*15 Sep 2011*

European Aviation Safety Agency

**COMMENT RESPONSE DOCUMENT (CRD)**

# CRD TO NPA 2011-01

## Certification Specifications for free gas balloons and hot air balloons

(31.003)

## EXECUTIVE SUMMARY

The Notice of Proposed Amendment (NPA) 2011-01, dated 7 February 2011, proposed new Certification Specifications for Free Gas Balloons (CS-31GB) and amendments to the Certification Specifications for Hot Air Balloons (CS-31HB).

Based on the review of stakeholders' comments, this CRD proposes the following key changes to the NPA 2011-01: more consistent factors of safety for both CS-31GB and CS-31HB; a completely revised and simpler proposal for the attachment of items of mass, and for Hot Air Balloons a specific AMC for fuel cell attachment straps; clarifications related to the protection of the envelope against tearing.

TABLE OF CONTENTS

## A. Explanatory Note

### I. Update on the consultation process for the NPA 2011-01

1. The Notice of Proposed Amendment (NPA) 2011-01, dated 7 February 2011, proposed new Certification Specifications for Free Gas Balloons (CS-31GB) and amendments to the Certification Specifications for Hot Air Balloons[1] (CS-31HB). By the closing date of 10 May 2011, the European Aviation Safety Agency ('the Agency') had received 40 comments from 10 National Aviation Authorities, professional organisations and private companies. Each individual comment has been responded to and can be accessed via the Comment Response Tool (CRT) on the EASA website following this link. A copy is also provided in section C.I. "Individual comments and responses to NPA 2011-01" of this document.

### II. Summary of stakeholders' comments and the Agency's response

2. The responses to the comments and the resulting text were drafted by the Agency after consultation with the NPA drafting group. As the drafting group mainly consisted of Gas Balloon experts, for the main topics (see below) that are also applicable to Hot Air Balloons, experts from authorities and industry were consulted. The following paragraphs provide a summary of the discussions and conclusion of the main topics that have been identified in the consultation process. All changes resulting from these main topics as well as from the other comments are provided in the section B.I. "Draft Decision to CS-31HB" and section B.II. "Draft Decision to CS-31GB".

3. **CS 31HB.25/CS 31GB.25 Factors of safety**

Comments on the inconsistency between the proposed factors of safety for Gas Balloons (GB) and Hot Air Balloons (HB) have resulted in a full review of this paragraph. Also comments and discussion on the "items of mass" in the new CS 31HB.27(g) and CS 31GB.27(e) are related to this topic.

The conclusion was that the factors of safety should be consistent in both CSs and that parts of the suspension system from any type of material should be clearly addressed. The paragraph is therefore re-structured and provided in a table for both CS-31HB and CS-31GB.

The NPA 2011-01 proposed for GB a safety factor of 3·5 for metallic components of the suspension system while no specific safety factor is mentioned for HB. Without specific requirements, this means that the safety factor for these parts in HB is 1·5 in accordance with CS 31HB.25(a). As mentioned above, safety factors have been made consistent, and in this case the factor of 1·5 has been agreed for both. The "reduction" from 3·5 to 1·5 for GB is considered justified for the following reason. The factor of 3·5 was taken from the initial German Gas Balloon code from 1938. At that time the environmental influences on metallic components used in Gas Balloons were not well known and the higher safety factor was taking that into account. Today this is no longer the case. A factor of 1·5 is also considered adequate in comparison to the factor of 2·25 for fibrous or non-metallic suspension parts because metallic parts are less susceptible to wear or deterioration by environmental influences. The re-structuring also impacts the numbering of the related AMC.

From comments on "items of mass" it was decided not to apply the safety factors of CS 31HB.25 or CS 31GB.25 to the loads for items of mass unless specifically mentioned as explained in the next paragraph.

---

[1] Decision No 2009/005/R of the Executive Director of the European Aviation Safety Agency of 26 February 2009.

4. **CS 31HB.27(g)/CS 31GB.27(e) Items of mass**

The proposal to relate the loads on items of mass to the loading experienced during the basket drop test is not retained because it was confusing and did not result in a satisfactory safety margin. The basket drop test can only be used to show that a basket is of a generally robust design.

In order to progress this important issue, an amended proposal was drafted and sent for comments to 25 National Aviation Authorities, professional organisations and balloon experts that are engaged in the certification of Hot Air Balloons. The reactions to this proposal showed no major objections against the new proposal, and for that reason it is included in this CRD and explained below.

The requirements in CS 31HB.27(g) and CS 31GB.27(e) describe that the items must not detach, and for that reason are related to the ultimate load. This is similar to what is in the requirement for restraint systems in HB and GB; also other Certification Specifications for emergency landing conditions (refer to several CS paragraphs 561) specify ultimate loads for items of mass. Ultimate g-load values (6 g horizontal and downward) are therefore proposed for the restraint of these parts (e.g. straps, belts and hooks) that are taken from the draft code for Hot Air Airship, drafted by the Balloon and Airships Panel of Experts (BAPE) in 2006. A complementing value of 2 g upward is introduced in order to prevent items of mass from bouncing upward after a hard landing. This is consistent with the value for restraint harnesses. (Refer to CS 31GB.30 or CS 31HB.30.) Load factors and safety factors are not applicable for these load "restraints" for items of mass.

In the discussion on items of mass it was concluded that, although Hot Air Balloon fuel cells and burners are heavy items, their restraints should not be subject to the requirements for items of mass but to their specific requirements. Applying the ultimate g-load to fuel cells restraints would result in a sub-standard compared to current attachments. An alternative is proposed in paragraph AMC 31HB.45(c) below. For the burner attachments no conclusion was reached at this time. Since no records of accidents are known where a burner became detached from its attachment as a result of that accident, it was decided not to propose any changes to the current requirement at this time.

5. **CS 31HB.44/CS 31GB.44 Protection of envelope against tearing**

Comments were raised for both HB and GB and showed that the proposal was prone to misinterpretation. The requirement is a design requirement of the envelope and is not intended to show flight capabilities of a damaged envelope. The objective is to show that the fabric and/or envelope design is sufficiently damage resistant. The provided test requirement in the AMC explains how this damage resistance of the material should be tested at maximum tension in service. This is not an existing or standard test because the existing tests all increase the load up to the point that tear propagation starts. This is not considered to represent the actual case when an envelope would be damaged. The load in that case would start to reduce because of the pressure loss in the envelope. Obviously, the AMC was not clear enough and has been rewritten.

6. **AMC 31HB.45(c) Fuel cells**

In order to introduce a means of showing compliance to the requirement for fuel cell straps that should prevent the potential high safety risk for balloon occupants when a fuel cell becomes detached, the following is proposed:

Contrary to the restraints for other items of mass, the 6 g horizontal and 2 g upward loads are proposed as limit loads. The safety factors of 1·5 is considered applicable to these attachments. This is proposed to capture the minimum static strength of straps currently used for the attachment of fuel cells. An additional characteristic of the straps is also added that requires that the straps properly retain the fuel cells and maintain that

function throughout the flight and landing. This proposal is also drafted to react to the concern expressed in the FAA Special Airworthiness Information Bulletin CE-11-44.

## III. Next steps

7. The Executive Director Decision for amending Decision No 2009/005/R of the Executive Director of the European Aviation Safety Agency of 26 February 2009 on Certification Specifications for Hot Air Balloons, and introducing a new Certification Specification for Free Gas Balloons will be issued at least two months after the publication of this CRD to allow for any possible reactions of stakeholders regarding possible misunderstandings of the comments received and answers provided.

8. Such reactions should be received by the Agency not later than 15 November 2011 and should be submitted using the Comment-Response Tool at http://hub.easa.europa.eu/crt.

## B. Draft Decisions

### I. Draft Decision to CS-31HB

The text of the amendment is arranged to show deleted text, new text or new paragraph as shown below:

1. deleted text is shown with a strike through: ~~deleted~~
2. changed or new text is highlighted with grey shading.
3. ….

indicates that remaining text is unchanged in front of or following the reflected amendment.

**CS 31HB.1 APPLICABILITY**

….

(b) a combination of heated air and a non-flammable gas being lighter than air (Mixed Balloons, also called Rozière).

**CS 31HB.2 Definitions**

Definition of terms used:

(a) The "envelope" contains the medium which provides the lift.

(b) A "Basket" is the ~~container~~ basket, seat frame or other means suspended beneath the envelope provided for the carriage of the balloon occupants.

….

**CS 31HB.25 factors of safety** (See AMC 31HB.25)

(a) A factor of safety must be used in the balloon design as provided in the table.

| | Safety factor |
|---|---|
| Envelope | 5·00 |
| Suspension components (fibrous or non-metallic) | 2·25 |
| Suspension components (metallic) | 1·50 |
| Other | 1·50 |

(b) A reduced factor of 2 or more may be used in the envelope design 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) The primary attachments of the envelope to the basket must be designed so that any single failure will not jeopardise safety of flight.

(d) For design purposes, an occupant mass of at least 77 kg must be assumed.

~~(a) Except as specified in paragraph (b) and (c) of this section, the factor of safety is 1·5.~~

~~(b) A factor of safety of 5 or more must be used in envelope design. A reduced factor of 2 or more 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. (See AMC 31HB.25(b))~~

~~(c) A factor of safety of at least 2·25 must be used in the design of all fibrous or non-metallic suspension components. The primary attachments of the envelope to the basket must be designed so that failure is extremely remote or so that any single failure will not jeopardise safety of flight. (See AMC 31HB.25(c))~~

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

….

(g) Each item of mass that could cause an unsafe condition if it broke loose must be restrained under all loads up to the ultimate loads specified in this paragraph. The local attachments in the load path between the restraints and the structure should be designed to withstand 1.33 times the specified ultimate loads (See AMC 31HB.27(g)):

- Horizontal 6 g,
- Downward 6g,
- Upward 2g.

**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.44 Protection of envelope against tearing**

~~The envelope must be designed so that hazardous propagation of tears or local damage will not result in a hazardous effect while the envelope is supporting limit loads.~~ The design of the envelope must be such that local damage, under limit load, will not grow to an extent that results in uncontrolled flight or landing. (See AMC 31HB.44)

~~**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.~~

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 CS 31HB.25~~(a) & (b) are~~ is concerned.

~~AMC 31HB.25(c)~~
~~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).~~

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 should be justified with the application of limit loads.

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

This requirement for items of mass does not apply to fuel cells that are subject to specific requirements in CS 31HB.45(c)

Items of mass (e.g. batteries or equipment) inside the basket or attached to the suspension system near or above the occupants should be considered because of their risk to the occupants.
Items of mass that do not cause a risk to the occupants during a hard or fast landing, but could become detached from the balloon (e.g. ballast attached to the outside of the basket in case of a mixed balloon), should be considered because of the potential loss of mass.

AMC 31HB.44
Protection of envelope against tearing

Unless it can be demonstrated that basic envelope fabric has sufficient ~~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 fabric between rip-stoppers should be taken into account in the proof of the structure.

Demonstration of sufficient rip-stopping capability of the envelope fabric

The objective of this demonstration is to show that the envelope fabric is sufficiently damage resistant. It therefore needs to be determined at what tear size the envelope fabric would continue to tear under the maximum tension and conditions (temperature) experienced in normal operation. In this AMC this tear size is called the critical damage.

In order to establish that the determined damage resistance is sufficient, the critical damage should be reviewed in relation to local damage foreseeable in normal operation. The local damages to be considered are:

- Existing damage that may be undetected during pre-flight inspection, and
- Limited damage, inflicted during flight where the size of the damage in itself would not result in a catastrophic failure (e.g. a limited damage caused by hitting a branch or other basket during take off).

The resistance of envelope fabric to damage propagation should be determined by test.

Determine the critical damage to the envelope fabric at the maximum tension experienced in service. Critical damage is the maximum damage at which growth does not occur.

Damage to be considered is:

- A slit in the most unfavourable direction;
- A crosswise slit in the most unfavourable directions.

Test requirements

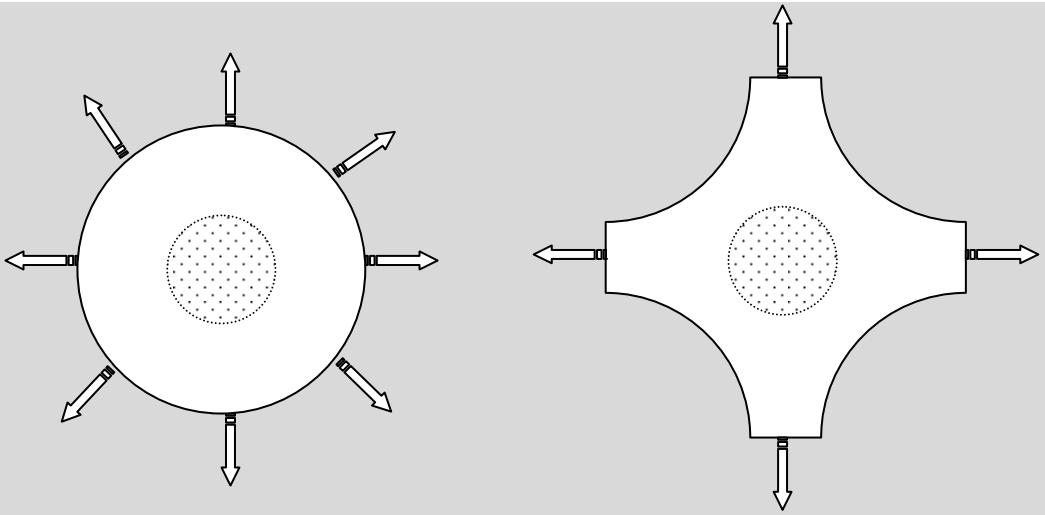
The envelope fabric should be tested at maximum tension experienced in service. The effects of temperature on the material properties must be taken into account.

The tension in the test area of the specimen of the fabric should be equal to the maximum tension experienced in service and the test method should not create unacceptable tension re-distributions in the test area when the test is conducted.

A step-wise increase of the damage (e.g. a cut with a sharp knife) should be used to determine the critical damage size.

Between the step-wise increases of the damage, enough time should be permitted for the tension re-distribution at the damage location.

The critical damage length of the material should be recorded.



Test area at limit load not influenced by the fabric clamp method

Examples of a circular or 2-directional test set-up

Pre-flight inspection requirements

The design of the envelope and pre-flight inspection method should be such that visible damage considerably smaller in length than the critical damage length can be detected during a pre-flight inspection. The impact of ageing and operating circumstances should be considered when establishing the margin between critical damage and detectable damage length (refer to CS 31HB.27(f)).

Design features that could possibly hinder detection of damage during a pre-flight inspection should be avoided or taken into consideration when the detectable damage length is determined.

Note 1: It is assumed that a visual pre-flight inspection will detect damage above 10 cm.

Note 2: The critical damage is a design property that should not be confused with acceptable damage as provided in the flight manual.

AMC 31HB.45(c)
Fuel cells

The ~~fastening~~ restraint of a full fuel cell (e.g. straps) should not detach under typical high g-loads experienced during a hard or fast landing.

In case of fuel cells supported at the lower end by the basket floor or other structure, the straps and buckle restraining a fuel cell shall be designed as applicable to a horizontal limit load of 6 g and upward limit load of 2 g. For this particular case, the factor of safety of 1·50 is applicable to these fuel cell straps irrespective of the materials used in their construction.

The strap and buckle design should be shown to maintain sufficient pre-tension after a typical flight cycle such that it can withstand the upward limit load of 2 g. Industry standards like EN 12195-2 or ASTM D3950 using the appropriate strap type and grade are considered appropriate standards.

Consideration of applied loads on fuel cells should include handling and transport cases.

~~AMC 31HB.83~~
~~Conspicuity~~

~~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.~~

## II. Draft Decision to CS-31GB

The text of the new proposed CS-31GB is shown in the format that will be used for publication of the future Agency's Decision introducing this new Certification Specification.

1. Deleted text from NPA 2011-01 is shown with a strike through: ~~deleted.~~
2. Text that is changed or new compared to NPA 2011-01 is highlighted with grey shading.

***European Aviation Safety Agency***

**Certification Specifications**

**for**

**Gas Balloons**

**CS-31GB**

**CONTENTS**

**CS–31GB - Gas Balloons**

**BOOK 1 – CERTIFICATION SPECIFICATIONS**

## BOOK 2 – ACCEPTABLE MEANS OF COMPLIANCE

### AMC SUBPART B – FLIGHT



### AMC SUBPART C – STRUCTURE



### AMC SUBPART D - DESIGN AND CONSTRUCTION



### AMC SUBPART F - EQUIPMENT



### AMC SUBPART G - OPERATING LIMITITATIONS AND INFORMATION

## BOOK 1: SUBPART A – GENERAL

### CS 31GB.1 Applicability

This airworthiness code is applicable to manned free balloons that derive their lift from gas being lighter than air.

### CS 31GB.2 Definitions

Definition of terms used:

(a) The "envelope" contains the medium which provides the lift.

(b) A "Basket" is the ~~container~~ basket, seat frame or other means suspended beneath the envelope provided for the carriage of the balloon occupants.

(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 conducting an entire flight at a single location.

(e) "Launch Restraint" is the temporary restraint of a free balloon for the purpose of initiating a free flight.

**BOOK 1: SUBPART B – FLIGHT**

**CS 31GB.12 Proof of compliance**

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:

(a) 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

(b) Systematic investigation of each mass if compliance cannot be reasonably inferred from the masses investigated.

**CS 31GB.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-31GB is shown. The maximum mass must be established so that it is not more than the least of: (See AMC 31GB.14(a))

(1) The maximum mass selected for the product;

(2) The design maximum mass, which is the highest mass at which each structural loading condition is shown; or

(3) The maximum mass at which compliance with each applicable flight requirement is shown.

(b) Minimum mass.

The minimum mass is the lowest mass at which compliance with each applicable flight requirement is shown. (See AMC 31GB.14(b))

Mass limitation information related to safe operation of the balloon must be included in the Flight Manual. (See CS 31GB.81(b)(2).)

**CS 31GB.16 Empty mass**

(See AMC 31GB.16)

The empty mass must be determined by weighing the balloon with installed equipment but without lifting gas.

**CS 31GB.17 Performance: climb**

(See AMC 31GB.17)

The balloon must be capable of climbing at least 90 metres 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.~~

**CS 31GB.20 Controllability**

The balloon must be safely controllable and manoeuvrable without requiring exceptional piloting skill. Associated operational limitations must be established and included in the Flight Manual. (See CS 31GB.81(b)(2).)

**BOOK 1: SUBPART C - STRUCTURE**

**CS 31GB.21 Loads**

Strength requirements are specified in terms of:

(a) limit loads that are the maximum loads to be expected in service, taking into account the load factors of CS 31GB.23 and

(b) ultimate loads that are limit loads multiplied by factors of safety of CS 31GB.25.

**CS 31GB.23 Load factor**

Flight load factor. In determining limit loads, the load factor must be at least 1·4.

**CS 31GB.25 Factors of safety**

(SEE AMC 31GB.25)

~~(a) Except as specified in paragraph (b), (c) and (d) of this section, the factor of safety is 1·5.~~

~~(b) A factor of safety of 5 or more must be used in the design of:~~

~~(1) the envelope and~~

~~(2) non-metallic components of the suspension system of the basket.~~

~~(c) A factor of safety of 3.5 or more must be used in the design of metallic connections in the suspension system.~~

~~(d) The suspension system must be designed so that failure of any single component will not jeopardise safety of flight (see AMC 31GB.25(d)).~~

(a) A factor of safety must be used in the balloon design as provided in the table.

| | Safety factor |
|---|---|
| Envelope | 5·00 |
| Suspension components (fibrous or non-metallic) | 2·25 |
| Suspension components (metallic) | 1·50 |
| Other | 1·50 |

(b) The primary attachments of the envelope to the basket must be designed so that any single failure will not jeopardise safety of flight.

(c) For design purposes, an occupant mass of at least 77 kg must be assumed.

**CS 31GB.27 Strength and proof of strength**

(See AMC 31GB.27)

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

(b) The structure must be able to withstand ultimate loads for at least 3 seconds without failure.

(c) Proof of strength of the envelope material and other critical design features must be tested. (See AMC 31GB.27(c).)

(d) The basket must be of a generally robust design and afford the occupants adequate protection during a hard or fast 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 31GB.27(d).)

(e) ~~Items of mass must be secured and must not detach under typical g-loads experienced during a hard or fast landing. (See AMC 31GB.27(e))~~ Each item of mass that could cause an unsafe condition if it broke loose must be restrained under all loads up to the ultimate loads specified in this paragraph. The local attachments in the load path between the restraints and the structure should be designed to withstand 1.33 times the specified ultimate loads (See AMC 31GB.27(e).)
Horizontal 6 g,
Downward 6g,
Upward 2g.

(f) The design and strength of components must also consider the effects of recurrent and other loads experienced during transportation, ground handling and rigging. (See AMC 31GB.27(f).)

(g) The effect of temperature and other operating characteristics that may affect strength of the balloon must be accounted for.

**CS 31GB.28 Tethered flight loads**

(a) The effects of the loads associated with tethered flight on the balloon's components and any additional equipment (if required) must be considered in the design. (See AMC 31GB.28(a).)

(b) The tethered restraint system must be designed so that any single failure will not jeopardise the safety of the occupants, the balloon and or third parties.

(c) Operational limitations, associated to tethered flight, must be established and recorded in the Flight Manual. (See CS 31GB.81(b)(2).)

**CS 31GB.30 Restraint harness**

(a) When an occupant restraint harness is installed, the harness must not fail when subjected to loads resulting from the occupant mass submitted to the following acceleration (See Figure 1):

(1) 2·0g Upwards

(2) 3·0g Horizontally in all directions.

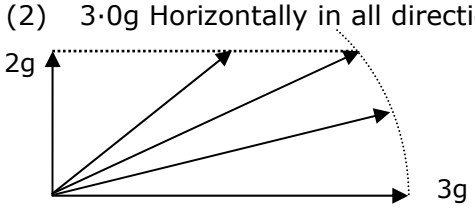



Figure 1 Restraint harness loads

An occupant mass of at least 86 kg 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 be shown to be able to withstand the loads prescribed in CS 31GB.30(a) multiplied by a fitting factor of 1·33.

## BOOK 1: SUBPART D - DESIGN AND CONSTRUCTION

### CS 31GB.31 General

The suitability of each design detail or part that bears on safety must be established by tests or analysis. ~~; and~~
~~(b) consider operations~~.

### CS 31GB.33 Materials

The suitability and durability of materials used for parts, the failure of which could adversely affect safety, must

(a) be established by experience or tests; and

(b) meet approved specifications that ensure that the materials have the strength and other properties assumed in the design data. (See AMC 31GB.33(b))

### CS 31GB.35 Fabrication methods

(See AMC 31GB.35)

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 31GB.37 Fasteners

(a) Fasteners (e.g. bolts, pins, screws, karabiners) used in the structure must conform to approved specifications. (See AMC 31GB.37(a))

(b) Locking methods must be established and documented.

(c) Unless a joint is free from relative movement, secondary locking means must be used.

(d) Self-locking nuts may not be used on bolts that are subject to rotation in service.

### CS 31GB.39 Protection of parts

(See AMC 31GB.39)

Parts, the failure of which could adversely affect safety 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.

### CS 31GB.41 Inspection provisions

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

### CS 31GB.43 Fitting factor

(a) A fitting factor of at least 1·15 must be used in the analysis of each fitting if the strength is not proven by limit and ultimate load tests that simulate the actual stress conditions 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. (See AMC 31GB.43(c).)

**CS 31GB.44 Protection of envelope against tearing**

(See AMC 31GB.44)

The design of the envelope must be such that local damage ~~due to foreseeable threats~~, under limit load, will not grow to an extent that results in uncontrolled flight or landing.

**CS 31GB.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) The envelope must be protected against bursting using a valve or appendix. (See AMC 31GB.49(c))

(d) There must be a valve to control the flight of the balloon. Proof of its reliable operation must be provided.

**CS 31GB.51 Disposable Ballast**

(See AMC 31GB.51)

(a) Disposable ballast must have means for safe storage and release. (See also CS 31GB.27(e).)

(b) A minimum amount of ballast must be defined and reserved for the final landing which is sufficient (when jettisoned) to reduce the speed of descent to an acceptable value. The minimum ballast must be provided in the Flight Manual. (See CS 31GB.81.)

**CS 31GB.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 31GB.55 Rapid deflation means**

(a) The envelope must have means to allow for rapid deflation after landing. The system must be designed to minimise 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 31GB.55(a).)

(b) If a 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 31GB.55(b).)

**CS 31GB.57 Control cords**

(a) General

(1) All control cords used for flight control must be designed and installed to preclude entanglement.

(2) The function of control cords should be identified to the pilot and marked in accordance with paragraph (b), (c)~~, (d)~~ and (~~c~~d) if applicable.

(3) The maximum force required for their operation must not exceed 340 N.

(4) 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 31GB.57(c))~~

(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 reseal any vent, the part of the cord handled by the pilot must be coloured white.

(d~~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 31GB.57(a)(3) above, the force required to operate an emergency deflation cord must not be less than 110 N.

**CS 31GB.59 Baskets**

(a) The basket may not rotate independently of the envelope unless:

(1) the rotation is under control of the pilot; and

(2) entanglement of operating lines is prevented. (See AMC 31GB.59(a).)

(b) Each projecting object on the basket, that could cause injury to the occupants, must be padded.

(c) Occupants of a basket must be protected during hard or fast landings against:

(1) falling from the basket;

(2) serious injuries. (See AMC 31GB.59(c).)

(d) When more than six occupants are carried, the basket must be divided into compartments, each containing not more than six occupants.

(e) Where basket proportions and compartmentation are such that more than one occupant may fall on top of another during landing, there must be means to minimise this possibility. (See AMC 31GB.59(e))

(f) Reasonable space must be provided for all occupants, with regard to both comfort during the flight and to safety during the landing. (See AMC 31GB.59(f))

(g) The space for the pilot must provide unobstructed operation in all flight phases.

(h) There must be hand holds for each occupant. (See AMC 31GB.59(h))

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

(j) The load-bearing parts (e.g. ropes or cables) of the suspension system must be protected against damage in normal service.

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

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

**CS 31GB.61 Electrostatic discharge**

(See AMC 31GB.61)

There must be appropriate electrostatic discharge means in the design of each balloon whose lift-producing medium contains a flammable gas to ensure that the effects of electrostatic discharge will not create a hazard.

**CS 31GB.63 Occupant restraint**

(a) There must be a restraining means for all occupants, which can take the form of hand holds. (See CS 31GB.59(h)).

(b) For baskets having a separate pilot compartment, there must be a suitable restraint for the pilot which must meet the strength requirements of CS 31GB.30. 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; and

(3) the possibility of inadvertent release is minimised.

**CS 31GB.67 Tethered flight**

(See AMC 31GB.67)

The pilot must be provided with an indication that any applicable limitations for tethered flight are being, or have been reached.

## BOOK 1: SUBPART F - EQUIPMENT

### CS 31GB.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 to identify its 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. (See also CS 31GB.27(e).)

### CS 31GB.72 Miscellaneous equipment

Each balloon must be equipped with a rate of climb/descent indicator (variometer).

## BOOK 1: SUBPART G - OPERATING LIMITATIONS AND INFORMATION

### CS 31GB.81 Operating instructions

(See AMC 31GB.81)

(a) Operating instructions must be furnished in a Flight Manual with each balloon.

(b) The Flight Manual must contain:

(1) A description of the balloon and its technical equipment with explanatory sketches;

(2) Operating limitations, normal procedures (including rigging, inflation, deflation and tethered flight (if applicable)), emergency procedures, and other relevant information specific to the balloon's operating characteristics and necessary for safe operation. This section of the manual requires approval (See AMC 31GB.81(b)(2).);

(3) Specification of the permissible lifting gas;

(4) Information for ground handling, transport and storage.

(c) The operating limitations, normal and emergency procedures, and other relevant information specific to the balloon's operating characteristics and necessary for safe operation must be provided to the pilot. (See AMC 31GB.81(c).)

### CS 31GB.82 Instructions for continued airworthiness

(See AMC 31GB.82)

(a) The instructions for Continued Airworthiness must include information essential to the Continued Airworthiness of all parts and appliances of the balloon as required by CS-31GB.

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

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

(d) The instructions for Continued Airworthiness must cover:

(1) detailed description of the balloon and its components, systems and installations;

(2) Handling instructions;

(3) Basic control and operating information describing how the balloon's components, systems and installations operate;

(4) Servicing information;

(5) A maintenance schedule against which the balloon must be inspected and maintained;

(6) Maintenance and inspection instructions;

(7) Repair instructions;

(8) Trouble-shooting information;

(9) Airworthiness limitations that set forth each mandatory replacement time, inspection interval and related inspection procedure. This section of the manual requires approval.

~~**CS 31GB.83 Conspicuity**~~

~~(See AMC 31GB.83)~~

~~The balloon must be conspicuous during operation.~~

**EASA Certification Specifications**

**for**

**Gas Balloons**

**CS-31GB**
**Book 2**

**Acceptable Means of Compliance**

## AMC SUBPART B – FLIGHT

AMC 31GB.14(a)
Mass limits

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

AMC 31GB.14(b)
Mass limits

Minimum mass. The determination of the minimum mass should take into consideration that the controllability of the balloon might be affected by a low internal pressure at low mass.

At least the following should be demonstrated:

In landing configuration with minimum crew, untaut condition and already disposed minimum ballast, all controls (e.g. parachute, valve, rip panel, control lines, etc.) should have a positive performance and function easily and smoothly.

Note: An untaut condition is a flight with a "slack" envelope and open appendix.

AMC 31GB.16
Empty mass

The equipment and configuration that are included in the empty mass need to be specified. Refer also to AMC 31GB.81(b)(2).

AMC 31GB.17
Performance: climb

The climb performance should be demonstrated by a test. The fully inflated balloon to maximum pressure appropriate to the conditions of the test should start from equilibrium at ground level. The climb performance should be met without excessive jettisoning of ballast. ~~"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 31GB.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 suspension system pick-up points (sometimes known as 'turnbacks') at the envelope should be regarded as part of the suspension system, rather than the envelope, as far as 31GB.25~~(b),(c) & (d) are~~ is concerned.

~~AMC 31GB.25(d)~~
~~Factors of Safety~~

"Suspension components" here are those parts of the balloon that carry the load between the lift force of the envelope and the weight force of the basket.

A net around the envelope taking these loads or suspension system pick-up points should be considered as part of the suspension system ~~in accordance with AMC 31GB.25(b)~~.

The individual structural elements in the suspension system should be dimensioned and configured or duplicated so that failure or absence of one structural element 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 only needs to be justified with the application of limit loads.

AMC 31GB.27
Strength and proof of strength

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 need to be performed in all other cases.

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

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, net mesh, etc. Also refer to CS 31GB.44 for Specific tear propagation requirements.

AMC 31GB.27(d)
Strength and proof of strength

A drop test needs to 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 should not result in deformation or fractures which, by their nature, could lead to the serious injury of occupants.

Note: 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. The structure is also able to absorb considerable kinetic energy during impact on the ground or against obstacles.

AMC 31GB.27(e)
Strength and proof of strength

Items of mass (e.g. batteries or equipment) inside the basket or attached to the suspension system near or above the occupants should be considered because of their risk to the occupants.

Items of mass that do not cause a risk to the occupants during a hard or fast landing, but could become detached from the balloon (e.g. ballast attached to the outside of the basket), should be considered because of the potential loss of mass.

~~Items of mass within the basket should be secured (e.g. straps) and should not detach under typical g-loads experienced during a hard or fast landing. Calculations of the static ultimate loads should assume g-loads experienced equal or higher to the loads in the 30° drop test (Refer to AMC31GB.27(d)). The following minimum values should be considered:~~

- ~~Horizontal speed should not be less than 2·25 m/s~~
- ~~Deceleration travel (braking distance) not less than 0·3 m for items attached in or to the basket~~
- ~~Load factor 1·4~~
- ~~Factor of safety 1·5~~

~~Also items of mass attached to the suspension system near or above the occupants should be considered because of their risk to the occupants.~~

~~Items of mass that do not cause a risk to the occupants during a hard or fast landing, but could become detached from the balloon (e.g. ballast attached to the outside of the basket), should be considered because of the mass lost.~~

AMC 31GB.27(f)
Strength and proof of strength

The strength requirements need to include consideration of loads during transport, ground handling and rigging. The loads need to be determined and the parts and components need to be designed in accordance with their designated use and dimensioned such as not to fail under recurrent loads.

AMC 31GB.28(a)
Tethered Flight Loads

Due to the complexity of tethered flight loading, a simple analysis using configurations based on industry best practice (e.g. 'restraints/tether lines in a "flat tripod" configuration with upwind and downwind v-bridles) can be used to determine the suitability of a design.

The structure needs to be designed so that stress concentrations beyond the limit of fatigue are avoided in areas where normal operation may produce varying stress.

Note: The greatest danger during tethering is if any element of the tethering equipment should fail with insufficient positive buoyancy for safe free flight. For this reason single point/single element tethering should not be considered.

**BOOK 2: SUBPART D - DESIGN AND CONSTRUCTION**

AMC 31GB.33(b)
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). Also the effects of environmental conditions, such as temperature and humidity expected in service need to be taken into account.

AMC 31GB.35
Fabrication methods

Approved fabrication methods here should be taken as being those produced by the applicant or those meeting internationally recognised standards as defined in the applicable type design data. Fabrication methods 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.

AMC 31GB.37(a)
Fasteners

Approved specifications in the sense of these requirements are the standards described in the AMC 31GB.33(~~a~~b)~~(2).~~

AMC 31GB.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 suitable protection of parts against deterioration or loss of strength, it is permissible to rely on instructions for continued airworthiness (e.g. recommended inspections or mandatory replacement of parts) (see also CS 31GB.82).

AMC 31GB.43(c)
Fitting factors

Approved practices here should be taken as being those produced by the applicant or those meeting internationally recognised standards as defined in the applicable type design data. Approved practices 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.

AMC 31GB.44
Protection of the envelope against tearing

Demonstration of sufficient rip-stopping capability of the envelope material.
The objective of this demonstration is to show that the envelope material is sufficiently damage resistant. It therefore needs to be determined at what tear size the envelope material

would continue to tear under the maximum tension and conditions (temperature) experienced in normal operation. In this AMC this tear size is called the critical damage.
In order to establish that the determined damage resistance is sufficient, the critical damage should be reviewed in relation to local damage foreseeable in normal operation.
The local damages to be considered are:

- Existing damage that may be undetected during pre-flight inspection, and
- Limited damage ~~due to foreseeable threats~~, inflicted during flight where the size of the damage in itself would not result in a catastrophic failure. (e.g. a limited damage caused by hitting a branch or other basket during take off)

~~Examples of foreseeable threats that can cause in-flight damage are hitting a branch or other basket during take off that causes a damage that without propagation due to operational loads would not result in a catastrophic failure.~~

The resistance of envelope fabric to damage propagation should be determined by test.
Determine the critical damage to the envelope fabric at the maximum tension experienced in service. Critical damage is the maximum damage at which growth does not occur.

~~Typical~~ Damage to be considered is:
A slit in the most unfavourable direction.
A crosswise slit in the most unfavourable directions.

Test requirements

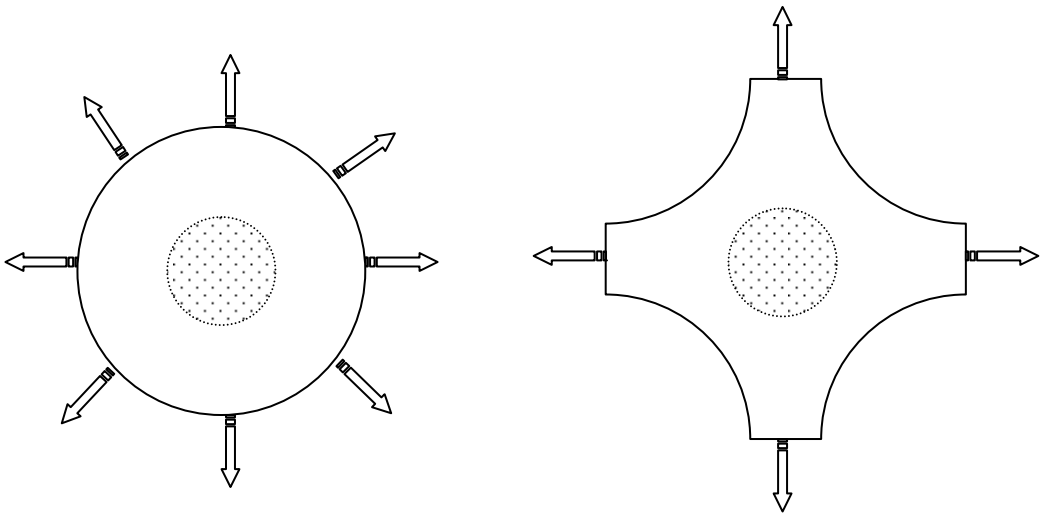
The envelope fabric should be tested at maximum tension experienced in service. The effects of temperature on the material properties must be taken into account.

The tension in the test area of the specimen of the fabric should be equal to the maximum tension experienced in service and the test method should not create unacceptable tension re-distributions in the test area when the test is conducted.

A step-wise increase of the damage (e.g. a cut with a sharp knife) should be used to determine the critical damage size.

Between the step-wise increase of the damage, enough time should be permitted for the tension re-distribution at the damage location.

The critical damage length of the material should be recorded.



Test area at limit load not influenced by the fabric clamp method

Examples of a circular or 2-directional test set-up

Pre-flight inspection requirements

The design of the envelope and pre-flight inspection method should be such that a damage length considerably smaller than the critical damage length will be discovered during a pre-flight inspection. The impact of aging and operating circumstances should be considered when establishing the margin between critical damage and detectable damage. (Refer to CS 31GB.27(g))

Design features that could possibly hinder discovery of damage during a pre-flight inspection should be avoided or taken into consideration when the detectable damage size is determined.

Note 1: It is assumed that an envelope damage exceeding 5 cm will be detected before flight due to the loss of gas.

Note 2: The critical damage is a design property that should not be confused with acceptable damage as provided in the flight manual.

AMC 31GB.49(c)
Control systems

The envelope is protected against bursting when it is equipped with an appendix or valve that can automatically release gas at the rate of at least 3% of the total volume per minute at the balloon's maximum operating pressure. The appendix or valve should be designed to prevent possible blockage during flight due to e.g. freezing, jamming or a reduction of the outflow opening due to deflection of the envelope and/or the outflow opening. ~~flattening of the appendix caused by the position on the envelope.~~

AMC 31GB.51
Disposable Ballast

Ballast material should be easily transferred, disposed of and dissipated. Means need to 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 dependent on the flight task, the weather, etc.

A minimum ballast quantity is considered sufficient if, when jettisoned, it stops a descent speed of 4 m/s.

Note: The shape and drag of the envelope can have an effect on minimum descent speed, resulting in a minimum descent speed above 4 m/s.

AMC 31GB.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 31GB.55(b)
Rapid deflation means

The installation of ~~turning vents or~~ a drag rope is considered as a suitable device to align the balloon during landing in the sense of this subparagraph.

~~AMC 31GB.57(c)~~
~~Control cords; Turning vent cords~~

~~In the interest 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 31GB.59(a)
Baskets

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 31GB.59(c)
Baskets

An internal height of the basket of 1·10 m, protecting the occupants carried from falling from the basket is considered compliant to this requirement.

AMC 31GB.59(e)
Baskets

Alignment of the basket for landing using ~~turning vents or~~ a drag rope or an equivalent feature and Flight Manual instructions specifying that the basket should be aligned to land on one of its longer sides can be used to show compliance to this requirement. No more than two occupants may be positioned in the landing direction without means to prevent them from falling on top of each other.

AMC 31GB.59(f)
Baskets

Unless otherwise justified on safety grounds, a minimum figure of between 0·25 m² and 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. There needs to be enough space provided for passengers to take a brace position for landing. The Agency should be consulted in cases where a basket's shape or compartmentation makes the measurement of this figure subjective.

AMC 31GB.59(h)
Baskets

Handholds need to be provided as an obvious means for the occupants to safely hold on to during a landing. The location or design of the handholds need to provide protection of the hands from impact during a landing.

AMC 31GB.59(l)
Baskets

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 31GB.61
Electrostatic discharge

Appropriate electrostatic discharge means are met when compliance with all of the following requirements is demonstrated.

(a) The surface resistance on the inside ~~one side~~ of the balloon envelope ~~(inside or outside)~~ after 24-hour storage at a relative air humidity of less than 50% must be value $10^9$ Ω or lower. The values are to be determined using approved measuring methods.

(b) The respective layer of non-conductive material (surface resistance in excess of $10^9$ Ω) must not be thicker than 0·3 mm unless it is enclosed by conductive layers.

(c) The balloon envelope and all other conductive parts of the balloon (surface resistance less than $10^9$ Ω) must be conductively connected to each other (resistance of connection less than $10^6$ Ω). This requirement also applies to the joints between the panels and reinforcements.

(d) There must be at least three independent discharge paths for the safe balance of the electrostatic charges from the inside of the envelope running to the bottom end of the basket.

(e) The discharge paths should run on the conductive side of the envelope from top to bottom and then further down to the ground. This requirement applies to the case when the balloon is in contact with earth's surface.

(f) Each discharge path under (d) must be of different kind or design to the other.

(g) Periodic maintenance checks of the surface resistance and discharge paths should be included in the instructions for continued airworthiness.

Note: More detailed information can be found in:

EN 61340-5-1&2:2007 *Protection of electronic devices from electrostatic phenomena – General Requirements & User guide*

IEC 60093 *Methods of Test for Volume Resistivity and Surface Resistivity of Solid Electrical Insulating Materials*

AMC 31GB.67
Tethered flight

The inclusion of an appropriate device or instrument (rated "weak link", hand held anemometer, windsock, etc.) to provide the pilot with an attention-getting indication of the balloon's tethering limitation, is considered compliant with CS 31GB.67.

**BOOK 2: SUBPART F - EQUIPMENT**

AMC 31GB.71(a)(4)
Function and installation

The correct functioning should not be impaired by operational circumstances such as icing, heavy rain, high humidity or low and high temperatures. The equipment, systems, and installations need to be designed to prevent hazards to the balloon in the event of a probable malfunction or failure of that equipment.

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 31GB.81
General

(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) Each part of the Flight Manual that is required to be approved needs to be segregated, identified and clearly distinguished from each unapproved part of that manual.

(c) A comprehensive list of approved basket and envelope configurations needs to be provided for each balloon model to enable operators, inspectors, etc. to easily establish an item's acceptability.

(d) If applicable, the operating limitations, normal and emergency procedures need to include procedures and limitations for tethered flight. These procedures and limitations need to include:

1. Site selection, layout and assembly,
2. The maximum wind speed and meteorological conditions for tethered operation,
3. The MTOM (if different from free flight),
4. The maximum height of the tether,
5. The minimum strength of ropes, rigging, etc.,
6. Limitations on occupancy (if applicable).

AMC 31GB.81(b)(2)
General

The operating procedures should contain instructions necessary for the safe operation of the balloon. In particular mitigating measures for risks of that specific type of balloon should be included. Examples are safety instructions for flying, filling or deflating envelopes using a flammable or poisonous gas as lifting gas.

Operating procedures need to provide empty mass information required by CS 31GB.16 in an unambiguous manner that will allow the verification of the balloon's mass limitations before flight.

AMC 31GB.81(c)
General

The operating limitations, normal and emergency procedures need to be available to the pilot during operation by providing the specific sections of the flight manual or by other means (e.g. placards, quick reference cards) that effectively accomplish the purpose.

AMC 31GB.82
Instructions for continued airworthiness

*The paragraph numbering of this AMC relates to the paragraph numbering of CS 31GB.82*

(c) If instructions for continued airworthiness are not supplied by the manufacturer or designer of parts and appliances installed in the balloon, the instructions for continued airworthiness for the balloon need to include the information essential to the continued airworthiness of the balloon.

If manuals from different manufacturers are used, they need to provide a practical arrangement.

(d)(1) The detailed description of the balloon and its components needs to include for each balloon:

- A description of the systems including the assembly and disassembly instructions;

- A parts list covering all construction and equipment components and the assemblies. Where applicable, individual parts need to be numbered so that they can be related to the different assemblies and that their number corresponds to the type plate of the assembly;
- A summary of the materials and consumables used with procurement details.

(d)(5) If applicable, the maintenance schedule may include instructions for continued airworthiness (e.g. recommended inspections or mandatory replacement of parts) to ensure the suitable protection of parts against deterioration or loss of strength, objective pass or fail criteria, e.g. applicable wear tolerances need to be provided.

(d)(6) The maintenance and inspection instructions need to provide information for removal and installation, cleaning, inspecting, adjusting, testing and lubrication of systems, parts and appliances of the balloon as required for continued airworthiness. Reference may be made to information from an accessory, instrument or equipment manufacturer as the source of this information if it is shown that the item has an exceptionally high degree of complexity requiring specialised maintenance techniques, test equipment or expertise.

(d)(9) If the instructions for continued airworthiness consist of multiple documents, the Airworthiness Limitations section need to be included in the principal manual.

~~AMC 31GB.83~~
~~Conspicuity~~

~~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.~~

*** * ***

## C. Appendix

### I. Individual comments and responses to NPA 2011-01

In responding to comments, a standard terminology has been applied to attest the Agency's acceptance of the comment. This terminology is as follows:

1. **Accepted** – The comment is agreed by the Agency and any proposed amendment is wholly transferred to the revised text.
2. **Partially accepted** – The comment is either agreed only in part by the Agency, or it is agreed by the Agency but any proposed amendment is partially transferred to the revised text.
3. **Noted** – The comment is acknowledged by the Agency but no change to the existing text is considered necessary.
4. **Not Accepted** - The comment or proposed amendment is not shared by the Agency.

**CRD table of comments and responses**

| **(General Comments)** | - |
|---|---|

| | |
|---|---|
| comment | *9* comment by: *Luftfahrt-Bundesamt*<br>The LBA has no comments on NPA 2011-01. |
| response | *Noted* |

| | |
|---|---|
| comment | *18* comment by: *DGAC FRANCE*<br>DGAC France is in favour of the proposed NPA on Free Gas Balloons and Hot AIr Balloons. |
| response | *Noted* |

| | |
|---|---|
| comment | *20* comment by: *Aero-Club of Switzerland*<br>Dear all,<br><br>the Aero-Club of Switzerland together with the associated Swiss Ballooning Federation thanks the Agency for the possibility to comment on this NPA.<br><br>Among others we have one very general comment: Please delete all passages having turning vents as subject.<br>Justification: In our view whilst landing gas balloons are not directed/ positionned by a turning vent. |
| response | *Accepted*<br>There are currently no gas balloon designs applying a turning vent. Alignment is, if necessary, achieved by a drag rope. The affected paragraphs will be corrected as shown in the resulting text. (Refer to CS 31GB.57(c), AMC 31GB.55(b), AMC 31GB.57(c) and AMC 31GB.59(e).) |

| | |
|---|---|
| comment | *26* comment by: *UK CAA*<br>Please be advised that the UK CAA have no comments to make on NPA 2011-01: Free Gas Balloons and Hot Air Balloons. |
| response | *Noted* |

**A. Explanatory Note - I. General** p. 3

| | |
|---|---|
| comment | *6* comment by: *FAA*<br>Attachment #1<br>EASA NPA No. 2011-01<br>The Small Airplane Directorate has reviewed the Notice of Proposed Rule Making, EASA NPA No. 2011-01, Free Gas Balloons (GS-31GB). We have the following comments:<br>· This purposed regulation continues the allowance of use of ***any*** lighter than air gas, including hydrogen. This has been the historic position in Europe and USA regulation. Comment: At some point in the future, both agencies should consider banning the use of flammable gases in manned balloons.<br>· There are unique specific structural strength requirements for free gas balloons which are different from hot air balloons. We have no disagreement with the requirements, but it is different from previous EASA regulation and current US regulation. Current Part 31 has same structural requirements for hot air and free gas balloons.<br>· Tethered ballooning is stipulated. US regulation does not stipulate tethered ballooning. We are simply pointing out this difference.<br>We have **no technical objection** with any content of this purposed rule making. Thanks for your consideration. |
| response | *Partially accepted*<br>The following three issues are addressed.<br>(1) With regard to the use of flammable gases, a future task could be considered to review safety of this application if supported by objective evidence. Mitigating measures against the risks of flammable gases have been and are included in the technical standards and found acceptable. This issue is not considered within the scope of this rulemaking task.<br>(2) The structural requirements for Gas Balloons have been reviewed by the drafting group and because of the different behaviour of Gas Balloons (Inertia forces of the envelope are much lower for gas balloons) differences remain for the landing load factor. The factors of safety are however made consistent for Hot Air Balloons and Gas Balloons. These are however not fully harmonised with FAR Part 31 as it was already the case when CS 31HB was introduced. Also proposals for items of mass and AMC for fuel cell restraints are new compared to the FAA rules. See resulting text of CS 31HB.25/CS 31GB.25, CS 31HB.27/CS 31GB.27 and |

AMC 31HB.45(c).

(3) The tethered flight loads and other requirements related to tethered flight in the proposed CS 31GB are, like in the CS 31HB, intended to cover the use of gas balloons designed for free flight in a tethered flight. This is obviously a difference in the scope with the FAA. A separate code is in preparation for the permanent tethered flight where free flight by design is not the intention.

**A. Explanatory Note - IV. Content of the draft Decision - 11. Drafting group considerations** p. 5-7

comment

*1* comment by: *John DAVIES*

Attachment #2

CS31GB.49

We are very worried about this.

We have unveiled our new design of gas balloon this year. It gives a major step forward in safety in the use of hydrogen, because the air and the highly flammable gas are not allowed to come into contact. This is so much safer than the old design in which air and hydrogen freely mix in the appendix while the fabric moves, crumples and rubs together. It also improves performance; if air is allowed to mix with the hydrogen, it makes part of the volume a non-lifting space and it effectively behaves like a smaller balloon.

The pressure relief is achieved by our servo system (the bulging thing at the base; see attachment). When the balloon becomes fully inflated, this pulls on the top gas valve automatically relieving the pressure. The gas exits into a chimney where it would be harmless if it did burn. We consider this system to be perfectly simple and reliable.

response

*Partially accepted*

The proposed AMC to 31 GB.49(c) is indeed providing only one acceptable means of showing compliance. We appreciate that you have shared another option to protect the envelope against bursting.

In order to accommodate these kinds of solutions, CS 31GB.49(c) is kept as proposed; however, the AMC is amended. See resulting text of AMC 31GB.49(c).

**B. Draft Decisions - I. Draft Decision to CS-31HB** p. 10

comment

*14* comment by: *CAA CZ*

**CS 31HB.1 (b) Applicability**

With respect to CS-31GB the use of a flammable gas for at least Mixed Balloons should be prohibited.

response

*Accepted*

Since CS 31HB is applicable to mixed balloons, the use of flammable gases should be excluded in this code. See resulting text of CS 31HB.1(b).

comment 15 comment by: *CAA CZ*

**CS 31HB.25 (d) Factors of safety**

Considering real population in Europe, we propose an occupant mass of at least 90 kg for design purposes.

response *Not accepted*

The lowest occupant mass of 77 kg is consistent within airworthiness codes (CS-23, CS-25 and FAR 31). It takes an average occupant weight into account, considering also children. Therefore, this minimum mass for an occupant is kept at 77 kg.

It should also be recognised that the maximum mass will be the determined for the balloon in accordance with CS 31HB.14 and provided in the Flight manual. Also for restraints it is 86 kg instead of the minimum of 77 kg.

comment 27 comment by: *Balóny Kubíček*

Attachment #3

**CS 31HB.44**

Kubicek Balloons generally agree with requirement CS 31HB.44 however the term "foreseeable threats" is unclear at all and has to be redefined.

JUSTIFICATION

1. Wording of AMC 31HB.44 is not consistent with CS 31HB.44; term "damage due to foreseeable threats" is by AMC 31HB.44 introduced as "Damages to be considered". In despite of meaning is clear, the wording of CS 31HB.44 should be corrected according with AMC 31HB.44 to avoid misunderstanding.
2. Examples of "foreseeable threads" are not applicable at all – balloon manufacturer is unable to presume size of thread after hitting of a branch. Should be 1m, 2m, 5m or half of envelope? (All of such damages were repaired in our maintenaince organisaton) To our opinion manufacturer can only assume there is no any in-flight damage during balloon operation. I guess there is no condition about possible in-flight damages in codes for aeroplanes.
3. Also condition "damage that without propagation … would not result in a catastrophic failure" is not applicable as well. As can be seen on attached movie, we have to expect a damage which has result in a catastrophic failure when an envelope is hit by a basket as this had happened. And I cannot imagine a design of a balloon which can withstand such a load.
4. "Standard" balloon rip-stop or HTN fabric has the critical damage under pressure in envelope far beyond possible damage for safe balloon operation. Furthermore envelopes are supported by horizontal load tapes to avoid damage propagation over critical size. For that reason finding of exact value of critical length of threat is useless and wasting of 5000$ (see explanatory note point V.15) for standard balloon fabric (in addition

proven by years of service). A condition for standard proven materials should be included.

The idea of detectable size of thread of size of 10 cm (Note 1) is very good and welcomed.

Petr Kubicek,
HDO Kubicek Balloons

P.S. the movie has changed extensinon to pdf.as I was unable to upload .avi file. To see the movie please change the extension back to .pdf file.

response

*Partially accepted*

Item 1 and 2.
The wording of CS 31HB.44 and AMC 31HB.44 will be changed for clarity and consistency. Please also refer to the specific paragraph in the explanatory note of this CRD. See resulting text of CS 31HB.44 and AMC 31HB.44. A similar change is also made to CS 31GB.

Item 3
The movie provided is a clear example where the damage continues because of the external force that continues. The panels are ripped open by the other basket that keeps pulling on the envelope fabric and line of the lower balloon. It is not our intention to request that an envelope can survive such a load and damage. The AMC is intended to show that the envelope fabric will not easily tear when it is locally damaged. From the comment it is clear that the intended meaning of the issue is not presented clearly enough in this AMC.

Item 4
The tear resistance of existing approved designs is not questioned by the introduction of this new requirement. It is introduced because there has been no objective AMC that covers this important design property. This AMC is introduced to make sure that future designs also use fabric that has enough resistance to tear propagation. Because the test provides a fabric property, one test can be used to show that the fabric is sufficiently resistant to tear for any design that has a load equal or lower to the test loads.

**B. Draft Decisions - I. Draft Decision to CS-31HB - AMC 31HB.27(g)** p. 11-12

comment

*8* comment by: *Cameron Balloon LTd*

Attachment #4

Ref AMC 31.HB.44 We wish to retain the current AMC. We have no objection to the proposed AMC being additionally included as a means of demonstrating that the basic envelope material can provide adequate rip-stopping capability in balloons where rip-stopping tapes are not used.

Please see attached Dicument DBL/TN/DCB/2691 **Position Paper: EASA NPA 2011-01. Amendments to CS 31HB.44 and associated AMC.**

response

*Accepted*

The existing AMC will be retained and a new AMC will be added to better provide means for showing acceptable fabric properties. See resulting text of

CS 31HB.44 and AMC 31HB.44.

comment 16 comment by: *CAA CZ*

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

From a practical point of view it would be much more appropriate to prescribe ultimate load factors in the basket (in a similar way to Figure 1 in CS 31HB.30) rather than speeds and deformations proposed in NPA as follows:

| | |
|---|---|
| Upward / downward ultimate load factor | 6.0 x 1.33 = 8 g |
| Sideward all directions ultimate load factor | 4.0 x 1.33 = 5.3 g |

response *Partially accepted*

It is agreed to add specific minimum g-values. The reasoning in the proposed AMC, that was intended to explain how the decelerations are derived from the 30° drop test, are after reconsideration shown to result in a too low load condition. Values derived from requirements for items of mass in crash landing conditions of other codes, such as the draft code for Hot Air Airships, are proposed. Also refer to the specific paragraph on this issue in the explanatory note of this CRD. See resulting text CS 31HB.27(g) and AMC 31HB.27(g).

comment 17 comment by: *CAA CZ*

**AMC 31HB.47 (d) Heater system test**

We propose to introduce AMC 31HB.47 (d) with link to an endurance test method of FAR31.47 (d), alternatively ELOS ACE-07-13 or any equivalent.

response *Not accepted*

Requirements for the heater test have not been proposed in the NPA and are out of the scope of this rulemaking task.

comment 19 comment by: *Balóny Kubíček*

Attachments #5 #6

**AMC 31HB.27(g)**
Kubicek Balloons generally agree with requirement CS 31HB.27 (g) however **AMC 31HB.27(g)** is unclear.

First at all it would be very difficult (and expensive) to measure "experienced values" during drop-test. Such value(s) would be very similar for all standard woven wicker and willow baskets and should be introduced into the AMC based on a research. During 2nd Balloon/Airship Manufacturers/PCM Meeting was discussed a value 8g.

Secondly, such g-loads are already introduced within the code – CS 31HB.27(b) and CS 31HB.30(a) ; I do not see the point why (theoretically) an occupant restrain harness or parts belonging to the balloon's suspension system can be detached under e.g. 8g load and items of mass not. These values should be equal and reasonable to avoid over-dimensioning of the structure (also safety factor 5 needs to be considered – CS 31HB.25(b))

And finally I do not understand to "minimum values should be considered"

- Why another load factor 1.4 is introduced? Load factor is already introduced in g-load. This value will result into unnecessary robust (and heavy) design of attachment points.
- Braking distance not less 0.3m. This value is unnecessary high for a burner unit attachment to a burner frame. All our burner frames were drop tested (AMC 31HB.27(d) and braking distance were around 7 cm (see report K32TT-DT for reference).
- Also do we need to take account this distance when considering minimum floor area for occupant (AMC 31HB.59(f)). I'm afraid that this will lead into unnecessary big basket layouts (especially in latitude dimension)
- How the value 2.25 m/s should affect design? If I simply count resulting g-load using 0.3m braking distance I'll get resulting g-load less than 1 (see Decceleration value.pdf for reference). I would appreciate more clarification on this to avoid confusion during certification process. Anyway why 2.25 m/s?

Kubicek Balloons agree with second paragraph of the **AMC 31HB.27(g)** ("Also items of mass attached …")

Petr Kubicek,
HDO Kubicek Balloons

response *Partially accepted*

The comment shows that the scope of this requirement for items of mass was insufficiently provided. The proposal in the NPA was drafted for attached items like equipment and batteries, not parts of the balloon like the suspension system or burners that are covered by existing requirements for the structure. This will be corrected.

It is agreed to change the requirement and related AMC. Please refer to the specific paragraph on this issue and AMC 31HB.45(c) in the explanatory note of this CRD.

The reasoning that the g-loads for restraints can be used is not fully shared. Forces acting on items of mass are at landing impact, down and sideways. The passenger restraint is to keep a person in the basket and therefore only the upward bounce load is used in the new proposal.

See resulting text CS 31HB.27(g) and AMC 31HB.27(g).

**B. Draft Decisions - II. Draft Decision to CS-31GB - Title page** p. 13

comment *21* comment by: *MOT Austria*

Attachment #7

Please find our comment attached. Thank you.

response *Noted*

comment 41 comment by: *MOT Austria*

**CS Para: AMC 31HB.27(g)**

**Comment:**
2.25 m/s horizontal speed isn't in compliance with max. Landing speed.
Landing load factor also not apply.

**Proposed Text:** Horizontal speed should not be less than 7.5 m/s.

**Justification:** Most of the TC-Holders apply a maximum surface wind speed of 7.5 m/s (15 kts) in the AFM.

response *Partially accepted*

The reasoning in the proposed AMC, that was intended to explain how the decelerations are derived from the 30° drop test, are after reconsideration shown to result in a too low load condition. Values derived from requirements for items of mass in crash landing conditions from other codes like the draft code for Hot-air airships are proposed.

See resulting text of CS 31HB.27(g) and AMC 31HB.27(g).

comment 42 comment by: *MOT Austria*

**CS Para: AMC 31HB.27(g)**

**Comment:** Deceleration distance not less than 0.3 m is counterproductive.

**Proposed Text:** Deceleration travel (braking distance not more than 0.3 m.

**Justification:** The more is non-critical!

response *Partially accepted*

The comment is correct, however due to reconsideration of the initial proposal it is not relevant anymore. Please refer to the specific paragraph CS 31HB.27(g)/CS 31GB.27(e) in the explanatory note of this CRD.

See resulting text of CS 31HB.27(g) and AMC 31HB.27(g).

comment 43 comment by: *MOT Austria*

**CS Para: AMC 31HB.27(g)**

**Comment:** The higher Factor of safety should be added for all fibrous or non-metallic components.

**Proposed Text:**
Factor of safety according CS31HB.25 (B). *Suspension should be deleted.* Or to add: Factor of safety 2.25 for all fibrous or non-metallic components.

**Justification:**
It seems that the factor of safety of 1.5 apply to all materials, even to non-metallic materials. Items of mass (fuel cells) are manly secured with textile straps.
31HB.25(c) takes only suspension components in consideration.

response *Not accepted*

Not accepted as suggested.

The safety factors for suspension components have been re-discussed and amended in order to cover all materials used for suspension components. It was however decided that these factors of safety for suspension components are not applicable to the attachments of items of mass for the following reason: the requirement in CS 31HB.27(g) describes that the items must not detach, and for that reason it is related to the ultimate load. This is also consistent with the requirement CS 31HB.30 for restraint systems and other Certification Specifications for emergency landing conditions. (Refer to several CS paragraphs 561.)

The newly drafted requirement for items of mass therefore now states g-loads for ultimate load that will provide sufficient safety margin without introducing or applying a specific safety factor.

It was however not considered adequate for the safety case of fuel cells that are therefore separately provided in CS 31HB.45(c).

Refer to the resulting text of CS 31HB.25, CS 31HB.27(g), AMC 31HB.27(g) and AMC 31HB.45(c).

comment *44* comment by: *MOT Austria*

**CS Para: AMC 31HB.44**

**Comment:** From my point of view it seems that the proposed examples of circular test set-up aren't a standardised version.

**Proposed Text:** Add reference to tensile strength and tear strength test method and fabric strength and tear propagation by David Schaffer:

Critical Length =
2 x Tear Strength
Stress

**Justification:** If there is no textile test norm and test apparatus available, I would suggest to relay on tensile strength and tear strength testing, standardised in EN / ASTM textile test norms.

response *Not accepted*

The proposed test set-up is not a standardised test set-up because existing tests do not cover the damage tolerance at a constant operating tension with increasing damage. The existing tear and tensile strength test measure the maximum forces which does not represent the damage tolerance aspects.

Please refer to the specific paragraph CS 31HB.44/CS 31GB.44 in the explanatory note of this CRD. Refer to the resulting text of CS 31HB.44 and AMC 31HB.44.

comment *45* comment by: *MOT Austria*

**CS Para: 31GB.2 (b)**

**Comment:** incomplete.

**Proposed Text:** …carriage of the balloon occupants, **equipment and ballast.**

**Justification:** For the sake of completeness, carriage of equipment and ballast could be mentioned.

response *Not accepted*

The definition as presented is consistent with CS 31HB.2. It is considered clear for the understanding of what is meant with basket even when it is not a woven wicker basket. Equipment and ballast are also sometimes attached to frames or the outside of the basket.

comment *46* comment by: *MOT Austria*

**CS Para: 31HB.2 (b)**
**31HB.59**

**Comment:** Incomplete

**Proposed Text:** ..equipment and fuel cells.

**Justification:** See above.

response *Not accepted*

See above.

comment *47* comment by: *MOT Austria*

**CS Para: 31HB.2 (b)**
**31HB.59**

**Comment:** It is not very clear if this requirement also apply to other means than baskets, sky chariot etc.

**Proposed Text:** Add to Basket, Seat Frame or other means provided for the occupants.

**Justification:** Many small HB are equipped with other means than baskets.

response *Not accepted*

The definition of basket in CS 31HB.2(b) is specifically provided to make clear that, when the CS mentions "basket", also other types of occupant carrying provisions are addressed.

See resulting text of CS 31HB.2(b).
Note: Also CS 31GB.2(b) is changed for consistency.

comment *48* comment by: *MOT Austria*

**CS Para: 31CB.17**

**Comment:** It needs more determination.

**Proposed Text:** …….in equilibrium at ground level with a tightly inflated balloon.

**Justification:** Determination more precise.

response

*Not accepted*

The test conditions will determine the weight and pressure limits. When this criterion can be met at lower pressures, it also complies.

comment

*49* comment by: *MOT Austria*

**CS Para: AMC 31GB.17**

**Comment:** Doesn't really fit with GB!
It needs more investigation.

**Proposed Text:** Add:
The test should be conducted by jettison of one sandbag with maximum **20 kg?** Mass.

**Justification:** The maximum amount of ballast should be specified to be jettisoned to reach adequate climb rate.
Suggestion: Amount of ballast what can be immediately (easily) jettisoned by one person (it will be one adequately secured sandbag).

response

*Partially accepted*

This requirement is included for consistency with CS 31HB. It is expected not to create a burden to show compliance for Gas Balloons. The "Conditions of the test" should also provide criteria that make sure that no exceptional procedure or configuration is used to meet the climb performance. The AMC 31 GB.17 will be elaborated to underline the objective. To specify the amount of ballast is, however, too prescriptive.

Refer to the resulting text of CS 31GB.17 and AMC 31GB.17.

comment

*50* comment by: *MOT Austria*

**CS Para: 31GB.25**

**Comment:** A factor of safety for fibrous or non-metallic components not belonging to the suspension system is missing.

**Proposed Text:** Add:
(e) A factor of safety 2.25 or more must be used for all fibrous or non-metallic components.
(e) becomes (f)

**Justification:** See also comment to
AMC 31GB.27(e) items of mass.
The mounting will be mainly with fibrous material.

response | *Not accepted*

Please refer to the specific paragraphs CS 31GB.25/CS 31GB.25 and CS 31HB.27(g)/CS 31GB.27(e) in the explanatory note of this CRD. The paragraphs for factors of safety and items of mass (CS 31GB.25 and CS 31GB.27(e)) are amended consistent with CS 31HB.

Please refer also to the response of comment 43. Refer to the resulting text of CS 31GB.25, CS 31GB.27(e) and AMC 31GB.27(e).

comment | *51* comment by: *MOT Austria*

**CS Para: AMC 31GB.27(e)**

**Comment:** See Comments to AMC 31HB.27(g) above.

**Proposed Text:** See Comments to AMC 31HB.27(g) above.

**Justification:** See Comments to AMC 31HB.27(g) above.

response | *Noted*

The response to comment 50 above also addresses this issue.

comment | *52* comment by: *MOT Austria*

**CS Para: AMC 31GB.37(a)**

**Comment:** Reference to AMC 31GB.33(a)(2) is wrong;

**Proposed Text:**
…..described in
AMC 31GB.33(b).

**Justification:** AMC 31GB.33(a)(2) doesn't exist.

response | *Accepted*

Corrected to read AMC 31GB.33(b). See resulting text of AMC 31GB.37(a).

comment | *53* comment by: *MOT Austria*

**CS Para: AMC 31GB.44**

**Comment:** See comments to AMC 31HB.44.

**Proposed Text:** See comments to AMC 31HB.44.

**Justification:** See comments to AMC 31HB.44.

response | *Not accepted*

Refer to comment No 44.

comment | *54* comment by: *MOT Austria*

**CS Para: AMC 31GB.59(e).**

**Comment:** Inconsistence with CS 31GB(d).

**Proposed Text:** "No more than two occupants may be positioned in the landing direction without means to prevent them from falling on top of each other", should be deleted.

**Justification:**
According 31GB(d), 6 occupants are allowed in an open basket. Without partitioned baskets (T, TT) there is no change to comply with! Hand holds an also
restraint harnesses for passenger are not a solution!

response *Not accepted*

Without a partition, a maximum of two persons may be behind each other in the landing direction. This can be achieved in an open 6 persons' basket with the appropriate landing positioning. Three persons aside each other and two persons behind each other in the direction of the landing. Each compartment in a larger basket needs to comply with the same requirement. It is agreed that a handhold does not provide a means for separation of occupants in a landing.

comment *55* comment by: *MOT Austria*

**CS Para: AMC 31GB.59(f)**
Also
31HB.59(f)

**Comment:** Minimum space for occupants between 0.25 m² and 0.3 m².

**Proposed Text:** …., a minimum figure of 0.25m² and for occupants with 100kg weight and more at least 0.3m² plan area……

**Justification:** A space value between 0.25 and 0.3 m² leads to un-necessary discussions. It also doesn't meet the intent of a CS.

response *Not accepted*

The objective of CS 31GB.59(f) is that reasonable space should be provided. The minimum space of 0.25-0.30 m² provided in the AMC is a rule of thumb consistent with CS 31HB. Introducing even more details concerning weight is considered too prescriptive with the risk that the objective is lost in details.

comment *56* comment by: *MOT Austria*

**CS Para:**
**AMC 31GB.61(a)**

**Comment:** Surface resistance to be measured inside **or** outside is questionable.

**Proposed Text:** The surface resistance of the balloon envelope (inside and outside) after….

**Justification:** I can't imagine that it is anyway to measure the
surface resistance inside or outside. I am aware of one procedure what asked for the inside.

response | *Partially accepted*

A suitable electrostatic design for hydrogen balloon fabric should have an electrostatic conductive layer on the inside of the fabric and should be antistatic effective (approximately $10^{11}$ Ω) on the outside if the thickness of the non-conductive layer is less than 0·3 mm.

See resulting text of AMC 31GB.61.

**B. Draft Decisions - II. Draft Decision to CS-31GB - BOOK 1: SUBPART C - STRUCTURE** p. 18-19

comment | *13* comment by: *CAA CZ*

**CS 31GB.25 (e) Factors of safety**
Considering real population in Europe, we propose an occupant mass of at least 90 kg for design purposes.

response | *Not accepted*

This is consistent within airworthiness codes (CS-23, CS-25 and FAR 31) This requires that the mass for an occupant is kept at 77 kg. For restraints it is however 86 kg.

**B. Draft Decisions - II. Draft Decision to CS-31GB - BOOK 1: SUBPART D - DESIGN AND CONSTRUCTION** p. 20-22

comment | *7* comment by: *John DAVIES*

CS31GB.31 (b) It is not clear what this means. Operational aspects are considered in specific areas of the code (e.g. tethering, road transportation, flight) so it is difficult to understand what the point of this additional requirement is without some explanation. It is difficult to imagine how this question could be answered other than with a statement that operations have been considered. This requirement should be deleted or explained.

response | *Accepted*

The split in this paragraph should not raise doubts about the intent of this requirement. Its objective is the same as for CS 31HB, but it was changed to emphasise that operational circumstances should not be forgotten. The requirement will be redrafted consistent with CS 31HB.

See resulting text of CS 31GB.31.

comment | *23* comment by: *Aero-Club of Switzerland*

CS-31GB 59(f)
Please clarify: What is the proof of the requirement for minimum basket floor surface per occupant (taking into account the brace position)? Is this to be understood as a practical demonstration, similar to the emergency evacuation tests we know from other CS?

response | *Noted*

The floor surface area provided in the AMC as a good rule-of-thumb. The floor area of between 0·25 m² and 0·3 m² plan area per passenger will provide in a conventional basket enough space for passengers to take their brace position for landing. A practical demonstration can be a good alternative to show that enough space is available for the passengers to take a brace position when there is an unconventional seating arrangement or basket shape.

comment *24* comment by: *Aero-Club of Switzerland*

CS-31GB-61(d)(5) and (6)
Please clarify: How is the continuing compliance with this paragraph to be maintained (periodic re-inspection of conductivity)? The text proposed and the AMC do not specifically address this subject, which we consider to be rather important by experience.

response *Accepted*

An additional requirement is included in AMC 31GB.61. See resulting text.

comment *25* comment by: *Aero-Club of Switzerland*

CS-31GB-81(d)(6)
Please clarify: In what cases is the limitation of occupancy not applicable? Are we talking of single-pilot only balloons (e.g) Colt Gashopper) or of balloons with clearly defined seats instead of simple baskets?

response *Noted*

This comment refers to AMC 31GB.81.

The additional occupant limitations for tethered flight are not applicable if they are the same as for free flight.

**B. Draft Decisions - II. Draft Decision to CS-31GB - BOOK 1: SUBPART G - OPERATING LIMITATIONS AND INFORMATION** p. 24

comment *3* comment by: *John DAVIES*

CS31GB.83 Conspicuity

Proposed Cameron comment: The proposed AMC suggest that gas balloons should have various colours, but for performance reasons it is important that they are reflective white. This applies to all manufacturers. Any balloon is more conspicuous than an all-white sailplane, so why do we have this requirement? It comes from the old FAR Part 31 which was written very long ago, when experience of balloons was very low. We should get rid of the whole requirement.

response *Accepted*

The requirement and related AMC are removed for both HB and GB. See resulting text.

comment *12* comment by: *CAA CZ*

**CS 31GB.81 Operating instructions**

Regarding the possibility to derive lift from a flammable gas we recommend to add the following in CS 31.GB:
1) absolute prohibition of smoking for pilots and occupants, using appropriate placards;
2) prohibition of transport of fire sources such as matches, starters, etc.;
3) or add a fire extinguisher to a mandatory equipment – CS 31GB.72.

response *Partially accepted*

It is agreed that risks related to the specifics of the lifting gas need to be mitigated. These mitigating measures should be addressed in the operating instructions and safety precaution should be made available. It is however not supported to introduce a specific paragraph in the CS for this purpose only. All information relevant to safe operation taking the specifics of the balloon operation into consideration need to be addressed. See resulting text of AMC 31GB.81(b)(2).

**B. Draft Decisions - II. Draft Decision to CS-31GB - BOOK 2: SUBPART C – STRUCTURE** p. 27-28

comment *10* comment by: *CAA CZ*

**AMC 31GB.27 (e) Strength and proof of strength**

From a practical point of view it would be much more appropriate to prescribe ultimate load factors in the basket (in a similar way to Figure 1 in CS 31GB.30) rather than speeds and deformations proposed in NPA as follows:

| | |
|---|---|
| Upward / downward ultimate load factor | 6.0 x 1.33 = 8 g |
| Sideward all directions ultimate load factor | 4.0 x 1.33 = 5.3 g |

response *Partially accepted*

It is agreed to withdraw the initial proposal relating to this paragraph on the basket drop test. Instead, specific ultimate loads have been introduced.

The structure to which these restraints are attached should be designed to withstand an ultimate load of 1.33 times these loads.

Please refer to the specific paragraphs CS 31HB.27(g)/CS 31GB.27(e) in the explanatory note of this CRD. See the resulting text of CS 31GB.27(e) and AMC 31GB.27(e).

**B. Draft Decisions - II. Draft Decision to CS-31GB - BOOK 2: SUBPART D - DESIGN AND CONSTRUCTION** p. 29-33

comment *2* comment by: *John DAVIES*

AMC 31GB.49 (c)

| | |
|---|---|
| | Proposed Cameron comment: Automatic relief valves should not be ruled out because (1) they can be designed safely, and (2) they are necessary for a system that will prevent the danger of highly flammable gas and oxygen mixing. The traditional appendix has an inherent danger, because it allows hydrogen and oxygen to come into contact in the presence of fabric layers rubbing against each other. |
| response | *Accepted*<br><br>Please refer to comment No. 1.<br><br>See resulting text of AMC 31GB.49(c). |

| | |
|---|---|
| comment | *11* comment by: *CAA CZ*<br><br>**AMC 31GB.61 Electrostatic discharge**<br><br>Regarding the possibility of electrostatic discharge before a direct contact with ground we propose to equip a gas balloon basket with a grounding wire of 3 to 5 metres in length in case of flammable gas balloons. |
| response | *Partially accepted*<br><br>In theory the idea of a grounding wire is good but the use in practice in Switzerland and Germany showed negative effects. Designs showed not to be very reliable and handling during fast landings was difficult. As the initial point of contact during a landing is between the basket and the ground, the discharge path (refer to paragraph (d) of AMC 31GB.61) should run to the lower end of the basket.<br><br>See Resulting text of AMC 31GB.61 paragraph (d). |