorporated (Draft B).
- o and finally as result of a subsequent review of those recommended changes by an EASA Core Group 9-lead CAA/LBA sub-group and discussion of these further changes with interested parties; both NAAs and industry were made. This document is the Draft C text.

³ Commission Regulation (EC) No 1702/2003 of 24 September 2003 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations. *OJ L 243, 27.9.2003, p. 6.*

Major Changes in this NPA in comparison to the draft CS 31HB from the CG9 Draft C are justified below. Rearrangement of paragraph structure and paragraph titles is sometimes introduced to improve the readability and harmonise with other EASA codes.

CS 31HB.28 Tethered flight loads (Added paragraph).

Justification:

Structural and operational aspects of tethered flight have a considerable impact on flight safety and were not addressed in airworthiness codes up to now.

CS 31HB.29 Ground Handling (Added paragraph).

Justification:

Structural aspects not related to the flight case but to i.e. assembly/disassembly in the field, transport and storage were not addressed in hot air balloon airworthiness requirements up to now.

CS 31HB.61 Static discharge (Removed and not harmonised with FAR 31).

Justification:

Requirement was only related to "mixed balloons" (Rozière) which are only operated with non-flammable lifting gas. Thus, static discharge may be omitted.

CS 31HB.67 Tethered flight (Added paragraph).

Justification:

An indication that limitations for tethered flight are being, or have been reached was not addressed in hot air balloon airworthiness requirements up to now.

V. Regulatory Impact Assessment

10. Purpose and intended effect

The Agency shall, in accordance with Article 43 of the Basic Regulation and the implementing rules adopted by the Commission, develop certification specifications, including airworthiness codes and acceptable means of compliance for each product, part or appliance for which a certificate is requested.

It is therefore that the Agency issues this Certification Specification for Hot-Air Balloons, with the intent to reflect the present state of the art and the best practices in this field. Since 28 September 2003 the Agency has issued 8 Type Certificates for Hot-Air Balloons using various Certification bases and Special Conditions such as the *British Airworthiness Requirements, Manned Free* and *FAR Part 31* corresponding to Manned Hot Air Balloons.

11. Options

The identified options for this subject would be to continue using the presently available Certification bases and special conditions as a certification basis, or to establish a common certification specification.

A common denominator would improve transparency and provide a level playing field for future Type Certification of Hot-Air Balloons which would also provide a common standard of safety.

12. Sectors concerned

Introduction of Certification Specifications for Hot-Air Balloons will mainly affect manufacturers of Hot-Air Balloons. There are approximately 10 major Hot-Air Balloon manufacturers in the EU member states, and several thousands Hot-Air Balloons are operated in EU member states.

13. Impacts

Safety

Introduction of Certification Specifications for Hot-Air Balloons will have no direct effect on present safety levels, since it is based on existing national certification specifications. It will on the other hand provide a better understanding and implementation due to standardised specifications, improved wording of the paragraphs and more precise and extended AMC material.

Economic

A positive economic impact can be expected from standardisation of the Certification Specifications. Since this newly proposed Certification Specifications are based on several existing Airworthiness Codes, with a high degree of similarities, a negative economic impact is not expected.

Social

No social impacts are expected from the introduction of CS-31HB.

Other aviation requirements outside EASA scope

There are no impacts on other aviation requirements outside the scope of EASA, such as security, Air Traffic Management and airports.

Foreign comparable regulatory requirements

The proposal is based on several European Certification bases and Special Conditions, as well as on FAR 31, aiming to achieve a consistent standard and a level playing field for European industry. Although the CS-31HB is not harmonised with FAR 31, the similarity to FAR 31 will reduce certification efforts.

Equity and fairness issues identified

Since most hot air balloons manufactured in Europe are already complying with the level of CS-31HB, and a substantial amount of the serial production hot air balloons operated in the USA are already imported from Europe, the introduction of these certification specifications will have little effect.

14. Summary and Final Assessment

Based on this RIA, the proposal of this NPA 07/2006 is considered as having no safety, social or environmental impact, and a reasonable positive economic impact. Therefore the progress of the proposal is justified.

B **Draft decision****I** **Draft Decision CS-31HB****BOOK 1: SUBPART A – GENERAL****CS 31HB.1 APPLICABILITY**

This airworthiness code is applicable to manned free balloons that derive their lift from-

- (a) heated air (Hot-Air Balloons)
- (b) a combination of heated air and a gas being lighter than air at a given temperature and given pressure (Mixed Balloons or Rozière).

CS 31HB.2 DEFINITIONS

Definition of terms used:

- (a) The envelope contains the medium which provides the lift.
- (b) A "basket" is assumed to be of conventional woven wicker design but it may also apply to other appropriate means of occupant accommodation, including gondolas, seats etc.
- (c) "Disposable Ballast" is the amount of ballast required to be available for flight path management.
- (d) "Tethered flight" is the temporary restraint of a free balloon whilst in flight; for the purposes of either initiating a free flight or conducting an entire flight at a single location.

BOOK 1: SUBPART B - FLIGHT**CS 31HB.12 PROOF OF COMPLIANCE**

- (a) Each requirement of this Subpart must be met at each mass 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 mass if compliance cannot be reasonably inferred from the masses investigated.

CS 31HB.14 MASS LIMITS

The range of masses over which the balloon may be safely operated must be established and at least consists of:

- (a) Maximum mass. The maximum mass is the highest mass at which compliance with each applicable requirement of CS 31HB is shown. The Maximum mass must be established so that it is not more than
- (1) the least of - (see AMC 31HB.14(a)):
 - (i) The maximum mass selected for the product;
 - (ii) The design maximum mass, which is the highest mass at which each structural loading condition is shown; or
 - (iii) The demonstrated maximum mass at which compliance with each applicable flight requirement is shown; or
 - (iv) The operational maximum mass, which is the maximum mass limitation in the Flight Manual (see CS 31HB.81) and which must not exceed the demonstrated maximum mass in (iii) above.
 - (2) Not less than-
 - (i) The mass with the maximum number of occupants, assuming a mass of 77 kg (170 lb) for each occupant, and
 - (ii) A minimum of 30% of the usable amount of fuel of the minimum required number of fuel cells.
- (b) Minimum mass. The minimum mass must be established so that it is not less than one of the following values, whichever is higher:

- (1) The sum of:
 - (i) The empty mass determined under CS 31HB.16
 - (ii) The mass of the required minimum occupants (assuming a mass of 77 kg (170 lb) for each occupant)
 - (iii) The minimum equipment as specified in CS 31HB.85
 - (iv) A minimum of 30% of the usable amount of fuel of a fuel cell.
- (2) The demonstrated mass, at which compliance with each applicable flight requirement is shown (see AMC 31HB.14(b)(2)); or
- (3) The operational minimum mass, which is the minimum mass limitation in the Flight Manual (See CS 31HB.81) and which must not be less than the demonstrated minimum mass in (2) above. (See AMC 31HB.14(b))

CS 31HB.16 EMPTY MASS

The empty mass must be determined by weighing the balloon with installed equipment but without easily removable items. (See AMC 31HB.16)

CS 31HB.17 PERFORMANCE: CLIMB

- (a) The balloon must be capable of climbing at least 91 metres (300 feet) in the first minute from a start in equilibrium at ground level. Compliance must be shown at the maximum mass appropriate to the conditions of the test. (See AMC 31HB.17(a))
- (b) Compliance with the requirements of paragraph (a) of this section must be shown at the maximum take off mass with a tolerance of +5%, -0%.

CS 31HB.20 CONTROLLABILITY

It must be shown - normally by demonstration with a balloon of the type for which certification is requested - that the balloon is safely controllable and manoeuvrable during take-off, ascent, descent, approach and landing without requiring exceptional piloting skill.

BOOK 1: SUBPART C - STRUCTURE**CS 31HB.21 LOADS**

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

CS 31HB.23 LOAD FACTORS

- (a) Flight load factor. In determining limit loads, the limit load factor must be at least 1.4.
- (b) Landing load factor. For all parts belonging to the balloon's suspension system, including the envelope to suspension system pick up points, limit load must be determined using a limit load factor of at least 3.0.

CS 31HB.25 FACTORS OF SAFETY

- (a) Except as specified in paragraph (b) of this section, the factor of safety is 1.5. A further factor of safety of at least 1.5 must be used in the design of all fibrous or non-metallic suspension components. (See AMC 31HB.25(a))
- (b) A factor of safety of at least 5 must be used in envelope design. The factor must be applied to the more critical of the maximum operating pressure or envelope stress. (See AMC 31HB.25(b))
- (c) 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 jeopardise 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 mass of at least 77 kg (170 lb) must be assumed.

CS 31HB.27 STRENGTH AND PROOF OF STRENGTH

- (a) The structure must be able to support limit loads without permanent deformations or other detrimental effects.

- (b) The structure must be substantiated by static test to be able to withstand ultimate loads for at least 3 seconds without failure. Proof of compliance with the strength requirements must cover the balloon's entire operating range. Proof by calculation only can be accepted for designs where it has been demonstrated by experience that such calculation gives reliable results. Load tests must be performed in all other cases.

- (1) For the balloon envelope, proof of strength must also make allowance for tear growth after damage of the envelope in order to prevent propagation of a tear to a hazardous size.
- (2) For the envelope tests may be performed on representative portions of the envelope provided the dimensions of these portions are sufficiently large to include critical design features and details such as critical seams, joints, load-attachment points, etc.

- (c) The basket must be of a generally robust design and afford the occupants adequate protection during a rough landing. There must be no design feature that by reasonably envisaged distortion or failure would be likely to cause serious injury to the occupants. (See AMC 31HB.27(c))

CS 31HB.28 TETHERED FLIGHT LOADS

The effects of the loads associated with tethered flight on the balloon's components (particularly the burner frame/load frame) must be assessed and accounted for in the design. Assessment may be by test or analysis, provided any analysis method is shown to be reliable. Any associated operational limitations must be established and recorded (see CS 31HB.81).

CS 31HB.29 GROUND HANDLING

The strength requirements must include consideration of the ground handling case. The loads occurring in service must be determined and the parts and components under particular stress must be designed in accordance with their designated use and dimensioned such as not to fail under recurrent loads.

CS 31HB.30 RESTRAINT HARNESS

- (a) When a occupant restraint harness is installed, the occupant must be safely restrained within

the basket when subjected to the following ultimate inertia load factors, subject to a maximum resultant of 3g:

- (1) 2.0g Upwards
- (2) 3.0g Horizontally in all directions

An occupant mass of at least 77 kg (170 lb) must be assumed for the purposes of this paragraph.

- (b) Local attachments in the load path between the safety belt or harness and the main structure of the basket, restraining the occupant, must not be less strong than the strength necessary for 1.33 times the loads corresponding to the acceleration specified in CS 31HB.30(a).

BOOK 1: SUBPART D - DESIGN AND CONSTRUCTION**CS 31HB.31 GENERAL**

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

CS 31HB.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. (See AMC 31HB.33(a))
- (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.
- (c) Envelope materials must be shown not to support continued burning if ignited by the heater when the balloon is inflated or in flight.

CS 31HB.35 MANUFACTURING PROCESSES

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.

CS 31HB.37 FASTENINGS

Bolts, pins, screws and rivets used in the structure must conform to an approved specification. This also applies to locking devices and methods. Unless the joint is free from relative movement secondary locking means must be used. Self-locking nuts may not be used on bolts that are subject to rotation in service. (See AMC 31HB.37)

CS 31HB.39 PROTECTION OF PARTS

Each part must be suitably protected against deterioration or loss of strength in service due to weathering, corrosion, heat, abrasion, ground handling, ground transport, flight conditions or other causes. (See AMC 31HB.39)

CS 31HB.41 INSPECTION PROVISIONS

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

CS 31HB.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 structural elements 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 the safety of which is based on comprehensive test data.

CS 31HB.44 PROTECTION OF ENVELOPE AGAINST TEARING

The envelope must be designed such that hazardous propagation of tears or local damage will not occur while the envelope is supporting limit loads. (See AMC 31HB.44)

CS 31HB.45 FUEL CELLS

- (a) Design

In the design of pressurised fuel cells (e.g. fuel cylinders), all relevant factors must be taken into account including internal pressure, ambient and operational air pressure and temperatures (including during carriage and storage) and dynamic loads. (See AMC 31HB.45(a))
- (b) Material

Material characteristics to be considered in the design of pressurised fuel cells must include yield strength, tensile strength, ductility, impact strength, fracture resistance, time-dependent strength (ageing), fatigue strength and corrosion resistance. The material must be compatible with the fuel used.
- (c) Wall thickness

The wall thickness of pressurised fuel cells

must be calculated with regard to pressure, temperature, maximum stresses and peak stress concentrations and will be supported by testing, in accordance with paragraph (e) below.

(d) Inertia Loads

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. (See AMC 31HB.45(d))

(e) Type Testing

The fuel cell cylinder design and manufacture must be verified by a test programme agreed by the Agency. This test programme must consider burst testing, fatigue testing, impact testing, drop testing, macro examination of the material of the cell cylinder and welded joints (if applicable) and material variability.

(f) Fuel cell fittings

A pressurised fuel cell (fuel cylinder) must be equipped with:

- (1) A shut-off valve on the main liquid supply without an excess flow valve, or any other restriction of full flow. This valve must be equipped with a self-sealing coupling, or other means to avoid the release of hazardous quantities of liquid gas should the control be inadvertently operated without a fuel line connected.
- (2) A pressure relief valve, which must not be connected to the liquid supply. The pressure relief valve must be shown to adequately protect the cylinder.
- (3) A means of controlling the maximum fill in accordance with the applicable gas handling legislation.
- (4) A fuel contents indicator. (See also CS 31HB.85(a))
- (5) A clearly visible label stating that the cylinders are only for use in hot air balloons
- (6) A data plate containing information necessary for safe operation. (See AMC 31HB.45(f)(6))

(g) Protection of the fittings

- (1) Guards must be fitted to all fuel cells to protect the valves and other tank-mounted equipment from either inadvertent operation or damage, particularly in the case of a hard or fast landing when occupants may be thrown about the basket or obstacles outside the basket may be

impacted. The guards must also be sufficiently robust to offer protection from damage during carriage.

- (2) Rigid extensions must not be fitted directly to fuel cell valves or fittings due to the likelihood of overload or fracture occurring in the case of a hard or fast landing. (See also CS 31HB.46)

CS 31HB.46 PRESSURISED FUEL SYSTEMS

- (a) For pressurised fuel systems each element, including the fuel cells, lines and connecting fittings, must be tested to, or have a safe working pressure of at least twice the maximum pressure to which the system will be subjected in normal operation. In the test, no part of the system may leak, fail or malfunction.
- (b) All parts of a pressurised fuel system must also be generally robust and capable of withstanding impact and abuse loads that are likely in service. (See AMC 31HB.46(b))
- (c) No part of the system may have an unprotected rigid extension that could be broken in any likely impact situation (see also CS 31HB.45(g)(2)).

CS 31HB.47 HEATER SYSTEM

- (a) When a heater is used to provide the lifting means, the system must be designed and installed so as not to create a fire hazard.
- (b) Parts adjacent to a heater (and if applicable, its flame) and the occupants must be protected from excessive heat.
- (c) There must be controls, instruments, or other equipment essential to 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 heater system (including, for a burner, the burner unit, controls, fuel lines, fuel cells, regulators, control valves, and other related elements) must be substantiated by an endurance test designed to reflect the limiting conditions likely to be encountered in service, both in kind and duration. The endurance test proposed by the manufacturers must be approved by the Agency.
- (e) For a burner system, 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.

- (g) For a burner, the pilot light (or other means of ignition) must be shown to operate reliably in typical gusts and rain, must be readily accessible for relighting and must be easily relit. Continued operation of a burner must be possible in the event of a sustained pilot light failure.
- (h) Except in single-occupant balloons, the heater system (which for burners includes the burner unit, fuel lines, fuel cells, regulators and control valves) must be designed so that in the event of any single failure, it will retain sufficient heat output to maintain level flight. (See AMC 31HB.47(h))

CS 31HB.48 OPERATIONAL RELIABILITY OF THE HEATER SYSTEM

The heater system (including, for a burner, the burner unit, controls, fuel lines, fuel cells, regulators, control valves, and other related elements) must be designed so that a single failure due to technical fault, wear or ageing of the whole system or parts thereof could not endanger the occupants. (see AMC 31HB.48)

CS 31HB.49 CONTROL SYSTEMS

- (a) Each control must operate easily, smoothly, and positively enough to allow proper performance of its functions. Controls must be so arranged and identified to prevent confusion and inadvertent operation.
- (b) Each control system and operating device must be designed and installed in a manner that will prevent jamming, chafing, or unintended interference from passengers or loose items of equipment. The elements of the control system must have design features or must be distinctly and permanently marked to minimise the possibility of incorrect assembly that could result in malfunctioning of the control system.
- (c) To prevent bursting of the envelope, each balloon using a captive gas as a lifting means (mixed balloon) must be equipped with a valve or appendix through which sufficient gas volume can be released automatically once the maximum operating pressure is reached.
- (d) Each hot air balloon must have a means to allow the controlled release of hot air during flight unless the Agency is satisfied that the balloon complies with CS 31HB.20 without it.
- (e) For the purpose of envelope material protection, each hot air balloon must have a means to indicate the maximum envelope skin temperature or maximum internal air temperature during operation. (See AMC 31HB.49(e))

CS 31HB.51 BALLAST

Each mixed balloon using ballast must have a means for its safe storage and controlled release. (See AMC 31HB.51)

CS 31HB.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.

CS 31HB.55 RAPID DEFLATION MEANS

- (a) The envelope must have means to allow for rapid deflation after landing. The system must be designed to prevent the possibility of inadvertent operation. If a system other than a manual system is used, the reliability of the system used must be substantiated. (See AMC 31HB.55(a))
- (b) If a mixed balloon is equipped with a lateral rapid deflation means, a device must be installed to align the balloon during landing in order to turn the rapid deflation means into its designated position. (See AMC 31HB.55(b)).

CS 31HB.57 CONTROL CORDS

- (a) General
 - (1) All control cords used for flight control must be designed and installed to preclude entanglement and inadvertent operation.
 - (2) The maximum force required for their operation must not exceed 340 N (75 lbf).
 - (3) All control cords used for flight control must be long enough to allow for an increase of at least 10% in the vertical dimension of the envelope.
- (b) Arming cords

If an arming device is employed to prevent inadvertent operation of an irreversible control, the part of the cord to be handled by the pilot must be coloured with yellow and black bands.
- (c) Turning vent cords

If turning vent cords are used to orient the balloon for landing, the part of cords to be handled by the pilot for turning to the left must be coloured black and the corresponding part of the cord used for turning to the right must be coloured green. (See AMC 31HB.57(c))
- (d) Venting cords
 - (1) If a venting cord is used to allow controlled release of the lifting gas and the vent can be resealed in flight, the part of the cord to

be handled by the pilot must be coloured with red and white bands.

- (2) If a further cord is required to re-seal any vent, the part of the cord handled by the pilot must be coloured white.

(e) Rapid or emergency deflation cords

- (1) If a cord is used for rapid or emergency deflation of the envelope and the device cannot be resealed in flight, the part of the cord to be handled by the pilot must be coloured red.

- (2) In addition to the force requirement of 31HB.57(a) above, the force required to operate an emergency deflation cord must not be less than 110 N (25 lbf).

CS 31HB.59 BASKETS OR OTHER MEANS PROVIDED FOR THE OCCUPANTS

- (a) The basket may not rotate independently of the envelope unless this movement is under the control of the pilot. (See AMC 31HB.59(a))
- (b) Each projecting object on the basket or other means provided for carrying occupants, that could cause injury to the occupants, must be padded.
- (c) The internal height of the basket sides must not be less than 1.10 m.
- (d) When more than six persons are carried, the basket must be divided into compartments, each containing not more than six persons.
- (e) When the basket proportions and compartmentation are such that more than one person might fall on top of another during landing, there must be a means of preventing this. This may be by alignment of the basket for landing, or by other effective means. (See AMC 31HB.59(e))
- (f) Reasonable space must be provided for each occupant, with regard to both comfort during the flight and to safety during the landing. (See AMC 31HB.59(f))
- (g) There must be at least one hand hold for each passenger.

- (h) Means must be provided to allow drainage of vapour or liquid from the bottom of the basket.

- (i) The load-bearing parts (e.g. ropes or cables) of the suspension system must be routed in a way that excludes the possibility of them being damaged in normal service.

- (j) The basket floor must not project beyond the sidewalls.

- (k) Information on limiting occupant configurations must be provided in the Flight Manual (CS 31HB.81). (See AMC 31HB.59(k))

CS 31HB.63 OCCUPANT RESTRAINT

- (a) For balloons having a separate pilot compartment, there must be a suitable restraint for the pilot which must meet the strength requirements of Subpart C. Additionally, the restraint must be designed so that:

- (1) The pilot can reach all the necessary controls when the restraint is correctly worn and adjusted.

- (2) There is a method of quick release that is simple and obvious.

- (3) The possibility of inadvertent release is minimised.

- (4) The possibility of injury to the pilot under the accelerations specified in CS 31HB.30 is minimised. (See AMC 31HB.63(a))

- (b) There must also be a restraining means for all other occupants, which can take the form of hand holds. As a minimum, there must be one such hand hold per occupant and both they and their supporting structure must meet the requirements of Subpart C.

CS 31HB.67 TETHERED FLIGHT

The pilot must be provided with an indication that any applicable limitations for tethered flight are being, or have been reached; such that the risk of damage to the balloon, or injury to its occupants, is minimized. (See AMC 31HB.67)

BOOK 1: SUBPART F - EQUIPMENT

CS 31HB.71 FUNCTION AND INSTALLATION

(a) Each item of required equipment must:

- (1) be of a kind and design appropriate to its intended function;
- (2) be labelled or marked as to its identification, function, or operating limitations, or any applicable combination of these factors;

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

(4) function properly when installed. (See AMC 31GB.71(a)(4))

(b) Instruments and other equipment may not in themselves, or by their effect upon the balloon, constitute a hazard to safe operation.

BOOK 1: SUBPART G - OPERATING LIMITS AND DETAILS**CS 31HB.81 FLIGHT MANUAL**

- (a) General: (See AMC 31HB.81)
For each type of balloon, a Flight Manual must be established. Where practical, a suitable place for its storage aboard the balloon must be provided.
- (b) Information in the Flight Manual and Approval:
The Flight Manual must contain all the information necessary for safe operation of the balloon as well as the operating limitations. This section of the manual requires approval. The necessary content of the Flight Manual includes:
- (1) A description of the balloon and its technical equipment with explanatory sketches;
 - (2) Specification of the permissible lifting gas (For mixed balloons only);
 - (3) The operating limits including CS 31HB.14;
 - (4) Emergency procedures.

CS 31HB.82 INSTRUCTIONS FOR CONTINUED AIRWORTHINESS

The applicant must provide a Balloon Maintenance Manual for the balloon and a maintenance schedule against which the balloon must be inspected and maintained in a serviceable condition. (See AMC 31HB.82)

CS 31HB.83 CONSPICUITY

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

CS 31HB.85 MINIMUM EQUIPMENT

Each balloon must be equipped with:

- (a) General:
- (1) A device to indicate the quantity of fuel available. (See AMC 31HB85(a)(1))
 - (2) A means that unambiguously indicates to the pilot from which fuel cell the burner is being fed.
 - (3) A device in the control system of each burner that indicates whether the heat output is high, normal or low. (See AMC 31HB85(a)(3))
 - (4) A standby source of ignition for the pilot light or burner.
 - (5) An envelope temperature indicator, which may either be of the continuous reading type or a type that gives a warning signal (see also CS 31HB.49(e)).
 - (6) An altimeter (See AMC 31HB.85(a)(6))
 - (7) Where flight manual limitations specify a rate of climb or descent; a rate of climb/descent indicator (variometer).
 - (8) A fire extinguisher. (See AMC 31HB.85(a)(8))
 - (9) For balloon types and sizes specifically approved for tethered operations (see CS 31HB.28), an EASA-approved, type and size-specific 'kit' of tethering components, including accompanying operational instructions for both flight and ground crews, must be provided.
- (b) For mixed balloons:
- (1) Minimum ballast, if applicable

BOOK 2: SUBPART B – FLIGHT**AMC 31HB.14(a)****Mass limits**

The maximum mass corresponds to the maximum buoyancy. The lift-producing medium is not part of the maximum mass.

AMC 31HB.14(b)(3)**Mass limits**

Minimum mass: In arriving at this figure, especially with larger balloons, attention should be paid to the ability to properly operate the balloon, in terms of both its heating and venting, with the reduced envelope rigidity associated with low mass operation.

The lift-producing medium is not part of the empty mass.

AMC 31HB.16**Empty mass**

"Easily removable items" here refers to instrument boxes, fuel cells designed as removable etc.

AMC 31HB.17(a)**Performance: climb**

"Conditions of the test" here refers to the combination of launch field elevation (launch altitude) and corresponding ambient air temperature.

BOOK 2: SUBPART C – STRUCTURE**AMC 31HB.25(a)****Factors of Safety**

"Suspension components" here are those components, from the base of the envelope down, upon which form the primary load paths of the trapeze, basket or other means provided for the occupants.

Note: Envelope to suspension system pick-up points should be included as part of the suspension system in accordance with AMC 31HB.25(b) below.

The individual structural elements in the suspension system should be dimensioned and configured or duplicated so that failure of one structural element (single failure) does not cause any uncontrollable operating condition. The factors of safety apply to all parts of the load bearing path (e.g. joints, splices, knots, terminals etc).

The post-single failure case need only be justified with the application of limit loads.

AMC 31HB.25(b)**Factors of safety**

The term "envelope" here includes the integral vertical and horizontal load tapes as well as the envelope fabric(s). It should be noted that the envelope to suspension system pick-up points (sometimes known as 'turnbacks') should be regarded as part of the suspension system, rather than the envelope, as far as 31HB.25(a) & (b) are concerned.

AMC 31HB.27(c)**Strength and proof of strength**

It has been shown by a number of decades of in-service experience that the traditional reinforced woven wicker and willow basket design offers a combination of resilience and impact resistance that can contribute considerably to the protection of occupants. They are able to absorb considerable kinetic energy during impact on the ground or against obstacles. They offer secure shelter for the occupants cowering behind the basket wall when crashing into trees or when being dragged by the wind over the ground.

A drop test must be performed if it is not possible to make use of an existing proven basket of the same or similar design (in terms of construction method, size, layout etc.) for a balloon of the size that is the subject of the application. In the absence of an alternative test proposal, this test must be performed at the maximum design mass of the basket in a manner that simulates the effects of gravity that occur as realistically as possible. The basket is dropped onto a horizontal concrete surface from a height of 1 m at 0°, 15° and 30°. The drop test must not result in deformation or fractures which, by their nature, could lead to the serious injury of occupants.

BOOK 2: SUBPART D - DESIGN AND CONSTRUCTION**AMC 31HB.33(a)****Materials**

Approved specifications here should be taken as being those produced by the applicant or those meeting internationally recognised standards as defined applicable in the type design data. Material specifications should be those contained in documents accepted either specifically by the Agency or by having been prepared by an organisation or person which the Agency accepts has the necessary capabilities. In defining design properties these material specification values should be modified and/or extended as necessary by the constructor to take account of manufacturing practices (for example method of construction, forming, machining and subsequent heat treatment).

AMC 31HB.37**Fastenings**

Approved specifications in the sense of these requirements are the standards described in the AMC 31HB.33(a).

AMC 31HB.39**Protection of parts**

Suspension system cables and components manufactured from stainless steels (corrosion resistant steels) are considered compliant with this requirement.

To ensure the protection of parts, it is permissible to rely on recommended inspections (details in the Maintenance Manual).

In cases where deterioration or loss of strength is unavoidable during the life of the product, details of appropriate mandatory replacement lives or in-service testing should be provided in the maintenance programme (see also CS 31HB.82).

AMC 31HB.44**Protection of envelope against tearing**

Unless it can be demonstrated that basic envelope material can provide such a rip-stopping capability, horizontal and vertical load tapes and/or other rip-stoppers should be incorporated into the structure of the envelope so that likely tear lengths are limited to those for which level flight can be maintained. Failure of the envelope between rip-stoppers should be taken into account in the proof of the structure.

AMC 31HB.45(a)**Fuel cells; Design**

Note: Road, ship or aircraft transport of fuel cells is an inherent characteristic of hot air balloon operation. In order to comply with Road Transport legislation it is recommended to consider in parallel to airworthiness issues the compliance with such legislation applicable to pressurised gas containers (e.g. ADR).

AMC 31HB.45(d)**Fuel cells; Inertia loads**

Consideration of applied loads should include handling and transport cases as well as the (see CS 31HB.30) flight cases.

AMC 31HB.45(f)(6)**Fuel cells; Fuel cell fittings**

The fuel cell data plate should include the following information:

- 1) The manufacturers name or mark
- 2) The type design approval number (if applicable)
- 3) The manufacturers serial number
- 4) The (proof) test pressure (in gauge pressure)
- 5) The date (month and year) of the initial inspection and the most recent Periodic Inspection
- 6) The date of the next Periodic Inspection
- 7) The stamp of the 'expert' who carried out the test(s) and inspection(s)

- 8) The water capacity (in Litres)
- 9) The UN number and the proper name of the gas or mixture of gases (e.g. UN1978 Propane)
- 10) The maximum filling mass and the Tare of the receptacle with the fittings and accessories as fitted at the time of filling, or the Gross mass

AMC 31HB.46(b)
Pressurised fuel systems

Fuel cells should not extend above the upper rim of the basket to prevent them from being impacted by obstacles outside the basket in case of hard or fast landing.

An example of an abuse case is the grabbing of a fuel hose by a passenger during a landing.

AMC 31HB.47(h)
Heater system

For those single occupant balloons which do not meet the single failure criteria in the requirement, measures to compensate for the increased likelihood of a cold descent landing (i.e. one without the assistance of a heater system) should be discussed with the Agency.

AMC 31HB.48
Operational reliability of the heater system

A hazard exists, if e.g. the output of the heater system due to a single failure becomes so low that compliance with the requirements under 31HB.20 becomes uncertain.

The requirement with regards to the ensurance of a permanently sufficient heat output will be considered as being met, if either two completely separated burners and fuel systems including fuel cells or only two separated fuel systems are existent which feed a single burner of very robust construction. For single occupant balloons see CS 31HB.47(h)

A permanently sufficient heat output is considered as available if the following values are used:

Single burner up to and including	2.500 m ³ (+10%)
Double burner up to and including	4.500 m ³ (+5%)
Triple burner up to and including	8.500 m ³
Quad burners or more from	8.500 m ³

AMC 31HB.49(e)
Control systems

The use of a signal warning device, which actuates at a temperature below the limiting safe temperature is an acceptable means of compliance.

AMC 31HB.51
Ballast

Ballast material should be easily transferred, disposed of and dissipated. Means must be provided to prevent freezing and/or blocking the release of the ballast material. The material should not pollute the environment.

Dry sand is a well proven material and is considered as suitable in the sense of this paragraph and this AMC.

The disposable ballast may be necessary for the pilot to perform the flight path management. The pre-take-off decision on the amount of disposable ballast should be left to the pilot as it is dependant on the flight task, the weather etc.

AMC 31HB.55(a)**Rapid deflation means**

A deflation is considered as "rapid" if after touch-down the balloon envelope is adequately prevented from "sailing" and being dragged too much over the ground by the wind.

AMC 31HB.55(b)**Rapid deflation means**

The installation of turning vents or a drag rope is considered as a suitable device in the sense of subparagraph (a).

AMC 31HB.57(c)**Control cords; Turning vent cords**

In the interests of reducing the pilot's workload during the critical approach phase, it should be possible to operate the turning vents (to a sufficient extent to align the basket for landing, if this is required) with one hand.

AMC 31HB.59(a)**Baskets or other means provided for the occupants**

The purpose of this subparagraph is to prevent entanglement of operating lines due to uncontrolled rotation. It should be noted that uncontrolled rotation may also occur during landings with basket tip-over if the plan view of the basket floor is circular or more than hexagonal.

AMC 31HB.59(e)**Baskets or other means provided for the occupants**

"Alignment of the basket for landing" here assumes the presence of "turning vents" or a "drag rope" or an equivalent feature and Flight Manual instructions specifying that the basket be aligned to land on one of its longer sides.

AMC 31HB.59(f)**Baskets or other means provided for the occupants**

Unless otherwise justified on safety grounds, a minimum figure of 0.3m² plan area should be used for each standing occupant, with proper account being taken of the specified size, number and position of equipment when applying this figure. The Agency should be consulted in cases where a basket's shape or compartmentation makes the measurement of this figure subjective.

AMC 31HB.59(k)**Baskets or other means provided for the occupants**

This information should state, for each permissible model of basket or other means provided for the occupants, the maximum permitted occupancy in relation to specified sizes, numbers and positions of equipment items.

AMC 31HB.63(a)**Occupant restraint**

Note: Operational legislation may also require pilot restraint to be fitted to balloons, which have a single compartment basket.

AMC 31HB.67**Tethered flight**

The inclusion of an appropriately rated "weak link" to provide the pilot with an attention-getting indication of the aircraft's tethering limitation, would be an acceptable means of complying with CS 31HB.67.

BOOK 2: SUBPART F - EQUIPMENT

AMC 31HB.71 (a)(4)

Function and installation

The correct functioning should not be impaired by icing, heavy rain, high humidity or low and high temperatures.

When ATC equipment and/or positioning lights as possibly required by operational rules are installed it should be shown that the electrical system is such that the operation of this equipment is not adversely affected.

BOOK 2: SUBPART G - OPERATING LIMITS AND DETAILS**AMC 31HB.81****Flight Manual**

- (a) It is recommended that the Specimen Flight Manual of CS-22 (AMC 22.1581) be used as guidance in the creation of a Balloon Flight Manual.
- (b) A comprehensive list of approved parts and appliances for each balloon model should be provided in the applicable Balloon Flight Manual, to enable operators, inspectors etc. to easily establish an item's acceptability.

AMC 31HB.82**Instructions for continued airworthiness**

The Balloon Maintenance Manual should comply with the following:

(a) Maintenance Manual

For each type of balloon, a Maintenance Manual must be established which contains all information necessary for the continued airworthiness of the balloon, in particular:

- (1) A description of the systems including the assembly and disassembly instructions;
- (2) Inspection programmes with indication concerning the kind and scope of maintenance work (scheduled inspections);
- (3) Special inspection procedures, if required;
- (4) Details of repairs with reference to the degree of difficulty and resulting associated demands placed on the agency that performs repair (e.g. manufacturer only, licensed repair station holding appropriate permit, skilled person);
- (5) Advice on annual inspection with checklist of items to be checked;
- (6) A summary of the materials used with procurement details.

(b) Parts list

For each type of balloon, a list must be established covering all construction and equipment components and the assemblies. Where applicable individual parts must be numbered so that they can be related to the different assemblies and that their number corresponds to the type plate of the assembly.

AMC 31HB.85(a)(1)**Minimum equipment**

A device that indicates whether the individual fuel cell is FULL and indicates the use of the last 30% (or more) of the usable amount of fuel is considered compliant with this requirement.

AMC 31HB.85(a)(3)**Minimum equipment**

A device that indicates the fuel pressure before entering each main blast valve is considered compliant with this requirement.

AMC 31HB.85(a)(6)**Minimum equipment**

Usually altimeters are integrated parts of 21st century instrument packs. The precision of approved instruments is not necessary as every balloon can be safely operated by pure judgement of the pilot.

AMC 31HB.85(a)(8)**Minimum equipment**

Fire extinguishers should:

- (a) conform to EN3 or an equivalent specification acceptable to the Agency.
- (b) have a minimum capacity of 2 kg when using dry powder, unless the capacity is otherwise determined by the applicant.
- (c) be at least of comparable effect when the extinguishing means is other than "dry powder".

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