Comment-Response Document 2012-24

Certification Specifications and Acceptable Means of Compliance for Tethered Gas Balloons ('CS-31TGB')

CRD TO NPA 2012-24 — RMT.0081 (31.003/004) — 04/07/2013
Related Decision 2013/011/R

EXECUTIVE SUMMARY

This Comment-Response Document (CRD) contains the comments received on Notice of Proposed Amendment (NPA) 2012-24 (published on 6th December 2012) and the responses, or a summary thereof, provided thereto by the Agency.

Based on the comments and responses, Decision 2013/011/R was developed that reflects the result of this rulemaking task.

The NPA 2012-24 proposed specific Certification Specification (CS) for Tethered Gas Balloons (TGB) (CS 31TGB) that were developed by a drafting group with participation from major European stakeholders in this field of aviation, and is based on the type certification bases applied to existing approved tethered gas balloons that show to have a satisfactory safety record.

Since the technical content was based on existing certification practice, no major issues were raised in the comments. They did help to identify some errors and items that obviously caused potential misinterpretation. These issues have been addressed and the quality of this new CS 31TGB has been improved thanks to the provided feedback.

As tethered gas balloons are not within the remit of the FAA, this CS is not harmonised.

Applicability	
Affected regulations and decisions:	CS-31TGB
Affected stakeholders:	Applicant for type certificates and major changes to type certificates of tethered gas balloons and the competent authority
Driver/origin:	Level playing field
Reference:	N/A

Process map	
Concept Paper:	No
Rulemaking group:	Yes
RIA type:	Light
Technical consultation during NPA drafting:	Yes
Publication date of the NPA:	2012/Q4
Duration of NPA consultation:	3 months
Review group:	No
Focussed consultation:	No
Publication date of the Decision:	2013/Q3

Table of contents

1. Summary of comments and resulting changes

This paragraph shows the highlights in tracked changes that have been made to the proposed draft CS 31TGB from NPA 2012-24 as a result of the comments received during the public consultation.

A number of comments also identified errors or editorial improvements that do not result in a change to the technical content of the CS-31TGB. These changes are not highlighted in this paragraph but are reflected in the final CS-31TGB in the annex to Decision 2013/011/R.

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

(a) deleted or amended text is shown with a strike through: ~~deleted~~

(b) new or amended text is highlighted with grey shading: new

(c) … indicates that remaining text is unchanged in front of or following the reflected amendment.

A summary of the comment and response, leading to a change as highlighted below, *are provided in a box and italic print* before each text change.

BOOK 1 SUBPART C — STRUCTURE

Comment to CS 31TGB.25; Some comments showed that there was uncertainty on what load factors and safety factors are applicable in case of mooring. Parts that are only subject to the loads in the mooring condition are not regarded as suspension and tethering components. A note is therefore added as follows in the table of CS 31TGB.25 as shown below.

CS 31TGB.25 Factors of safety

…

	Safety factor
Envelope	5·00
Suspension and tethering components (fibrous or non-metallic)	3·50
Suspension and tethering components (metallic)	2·50
Other (This includes mooring components not used for suspension or tethering)	1·50

…

BOOK 1 SUBPART F — SYSTEMS AND EQUIPMENT

Comment to CS 31TGB.75; It was commented and partially agreed that the standard colour of caution lights is amber or yellow. This is corrected as shown below.

CS 31TGB.75 Warning, caution, and advisory lights

If warning, caution or advisory lights are installed, these are:

(a) red, for warning lights (lights that indicate a ~~hazard~~ condition that demands immediate corrective action);

(b) amber or yellow, for caution lights (lights that indicate a condition that requires immediate awareness and the possible need for subsequent corrective action);

…

BOOK 2 SUBPART D — DESIGN AND CONSTRUCTION

Comment to AMC1 31TGB.45; A concern was expressed that the AMC1 31TGB.45 would make existing data invalid and re-testing would result in high costs and investment in new testing equipment.

It is explained in the response to this comment that this AMC is one, but not the only means of showing compliance to the requirement. In order to better explain the background of this AMC it has, therefore, been elaborated. The added explanation is derived from the similar AMC that exists in CS-31GB and CS-31HB. The changes are provided in the text below.

AMC1 31TGB.45 Protection of 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 that the envelope material would not continue to tear under the maximum tension and conditions (temperature) experienced in normal operation.
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.

….

A typical test set-up is provided below.

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.

….

Comment to AMC1 31TGB.49; Comments received showed that the proposal did not clearly state what safety factors would be applicable for the mooring case when a balloon is inflated above the pressure for flight operation. The following change is made for clarification.

AMC1 31TGB.49 Limiting of operating pressure

….

(a) Balloon systems staying inflated above maximum wind speed for flight operation

These balloon systems ensure envelope tautness by a ballonet or other means of feeding/discharging gas into the envelope when moored on the ground in parking position to withstand the dynamic pressure of considerably high wind speeds. Here

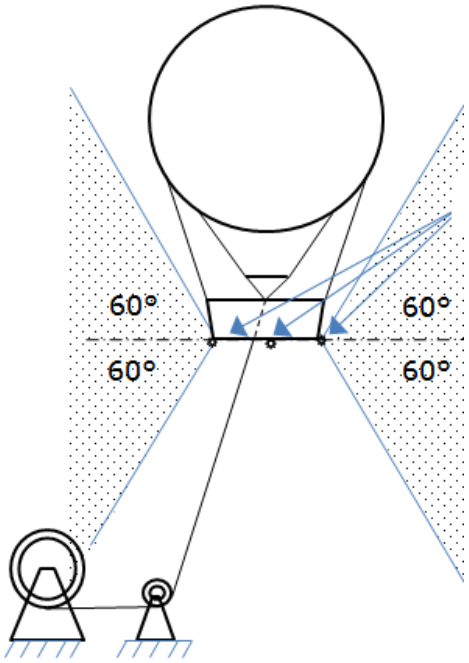
the maximum operating pressure is the maximum pressure established by the designer for high wind speeds whilst moored in parking condition to the ground. Under this condition the safety factors ~~less the ascent factor in CS 31TGB.23(b) should be fully maintained~~ in CS 31TGB.25 are applicable. The ascent factor in CS 31TGB.23(b) is, however, not applicable in the parking position. The response pressure of the automatic lifting gas release valve usually is higher than the maximum operating pressure to prevent the envelope from getting pumped out below dynamic pressure of the wind by unexpected gusts. A factor of not less than 1·4 times the maximum operating pressure during mooring has been shown by practical experience to be applicable.

….

Comment to CS 31TGB.65; The requirement for night lighting could potentially lead to non-acceptance of currently used concepts for night lighting that meet the safety intent. For that reason the following new AMC is introduced.

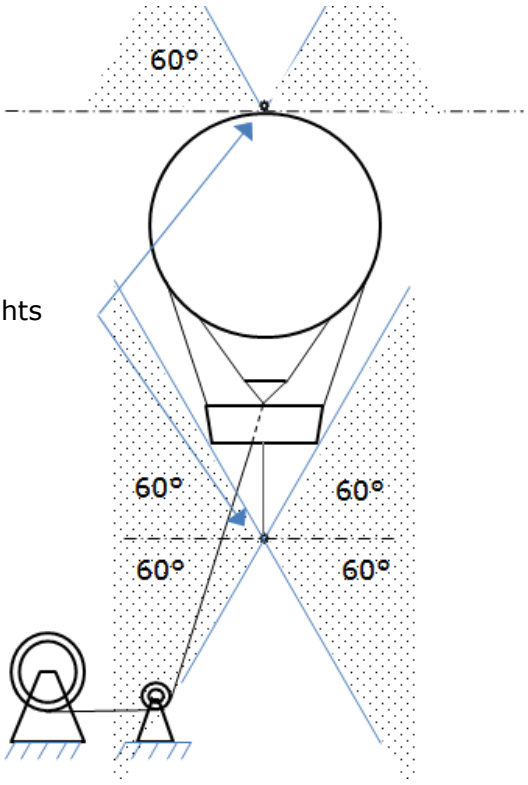
AMC1 31TGB.65(b) Night lighting

The following two schematics illustrations for anti-collision light arrangements show vertical coverage and positions that meet the requirements of CS 31TGB.65(b)(2) and (3).



Option 1 Anti-collision lights at the circumference of the gondola

Anti-collision lights



Option 2 Anti-collision light on top of the envelope and a complementary light suspended below the gondola

The horizontal 360° coverage requirement is applicable to a distance between 100 m and 3700 m (2 NM). It is acceptable that the light from the anti-collision lights is not visible from positions closer than 100 m horizontally from the balloon.

Comment to AMC1 31TGB.69(c); The intent of the AMC was not clear and has been improved by the following change.

AMC1 31TGB.69(c) Electric cables and equipment

The risk of short circuit for the electrical cable between battery and master switch is minimised when the ~~This is normally achieved by limiting~~ unprotected battery to master switch cables, of an adequate capacity, have ~~to~~ a maximum length of 0·5 m.
….

2. Individual comments and responses

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

(a) **Accepted** — The Agency agrees with the comment and any proposed amendment is wholly transferred to the revised text.

(b) **Partially accepted** — The Agency either agrees partially with the comment, or agrees with it but the proposed amendment is only partially transferred to the revised text.

(c) **Noted** — The Agency acknowledges the comment but no change to the existing text is considered necessary.

(d) **Not accepted** — The comment or proposed amendment is not shared by the Agency.

2.1. CRD table of comments and responses

(General Comments)	-

comment	*1* comment by: *UK CAA* Please be advised that the UK CAA do not have any comments on NPA 2012-24, Certification Specifications, Acceptable Means of Compliance and Guidance Material for Tethered Gas Balloons (CS-31TGB).
response	Noted.

comment	*4* comment by: *DGAC France* This draft CS does not include conditions linked to the balloon mooring such as the necessity of an automatic deflation means when the balloon is moored (CS 31TGB.51) and The balloon should be provided with a mean to pressurize the balloon at a suitable pressure to counter balance the wind load and keep the intended shape of the balloon at max windspeed indicated for mooring –(CS 31TGB.22)
response	Noted. See the responses to the specific issues in comment No 19, 22 and 23 of this CRD

comment	*25* comment by: *Luftfahrt-Bundesamt* The LBA has no comments on NPA 2012-24.
response	Noted.

comment	*26* comment by: *DGMR-Sys-A/H/C* Attachment #1 Dear Sir, Madame, I'm currently working as assistant material manager for Belgian Army. My work field is helicopters and the tethered balloon used in Para Troopers Training Centre at Schaffen. I've overviewed the draft of the EASA doc and inserted some comments on this

	document. As I couldn't log in to use CRT-tool, I've inserted a annexe file to this email. Hopefully this will complies with your requirements.
response	Partially accepted. The Agency appreciates the feedback that was provided. The individual comments have been answered in the attachment (see paragraph 2.2. Attachments) to this CRD and corrections and clarifications have been introduced in the Decision.

B. Explanatory Note IV. Summary of proposed new CS-31TGB CS-31TGB — Subpart G — Operating limits and details p. 7

comment	*17* comment by: *AEROPHILE* **CS-31TGB — Subpart G — Operating limits and details** The Subpart G does not introduce fundamental changes compared to currently used certification basis. What is new, are requirements that reflect the current method, instructions and information used by the major stakeholders to train and qualify the persons that operate the TGB. The Agency considers these new requirements an acceptable standard that potentially can be referred to in future regulations for operator training if and when these would be developed. The proposed TGB talks about 'operator' instead of pilot since the control of the TGB can be both from the ground, basket, or both. [M1] This standard for the method, instructions, and information to train and qualify operators for the tethered gas balloon operation included in the CS, is considered to support an acceptable level of safety for TGB operations. Note: The FAA has published a notice of proposed rulemaking that also proposes to exclude tethered launches from existing licensing requirements. (Docket No: FAA–2012–0045; Notice No.12–05) *NPA 2012-24 3 Dec 2012* [M2] **Comments** [M1]There is no requirements on how to decide if the operator can remain at ground or should be on board, it would be good to explicite. In my opinion no operator on board should be limited to a balloon where all passengers are individually secured in a harness with no possible action to the balloon, and for a maximum of 6 passengers. The operator should be mandatory on board in all other cases. [M2]This notice is about rockets and not balloons, irrelevant.
response	Noted. The operational requirements are not part of the CS and will be addressed in a future operational rulemaking task. The only reason for mentioning this is to explain the use of the word 'operator' in this NPA. During the comments review it was decided to change the term 'operator' to 'crew' in order to prevent confusion with the definition of operator in the Basic Regulation. It was irrelevant to refer to the FAA activity that turns out not to be related.

D. I. BOOK 1 SUBPART A — GENERAL - CS 31TGB.1 Applicability p. 10

comment	*5* comment by: *DGAC France* Balloons that derive their lift from a flammable gas have been excluded from the scope of the certification specification. Concerning this type of balloons, does it mean that this entire certification specifications and complementary requirements will be proposed as special conditions whenever a manufacturer applies? An alternative solution could be to directly include them in the scope and insert special mentions in relevant paragraphs.
response	Noted. The requirements in the proposed CS 31TGB are considered as the certification specifications for tethered gas balloons, as mentioned in 21.A.17 'Type-certification basis'. When features (such as the use of a flammable gas) are introduced that are not appropriately covered in this CS, special conditions will be added by the Agency. The option to specify specific requirements for the use of flammable gas was considered in the drafting group but not included because it was expected that discussion on this specific issue would delay publication of the CS.

comment	*6* comment by: *DGAC France* With this definition, the French DGAC has a concern that various fairground attractions that have never been certified in France could fall in the domain of applicability of the certification code. Only TGBs 'which have a maximum empty mass, including fuel, of no more than 70 kg' correspond to annex II to R(CE) n°216/2008 criteria. This weight limitation might not be enough to exclude all these fairground attractions from the requirement to comply with CS-31TGB These aircraft are defined as follows: number of pax ≤ 2, maximum operations height ≤ 50m. DGAC-France would appreciate to allow these aircraft to be operated without any certificate of airworthiness and therefore without any type certification.
response	Noted. The comment is out of scope. CS-31TGB are the certification specifications which will be used in the certification basis for TGB when an application is accepted by the Agency. It does not change the scope of applicable aircraft that are subject to the Basic Regulation or excluded by Annex II of that regulation.

D. I. BOOK 1 SUBPART A — GENERAL - CS 31TGB.2 Definitions (See AMC1 31TGB.2) p. 10

comment	*7* comment by: *DGAC France* The definition of Tethered Gas Balloon given in (a) could be clarified. Does the definition of a tethered gas balloon include the tether system? Or is it only a characteristic? *Alternative solution: A tethered gas balloon consists of a balloon system (envelope, suspension system and gondola)* ***and*** *the tether system that continuously anchors it during operation.*
response	Accepted. The tethered gas balloon is not a characteristic but a system as reflected by the definition. The change is accepted because it better shows that the tethered gas

	balloon is the total of balloon system and tether system. Both are part of one type certificate covering the interaction between tether system and balloon.
comment	*8* comment by: *DGAC France* In § (h), the use of the term "operator" doesn't seem appropriate; operators are generally associated with an entity that operates an aircraft (ICAO definition). "Person in command" or "person in charge of the manoeuvres" seem more appropriate.
response	Partially accepted. The definition of operator that is included in this CS creates confusion and discussions. It is therefore deleted, and the lines that contained the word 'operator' have been made self-explanatory.

D.III. BOOK 1 SUBPART C — STRUCTURE - CS 31TGB.25 Factors of safety p. 12

comment *18* comment by: *AEROPHILE*

CS 31TGB.25 Factors of safety

(a) A factor of safety is used in the balloon design as provided in the table. Safety factor	
Envelope	5·00
Suspension and tethering components (fibrous or non-metallic)	3·50
Suspension and tethering components (metallic)	2·50
Other **Comment** Is the mooring included here? It would be good.	1·50

response Noted.
Mooring components specifically used for mooring are not considered as 'suspension and tethering components' and regarded as the 'other' with respect to the applicable factor of safety. The requirement will be changed for clarification.

D.III. BOOK 1 SUBPART C — STRUCTURE - CS 31TGB.27 Strength and proof of strength p. 12

comment	*9* comment by: *DGAC France* An AMC should be created for CS 31TGB.27(d), as it exists for (c) and (f) and the link to this AMC should be indicated in this §.
response	Partially accepted. CS 31TGB.27(d) was inadvertently kept while the content was already covered by AMC1 31TGB.27(c).

D.IV. BOOK 1 SUBPART D — DESIGN AND CONSTRUCTION - CS 31TGB.51 Rapid deflation means (See AMC1 31TGB.51) p. 14

comment	*10* comment by: *DGAC France* Is it realistic to consider the tether system in the certification specifications? This could lead to the need of having Form Ones also for winches and to control their design for the TC holder. Is it really EASA's intent? DGAC feels like that considering that the winch is not included in the type design highly simplifies the problems linked to the winch production and the replacement of winches spare parts. At the present time, the POAs have no competency to deliver EASA Form Ones to such parts and winch manufacturers do not want to apply Part 21 subparts F or G.
response	Not accepted. Because of the interaction between the winch and the balloon it is important that the airworthiness requirements address both as well as their interrelationship. The CS is introduced to establish the airworthiness of the entire system. Although production and parts release (Form-1) issues are not in the scope of a CS or this rulemaking task, it needs to be stated that a POA can still release these parts when the winch is regarded as sub-contracted manufacturing. Some alleviation has been created to address the problems encountered with parts that are produced by non-aviation manufacturers in Annex Part-21 21.A.307(c) in Commission Regulation (EU) 748/2012. It is, however, also acknowledged that this is not the final solution to this problem. A new rulemaking task (See ToR RMT.0018 and RMT.0571 (21.026).pdf) has therefore started.

D.V. BOOK 1 SUBPART F — SYSTEMS AND EQUIPMENT - CS 31TGB.75 Warning, caution, and advisory lights p. 17

comment	*11* comment by: *DGAC France* In § (b) Replace "Yellow" by "Amber", the adequate colour for caution lights.
response	Partially accepted. To be consistent with other certification specifications, the use of both amber or yellow is accepted.

D.VI. BOOK 1 SUBPART G — OPERATING LIMITS AND DETAILS - CS 31TGB.81 Flight manual (See AMC1 31TGB.81) p. 17

comment	*12* comment by: *DGAC France* In the title withdraw "(see AMC1 31TGB.81)" AMC1 31TGB.81(c) and AMC1 31TGB.81(b)(2) are missing. At the end of § CS 31TGB.81 (b)(5), add: ""(see AMC1 31TGB.81(b)(5))"
response	Partially accepted. The references in the NPA to the AMC are incorrect in CS 31TGB.81 and only AMC1 31TGB.81(b)(5) was supposed to be referred to. The references are corrected.

comment	*28* comment by: *Josef Huber* Dear Madam, Sir Basically we appreciate this rule, even the offered operation height up to 500 m (previous regulation 150 m). The tether height of 500 m (above minimum flight altitude) may be handled by a NOTAM of the NAA. The in CS 31TGB.81(C) mentioned AMC1 31TGB.81(c) is missing. I would like to establish in this point that the Agency has to agree on a single person operation ground or gondola.
response	Partially accepted. References to AMC in CS 31TGB.81 have been corrected as explained in the comment above. Note: The CS should not be considered as an operational rule and for that reason the 500 m operational height indicated in CS 31TGB.1 is providing the applicability of these technical specifications. When a design is made for a TGB that will be operated more than 500 m above the ground, other technical requirements will be needed. The minimum number and qualifications of those persons operating the balloon needs to be established and provided in the flight manual. The CS does not specify the design criteria that would mandate a number of persons operating the balloon because of the variety of designs. Also the proposal to agree on a single person operation on the ground or in the gondola is an operational aspect that is not part of the CS.

D.VI. BOOK 1 SUBPART G — OPERATING LIMITS AND DETAILS - CS 31TGB.83 Operator training and training information (See AMC1 31TGB.83) p. 18

comment	*13* comment by: *DGAC France* Some requirements in this paragraph have nothing to do with certification specifications regulation, but should be defined in the operational requirements. Training and proof of completion are out of the scope ((c), (d) and (e) are irrelevant). Only a description of the required persons in charge of the manoeuvres should be included.
response	Not accepted. It is true that the training information in CS 31TGB.83 is normally not found in a CS. A pragmatic approach was followed, based on the current practice and experience in TGB, where the CS only specifies the content of this information. It is the intent to refer from future operational rules to this acceptable standard for the content instead of creating another separate document with the operational rules. Also from the Operational Suitability Data point of view, that is part of the type certificate data, this CS requirement is especially for the dedicated TGB environment seen as a pragmatic and user-friendly solution.

comment	*20* comment by: *AEROPHILE* **CS 31TGB.83 Operator training and training information (See AMC1 31TGB.83)** For a safe operation of the balloon, a training manual for operators is made available that contains as a minimum the following:

	(a) Operating instructions and information as required by CS 31TGB.81; (b) Minimum operator qualifications; (c) Minimum training requirements, both theoretical and practical as appropriate; (d) A method to show proof of successfully completing the training; and (e) Recommended training requirements **Comment** We can add a requirement for regular skill check, especially in case of long stop in the practice.
response	Not accepted. This paragraph in the CS only specifies the content of this information and does not regulate operational aspects. See also the comment above.

D.IX. BOOK 2 SUBPART C — STRUCTURE - AMC1 31TGB.22 In-Service load cases p. 20-21

comment	*21* comment by: *AEROPHILE* **IX. BOOK 2 SUBPART C — STRUCTURE** **AMC1 31TGB.22 In-Service load cases** Inflation/mooring The 'inflation and mooring cases' referred to in this requirement cover assembly, disassembly, inflation, deflation and mooring load cases. Mooring load cases cover both low and high mooring, if applicable. When the balloon is moored in the parking position (low mooring) the maximum gas pressure in the envelope is normally identical to the 'maximum gas pressure' established for any of the flight conditions. If the low mooring operation, however, allows for a precautionary increased pressure of the gas in the envelope this load case is also considered **Comment** The balloon should be provided with a mean to pressurize the balloon at a suitable pressure to counter balance the wind load and keep the intended shape of the balloon at max windspeed indicated for mooring.
response	Not accepted. A precautionary increased pressure in the envelope can be a method to address high wind speeds but will depend on the specific balloon design. Requirements for such a feature are, therefore, not mandatory.

D.X. BOOK 2 SUBPART D — DESIGN AND CONSTRUCTION - AMC1 31TGB.44 Protection of envelope against tearing p. 23

comment	(Later added comment) comment by: *Lindstrand Technologies Ltd* AMC 31 TGB.45 We have been considering the proposed changes to CS-31TGB and have some strong reservations over 'AMC 31TGB.45 protection of envelope against tearing.' I apologise unreservedly for not following the NPA comment path in good time however we would like to comment anyway here. We have over the years gathered a huge database of historical cradle to grave

	statistics on the various fabrics that we have used based on our existing test methods, and the introduction of any new method immediately invalidates all of our established design values. We note also that this compliance method does not align with CS-30T/FAA TAR's, CS-30N, -30T or the LFLS etc Another point of consideration is the massive investment in test machinery, we have four fabric tensile testing machines, two of which are dedicated to in production testing. It would take years to get back to the point that we are at now with a radically different test method.
response	Accepted. The AMC1 31TGB.45 as reflected in the NPA should have been as closely as possible consistent with the AMC 31GB.44 for gas balloons. The proposed AMC for TGB failed to show the more elaborate information that better explains the intension. This is corrected in the publication of the Decision. The provided AMC is by definition not the only way how compliance can be shown. It, however, provides a test set-up that does not require extensive test machines.

D.X. BOOK 2 SUBPART D — DESIGN AND CONSTRUCTION - AMC1 31TGB.49 Limiting of operating pressure p. 23

comment	*3* comment by: *Ballonbau Wörner* AMC 31 TGB.49 Replace: Under this condition, the safety factor less the ascent factor in CS 31.23(b) should be fully maintained. By: Under this condition, the safety factors in CS 31 TGB.25 without the load factors in CS 31 TGB.23 should be fully maintained. Or alternatively Under this condition, the safety factors in CS 31 TGB.25 should be fully maintained. Justification: The load factors of flight, ascent and gust are not applicable in parking position. Proposal: This information should be shifted to AMC 31 TGB.25 with a reference to AMC 31 TGB.49. The reading could be: The safety factors should be fully maintained in parking position, too.
response	Partially accepted. The wording has been changed for clarity as followed: AMC1 31TGB.49(a) … Under this condition the safety factors in CS 31TGB.25 are applicable. The ascent factor in CS 31TGB.23(b) is, however, not applicable in the parking position.

comment	*22* comment by: *AEROPHILE* **AMC1 31TGB.49 Limiting of operating pressure**

	The envelope pressure is limited to prevent the envelope from bursting. However, the definition of the envelope's maximum operating pressure depends on the design of the tethered gas balloon system. For inflated balloon systems the operating conditions are not limited to flight but also include the parking conditions if the balloon system stays inflated for a prolonged period between the flight operations. Thus, different cases need to be considered: (a) Balloon systems staying inflated above maximum wind speed for flight operation [M1] These balloon systems ensure envelope tautness by a ballonet or other means of feeding/discharging gas into the envelope when moored on the ground in parking position to withstand the dynamic pressure of considerably high wind speeds. Here the maximum operating pressure is the maximum pressure established by the designer for high wind speeds whilst moored in parking condition to the ground[M2]. Under this condition, the safety factors less the ascent factor in CS 31TGB.23(b) should be fully maintained. [M3] The response pressure of the automatic lifting gas release valve usually is higher than the maximum operating pressure to prevent the envelope from getting pumped out below dynamic pressure of the wind by unexpected gusts. A factor of not less than 1·4 times the maximum operating pressure during mooring has been shown by practical experience to be applicable. (b) Balloon systems other than described in (1) These balloon systems are usually smaller and ensure envelope tautness by means other than described under (1), i.e. by flexible parts in the envelope. They are designed for maximum wind speed during flight operation and will normally be deflated during high wind speed weather conditions. Here the maximum operating pressure is the pressure for flight operation established by the designer. The response pressure of the automatic lifting gas release device is not less than 1·15 times the maximum operating pressure. For clarification, it should be noted that in a strict sense the automatic pressure release device can only prevent the further rise of pressure for the very moment. After release the device should close again in order to minimise the loss of lifting gas. If after a while the pressure increases again for any reason, the device will also open again. This behaviour is intended and does not impair safety. **Comments** [M1]The flight manual should state clearly the maximal windspeed the balloon can stand. [M2]And which makes it possible to keep the intended shape of the envelope by counter balancing the wind load. [M3]This is acceptable for the mooring parts if the safety factor for mooring is 1,5 (CS31TGB.25). For other parts (envelope, suspension system), a lower safety factor should be accepted (3 instead of 5 for the envelope, and 3 instead of 3,5 for the net) if it is proved that the wind load at mooring cannot have consequences on the airworthiness of the balloon.
response	[M1] Not accepted. It is considered impractical to require a specific maximum wind speed because it cannot be determined and tested in a way that would provide clear fail or pass criteria in true conditions. Recommended wind speed limitations should be provided for operational purposes. [M2] Not accepted. The proposed addition is covered by the first sentence of this paragraph 'These balloon systems ensure envelope tautness by a ballonet or other means of feeding/discharging gas into the envelope when moored on the ground in parking position to withstand the dynamic pressure of considerably high wind speeds.' [M3] Partially accepted.

	As stated above in the response to comment 3, the flight load factor is not applicable for the mooring (parking) case. All other safety factors remain applicable, which means 1·5 for mooring parts as confirmed in the response to comment 18 of this CRD.

D.X. BOOK 2 SUBPART D — DESIGN AND CONSTRUCTION - AMC1 31TGB.51 Rapid deflation means p. 23

comment	*23* comment by: *AEROPHILE* **AMC1 31TGB.51 Rapid deflation means** Rapid deflation means are used to deflate the envelope in cases like e.g. when: wind speeds increase above the wind speed limitations for low mooring; required during inflation before attachment of the tether cable; or included in emergency procedures for unintended free flight. **Comment** Automatically in case of breaking away under low mooring position
response	Accepted. A note is added to reflect that the rapid deflation means should act automatically when the balloon is not monitored by the operator during low mooring in high wind conditions.

D.X. BOOK 2 SUBPART D — DESIGN AND CONSTRUCTION - AMC1 31TGB.53(a) Tether system p. 23-24

comment	*16* comment by: *DGAC France* Requiring a FMEA is a strong requirement. The French DGAC doubts that such tool should be understandable to manufacturers and PCM … If it is required, it is necessary to define in this AMC how it must be built and with which information.
response	Not accepted. The FMEA has been used in several certification processes. Developing a generic standard as AMC is expected to slow down the development of this CS and can be considered for future rulemaking if experience shows that there is need for this.
comment	*19* comment by: *AEROPHILE* **CS 31TGB.53 Tether system** (a) The suitability, durability, and reliability of the tether system is established for all phases of operating. (See AMC1 31TGB.53(a)) (b) In operation and mooring the balloon is securely and reliably anchored to the ground. (c) Precautions are to be taken to prevent the balloon from breaking away when moored to the ground due to the effect of wind exceeding the maximum wind speed stated in the Flight Manual. **Comment** I propose to require an automatic quick deflation of the balloon in case it breaks away from its low mooring position (most likely situation to break away in highest

	wind).
response	Partially accepted. An automatic rapid deflation is considered as one of the possibilities but not the only one. Therefore, the following change and additional AMC are included. (c) Precautions are to be taken to mitigate the risks on the balloon when moored to the ground ~~prevent the balloon from breaking away when moored to the ground~~ due to the effect of wind speed exceeding the maximum stated in the Flight Manual.(See AMC1 31TGB.53(c)) AMC1 31TGB.53(c) (New) An automatic rapid deflation (See CS 31TGB.51) of the balloon, in case it breaks away from its low mooring position or any other system that will prevent uncontrolled free flight, is an acceptable risk mitigation.
comment	*24* comment by: *AEROPHILE* **AMC1 31TGB.53(a) Tether system** The suitability, durability, and reliability of the tether system, including the tether control systems, is determined by a Failure Mode Effect Analyses (FMEA) covering all phases of operation. For components of the tether system (i.e. the winch) compliance with the requirement of CS 31TGB.53(a) can be shown by a certificate from an expert body provided that: (a) this certificate specifies the conditions for safe operation of the winch that cover the conditions for safe operation of the balloon; (b) the winch system is capable of safely fulfilling the task of a tethered gas balloon winch; (c) compliance with the Machinery Directive 2006/42/EC (or equivalent (US) requirements) is the basis for the tethered gas balloon winch system; (d) modifications to the winch design do not invalidate the applicable requirements from the certificate that remain applicable after the modification. *Note: The overload protection of industrial winches is not applicable in the TGB application because overload cannot occur in a TGB application;* (e) the expert body is an EC-notified organisation which has a certified structure and a proven capability and experience. 'Certified' means an approval by the government which requires an organisational structure and entails extended liability. 'Proven capability' means successfully managed projects that are reasonably comparable to the balloon winch case. Usually these are cranes, elevators[M1] or similar winch technology; (f) the final report complies with the Annex II of the Machinery Directive 2006/42/EC (or equivalent (US) requirement); and (g) there is an alternative retrieve system which is able to cover a major winch failure[M2] **Comments** [M1]rides [M2]This alternative retrieve system can be incorporated into the same machinery as the primary winch.
response	Partially accepted. [M1] 'Rides' is added as an example. [M2] It is not considered relevant to say that the alternative retrieve system can be incorporated into the same machinery and by that hint at a specific design solution. The main objective remains that an alternative retrieve system is

	available to retrieve the balloon in case of a major winch failure.

D.X. BOOK 2 SUBPART D — DESIGN AND CONSTRUCTION - AMC1 31TGB.65(c) Night lighting p. 24

comment	*2* comment by: *Ballonbau Wörner* AMC 31 TGB.65(c) A schematic drawing of the possible location of the ACL would be very helpful (as the one of AMC 31 TGB.2) to show to the local officers who are in charge of the operational issue. Justification: One of the most frequently points of disagreement for issuing of the night flight permission is the kind and position of the anti-collision light. A clarification would be highly appreciated.
response	Partially accepted. A new AMC1 31TGB.65(b) has been added to show the intent of this requirement.

D.XII. BOOK 2 SUBPART G — OPERATING LIMITS AND DETAILS AMC1 31TGB.82 Instructions for continued airworthiness p. 28

comment	*15* comment by: *DGAC France* The first sentence of (c) as written in the NPA is not completely understandable. DGAC France suggests the following: "The TCH must provide in any case ICAs for the balloon. These ICAs may refer to ICAs provided by the manufacturer or the designer of parts and appliances installed in the balloon."
response	Paragraph (c) of CS 31TGB.82 (not the AMC) deals with the format and organisation of manuals and is consistent with CS-31GB.

D.XII. BOOK 2 SUBPART G — OPERATING LIMITS AND DETAILS AMC1 31TGB.83 Operator training and training information p. 28-29

comment	*14* comment by: *DGAC France* Same comment as for CS 31TGB.83
response	Not accepted. Please refer to the response to comment 13.

2.2. Attachments

Attachment to comment 26.

European Aviation Safety Agency

NOTICE OF PROPOSED AMENDMENT (NPA) 2012-24

DRAFT DECISION OF THE EXECUTIVE DIRECTOR OF THE EUROPEAN AVIATION SAFETY AGENCY

On Certification Specifications, Acceptable Means of Compliance and Guidance Material for Tethered Gas Balloons ('CS-31TGB')

I. BOOK 1 SUBPART A - GENERAL

CS 31TGB.1 Applicability

These Certification Specifications (CSs) are applicable to non-free flying manned tethered gas balloons that operate up to a maximum altitude of 500 m above the surface, and that derive their lift from non-flammable gas being lighter than air.

CS 31TGB.2 Definitions (See AMC1 31TGB.2)

Definition of terms and principles used:

a) A tethered gas balloon is a balloon system (envelope, suspension system and gondola) that is continuously anchored by a tether system during operation.
b) The tether system (winch, pulley, cable and swivel point) includes all components affected by forces resulting from tethering up to and including interface parts with the foundation or counterweight.
c) The mooring system includes all components affected by forces resulting from the applicable types of mooring (e.g. high and/or low mooring).
d) The suspension system includes all components suspending the gondola to the envelope (if applicable including the net).
e) The gondola accommodates the balloon occupants and can e.g. be a gondola, container, trapeze, harness, seat or platform suspended beneath the envelope.
f) The envelope contains the lifting gas.
g) The swivel point is the connection between the tether system and balloon system allowing rotation of the balloon independent from the tether cable.
h) Ascent/descent system is the part of the tether system raising and lowering the balloon.
i) The maximum lift is the sum of maximum static lift from the lifting gas volume and the maximum dynamic lift, at sea level in International Standard Atmosphere conditions.
j) The maximum dynamic lift is the highest lift force at the chosen maximum operating wind condition at sea level in International Standard Atmosphere conditions.
k) The operator(s) of a tethered gas balloon is/are the person(s) that control(s) the tethered gas balloon from the ground, gondola or both.

II. BOOK 1 SUBPART B - FLIGHT

CS 31TGB.12 Proof of compliance

Each requirement of this Subpart is met at each mass and lift combination within the operating conditions for which certification is requested. This is 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 and lift combination if compliance cannot be reasonably inferred from the masses investigated.

CS 31TGB.14 Mass limits (See AMC1 31TGB.14)

The range of masses over which the balloon may be safely operated is 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-31TGB is shown. The maximum mass is established so that it is not more than the least of:
(1) The maximum mass selected for the product; or
(2) The design maximum mass, which is the highest mass at which each structural loading condition is shown.

(b) Minimum mass:
The minimum mass is the lowest mass at which compliance with the structural loading requirement is shown for the tether system.

(c) Mass limitation information related to safe operation of the balloon are included in the Flight Manual. (See CS31 TGB.81(b)(2))

CS 31TGB.20 Controllability

(a) The balloon is safely controllable and maneuverable without requiring exceptional piloting skill. Associated operational limitations are established and included in the Flight Manual.
(See CS31TGB.81 (b) (2))

(b) The controllability of the balloon or other mitigations are provided to give each occupant reasonable chance of escaping serious injury in the following emergency conditions.
(See AMC1 31TGB.20 (b)):
(1) Potential or unintended free flight.
(2) Terminating operation in wind conditions exceeding the operating limits by 50 %.
(3) Tether system failure that prevents descent from the maximum operating height or any other height if considered more critical.

III. BOOK 1 SUBPART C - STRUCTURE

CS 31TGB.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 CS31TGB.23; and

(b) Ultimate loads that are limit loads multiplied by factors of safety defined in CS31TGB.25.

CS 31TGB.22 In Service load cases (See AMC1 31TGB.22)

The strength requirements include consideration of the applicable service load cases such as:

- Inflation;
- Flight;
- Mooring.

The loads are determined and the parts and components under particular stress designed in accordance with their designated use and dimensioned such as not to fail under recurrent loads.

CS 31TGB.23 Load factors

(a) Flight load factor. In determining limit load, the flight load factor is at least 1.4, except for (b).

(b) Ascent load factor. In determining limit load on the tether system, the ascent load factor appropriate for the type of operation is established and applied to the static load cases on the tether system.
(See AMC1 31TGB.23 (b))

(c) Gust load factor. In determining limit load, the gust load factor is established for the effect of gusts as defined in the operating limitations.
(See AMC1 31TGB.23 (c))

CS 31TGB.25 Factors of safety

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

	Safety factor
Envelope	5.00
Suspension and tethering components (fibrous and non-metallic)	3.50
Suspension and tethering components (metallic)	2.50
Other	1.50

(b) Regardless of the materials used, the load-bearing components of the suspension and tethering system is designed so that failure of any single component will not jeopardise safety of flight, and that total failure is extremely remote. Account is taken of any reasonably foreseeable dynamic or asymmetric loading affects associated with the initial element's failure. (See AMC1 CS 31TGB.25(b))

Comment [SC1]: CS to be deleted
EASA: Accepted

(c) Where no provision is made for duplication in the suspension or tether system, the factor of safety is to be multiplied by a factor of 1.5.

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

CS 31TGB.27 Strength and proof of strength

(a) The structure is able to support limit loads without permanent deformation or other detrimental effects.

(b) The structure is 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 are tested.
(See AMC1 31TGB.27 (c))

(d) Load tests for the envelope can be performed on portions of the envelope provided the dimensions of these portions are sufficiently large to include critical construction and design details such as transitions between different materials, load attachment points, seams, etc.

(e) The gondola is of a generally robust design and provides the occupants adequate protection during a hard landing.

(f) The design and strength of components also considers the effects of recurrent and other loads experienced during transportation, ground handling, and mooring.
(See AMC1 31TGB.27 (f))

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

IV. BOOK 1 SUBPART D - DESIGN & CONSTRUCTION

CS 31TGB.31 General

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

CS 31TGB.33 Materials

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

(a) Are 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 AMC1 31TGB.33 (b))

CS 31TGB.35 Fabrication methods

The method of fabrication used is producing a consistently sound structure. If a fabrication process requires close control to reach this objective, the process is performed in accordance with an approved process specification.

CS 31TGB.36 Stress concentrations

The structure is designed to avoid, as far as practicable, points of stress concentration and variable stresses above the fatigue limit likely to occur in normal operation.

CS 31TGB.37 Fasteners

(a) Fasteners (e.g. bolts, pins, screws, karabiners) used in the structure conform to approved specifications.
(See AMC1 31TGB.37 (a))

(b) Locking methods are established and documented.

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

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

CS 31TGB.39 Protection of parts (See AMC1 31TGB.39)

Parts, the failure of which could adversely affect safety, are 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 31TGB.41 Inspection provisions

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

CS 31TGB.43 Balloon system controls

(a) Each control operates easily, smoothly, and positively enough to allow proper performance of its functions. Controls are arranged and identified to prevent confusions and subsequent inadvertent operations.

(b) Each control system and operating device is 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 have design features or are distinctly and permanently marked to minimize the possibility of incorrect assembly that could result in failure of the control system.

(c) Control cords

(1) General

(i) All control cords used for flight control are designed and installed to preclude entanglement and inadvertent operation.

(ii) The maximum force required for their operating does not exceed 340 N.

(iii) All control cords used for flight control are long enough to allow an increase of at least 10 % in the vertical dimension of the envelope.

(iv) Arming cords. If an arming device is employed to prevent inadvertent operation of an irreversible control, the part of the device to be handled by the operator is coloured with yellow and black bands.

(2) Venting cords

(i) 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 operator is coloured with red and white bands.

(ii) If a further cord is required to re-seal any vent, the part of the cord handled by the operator is coloured white.

(3) Rapid or emergency deflation cords.

(i) 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 operator is coloured red.

(ii) In addition to subparagraph CS 31TGB.43(c)(1)(ii) the force required to operate the emergency deflation cord is not less than 110 N.

CS 31TGB.45 Protection of envelope against tearing (See AMC1 31TGB.45)

The design of the envelope is such that, while supporting limit load, local damage will not grow to an extent that results in uncontrolled landing.

CS 31TGB.47 Precautions against loss of lifting gas

The envelope is designed to exclude the possibility of loss of lifting gas likely to adversely affect safe operation taking into account wind pressure, temperature and fluctuations in air pressure over the permissible operating range.

CS 31TGB.49 Limiting the operating pressure

The balloon is equipped with an automatic and/or manual lifting gas release device. The response pressure of an automatic pressure release device is established. The quantity of gas to be released by the pressure release device is large enough to prevent a further increase in pressure. Opening of a pressure relief device is unambiguously indicated to the operator.
(See AMC1 31TGB.49)

CS 31TGB.51 Rapid deflation means (See AMC1 31TGB.51)

The envelope has a means allowing rapid deflation of the balloon.

CS 31TGB.53 Tether system

(a) The suitability, durability, and reliability of the tether system is established for all phases of operating.
(See AMC1 31TGB.53 (a))

(b) In operation and mooring the balloon is securely and reliably anchored to the ground.

(c) Precautions are to be taken to prevent the balloon from breaking away when moored to the ground due to the effect of wind exceeding the maximum wind speed stated in the Flight Manual.

CS 31TGB.59 Gondola (See AMC1 31TGB.59)

(a) The gondola may not rotate independently of the envelope unless safe operation is assured.

(b) Each projecting object in the gondola, that could cause injury to the occupants, is padded.

(c) A holding grip is provided for each occupant.
(See AMC1 31TGB.59 (c))

(d) Reasonable space is provided for all occupants, with regard to both comfort during the flight and to safety during the landing.
(See AMC1 31TGB.59 (d))

(e) Occupants and items in the gondola are protected from falling from the gondola.

(f) The gondola occupant securing devices (e.g. doors or harnesses) comply with the following requirements:
  (1) The device is closed and locked during flight against unintentional opening by persons or as the result of a mechanical failure.
  (2) The device can be opened by occupants and operators.
  (3) Operation of the device shall be simple and obvious.
  (4) The device has a visual indication that it is properly closed and locked.

CS 31TGB.65 Night lighting

(a) If the balloon is operated at night, illumination of controls, equipment and essential information is provided for the safe operation of the balloon.
(See AMC1 31HB/GB.65 (a))

(b) An Anti-Collision light system is installed which complies with the following:
  (1) The Anti-Collision light consists of one or more flashing red (or flashing white) light(s) with an effective flash frequency of at least 40, but not more than 150, cycles per minute.
  (2) The Anti-Collision light provides 360° horizontal coverage and at least 60° vertical coverage above and below the horizontal plane.
  (3) The Anti-Collision light is located between the top of the envelope and bottom of the gondola.
  (4) The Anti-Collision light is at least visible from a distance of 3.7 km (2 NM) at night under clear atmospheric conditions.
  (5) The Anti-Collision light system can be switched on/off during flight.

(c) The night lighting will not impair the operators' vision or performance during operation.
(See AMC1 31TGB.65(c))

CS 31TGB.67 On-board power units (See AMC1 31TGB.67)

If an on-board power unit is used to provide electrical power during operation, the system is designed and installed so as not to create a fire hazard.

CS 31TGB.68 Master switch arrangement

(a) There is a master switch arrangement to allow ready disconnection of electric power sources from the main bus.

Comment [SC2]: Must be AMC1 31TGB65(a)
EASA: Accepted

Comment [SC3]: Impossible above because this will:
-installation on the envelope might damage the tissue (friction)
EASA: *Do we already have examples that this is applied?*
- Interfere with night sight of operator (see (c)).
EASA: *The position of the Anti-Collision light should be such that (c) is also complied with.*
- Can location be on nose end and rear end of balloon?
EASA: *A location on the nose and rear end is acceptable with respect to (b)(3) but also other provisions like (b)(2) need to be complied with. See also new introduced AMC1 31TGB.65(b)*

Comment [SC4]: One master switch or circuit breakers?
EASA: Both are acceptable provided that the other requirements are met. This addresses the switching arrangement.

(b) The point of disconnection is adjacent to the sources controlled by the switch.
(c) The master switch or its controls is installed so that the switch is easily discernible and accessible to the operator or occupant.

CS 31TGB.69 Electric cables and equipment

(a) Each electric connecting cable has adequate capacity and is correctly routed, attached and connected so as to minimise the probability of short circuits and fire hazards.

(b) Overload protection is provided for each electrical equipment. No protective device protects more than one circuit essential to flight safety.

(c) Unless each cable installation from the battery to a circuit protective device or master switch, whichever is closer to the battery, is of such power carrying capacity that no hazardous damage will occur in the event of a short circuit, this length of cable is protected or routed in relation to parts of the balloon's structure that the risk of short circuit is minimised. (See AMC1 31TGB.69(c))

Comment [SC5]: Referring to airworthiness regulations as used on aircrafts
EASA: Please clarify the comment

Comment [SC6]: See CS31TGB.68
EASA: The switching element that is the closest to the battery can be either one or the other. In some arrangements both are in the system.

V. BOOK 1 SUBPART F -SYSTEMS & EQUIPMENT

CS 31TGB.71 Function and installation

(a) Equipment is:
  (1) Of a kind and design appropriate to its intended function;
  (2) Labelled as to its identification, function, or operating limitations, or any applicable combination of these factors; and
  (3) Installed according to limitations specified for that equipment.

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

(c) The following instruments are installed if required to monitor the operating limitations.
(See AMC1 31TGB.71(c)):
  (1) An envelope pressure gauge which displays the limits of permissible internal pressure. The operator is warned by an unambiguous signal if the limit of airborne operating pressure is exceeded.
  (2) A temperature measuring device mounted at the most appropriate point of the envelope.
  (3) A wind velocity measuring device mounted at the most appropriate point of the envelope.
  (4) A load cell at the most appropriate place in order to monitor the tensile force in the tether cable in service.
  (5) Device(s) to provide the operational or design limitations information to the operator.

(d) Systems and equipment that need to function properly for safe operation are identified in the operational instructions.
(See AMC1 31TGB.71 (d))

Comment [SC7]: On Belgian PTB this is covered by the METEO Service in the Tower near the DZ.
EASA: Unless this would be at the operating height of the balloon this would not provide the same operating information.

CS 31TGB.73 Instrument marking

The following applies to all monitoring instruments:

(a) If the cover glass of the instrument is marked and adequate measures are taken to ensure that the cover glass remains in its correct position relative to the graduated dial.

(b) All markings are sufficiently wide and applied to ensure that they are easily and clearly readable by the operator.

(c) The ranges for analogue indicators are identified as follows:
  (1) Normal operating range – green;
  (2) Caution area – yellow; and
  (3) Permissible maximum or minimum value - red radial line.

(d) For digital indicators, the limits of use are displayed close to the indicator or a red signal is showing when the permissible limits are exceeded.

CS 31TGB.75 Warning, caution, and advisory lights

If warning, caution or advisory lights are installed, these are:

(a) red, for warning lights
(Lights that indicate a hazard that demands immediate corrective action);

(b) yellow, for caution lights
(Lights that indicate the possible need for subsequent corrective action);

(c) green, for safe operation lights; and

(d) of any other colour, including white, for lights not described in paragraphs (a) through (c) of this paragraph, provided the colour differs sufficiently from the colours prescribed in paragraphs (a) through (c) to avoid possible confusion; and
(e) Visible under all likely lighting conditions.

VI. BOOK 1 SUBPART G - OPERATING LIMITS & DETAILS

CS 31TGB.81 Flight manual (See AMC1 31TGB.81)

(a) Operating instructions are provided in a Flight Manual with each balloon.
(b) The Flight Manual contains:
  (1) a description of the balloon and its technical equipment with explanatory sketches;
  (2) Operating limitations, normal procedures (including mooring, inflation, deflation and tethered flight), 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 AMC1 31TGB.81 (b) (2));
  (3) specification of the permissible lifting gas;
  (4) information for ground handling, transport and storage; and
  (5) Site preparation instructions and installation information required for safe operation.
(c) The operating limitations, normal and emergency procedures, and other relevant information specific to the balloon's operating characteristics and necessary for safe operation are provided to the operator. (See AMC1 31TGB.81(c))

CS 31TGB.82 Instructions for continued airworthiness

A Maintenance Manual and a Maintenance Schedule, against which the balloon must be inspected and maintained in a serviceable condition, are provided with each balloon.
(See AMC1 31TGB.82)

(a) The instructions for Continued Airworthiness include information essential to the Continued Airworthiness of all parts and appliances of the balloon as required by CS31TGB.
(b) The instructions for Continued Airworthiness are in the form of a manual or manuals as appropriate for the quantity of data provided.
(c) The format of the manual or manuals is provided in a practical arrangement.
(d) The instructions for Continued Airworthiness 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 is inspected and maintained;
  (6) maintenance and inspection instructions;
  (7) repair instructions;
  (8) troubleshooting information; and
  (9) Airworthiness limitations that set forth each mandatory replacement time, inspection interval and related inspection procedure. This section of the manual requires approval.

CS 31TGB.83 Operator training and training information (See AMC1 31TGB.83)

For a safe operation of the balloon, a training manual for operators is made available that contains as a minimum the following:

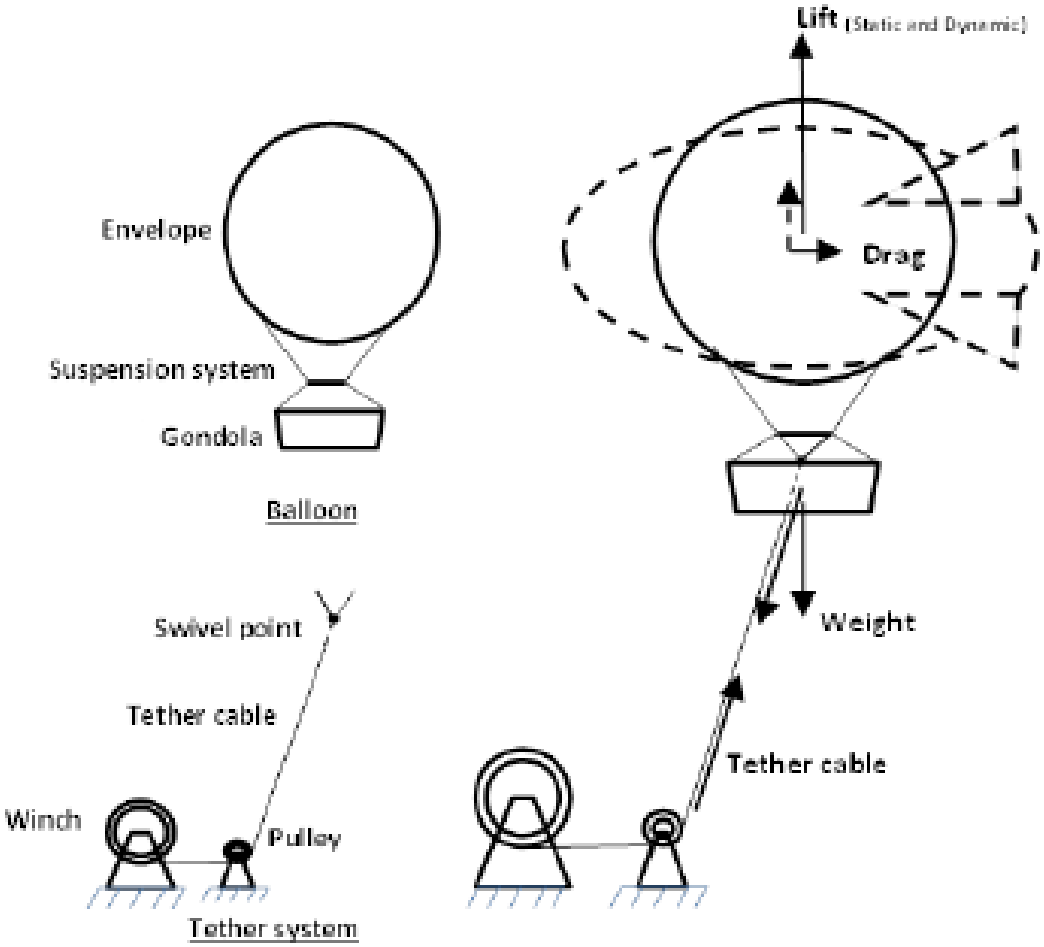
(a) Operating instructions and information as required by CS31TGB.81;
(b) Minimum operator qualifications;
(c) Minimum training requirements, both theoretical and practical as appropriate;
(d) A method to show proof of successfully completing the training; and
(e) Recommended training requirements.

VII. BOOK 2 SUBPART A - GENERAL

AMC1 31TGB.2 Definitions

The illustration below shows a typical example of the various systems, parts and forces of the tethered gas balloon in order to distinct their function as provided in the definitions.

Note: Lift*Dynamic is disregarded for load cases of spherical envelope shapes.



VIII. BOOK 2 SUBPART B - FLIGHT

AMC1 31TGB.14 Mass limits

(a) Maximum mass

The maximum mass results in a weight force that is equal or lower to the maximum static lift force. The lift-producing medium is not part of the maximum mass.

For each structural loading case the maximum mass is established. The maximum mass consists of the balloon and the length of the tether cable, which weight force acts upon the balloon in the specific load case.

The maximum design mass of the product is the least of the maximum masses established for the load cases or a lower maximum mass if so selected by the applicant.

(b) Minimum mass

The minimum mass is the mass that results in the highest loading in the tether system under the following conditions for which compliance to the structural requirements is shown:

- Maximum deceleration during ascent
- Maximum static lift
- Maximal permissible wind speed of operation

Since the mass increases with the extension of the tether cable, the critical case for the minimum mass is reached at the beginning of the ascent.

Mass limitations and information, e.g. pay load are established from the maximum and minimum masses and provided in the Flight Manual.

AMC1 31TGB.20 (b) Controllability

It is established by analysis that the hazards from the specified emergency conditions are mitigated by design or procedures. Failure modes that can result in an unintended free flight of the balloon with occupants are included in this analysis.

A suitable device (e.g. electronic altitude pressure switch combined with an ascent velocity detector) ensuring that the envelope does not burst and a lifting gas valve is operated such that a descent occurs in a manageable manner is regarded as acceptable.

A suitable procedure describes all necessary measures to be taken for the recovery.

If procedures for these emergency conditions are not covered by the normal operating procedures they are included in the Flight Manual.

Comment [SC8]: Installed in WINCH : Is that OK
EASA: The device intended here is a device that controls the envelope pressure in case of an unintended free flight.

IX. BOOK 2 SUBPART C — STRUCTURE

AMC1 31TGB.22 In-Service load cases

(a) Inflation/mooring
The 'inflation and mooring cases' referred to in this requirement cover assembly, disassembly, inflation, deflation and mooring load cases. Mooring load cases cover both low and high mooring, if applicable. When the balloon is moored in the parking position (low mooring) the maximum gas pressure in the envelope is normally identical to the 'maximum gas pressure' established for any of the flight conditions. If the low mooring operation, however, allows for a precautionary increased pressure of the gas in the envelope this load case is also considered.

(b) Flight
Flight load cases cover the operation within the established limitations (temperature, wind speed, mass, and ascent/descent speed limitations). A dynamic lift component is considered in the load cases for the sudden deceleration of the ascent/descent unit and when the envelope shape is not spherical and generates lift in wind conditions. When a dynamic lift component is applicable, gust loads are considered as well as potential oscillation behaviour of the balloon and the tether caused by airflow and from variations in the lift component and its centre of pressure.

AMC1 31TGB.23 (b) Ascent load factors

The ascent load factor is applied to the static tether system load to cover dynamic loads to the tether system resulting from decelerations during the ascent. The maximum deceleration typically occurs when an emergency stop is made during maximum ascent speed. The highest loads are typically experienced when this occurs at maximum static lift and minimum balloon weight and minimum deceleration travel. Minimum balloon weight and minimum deceleration travel coincide at low tether cable length when the mass of the tether cable is the lowest and the elongation or slack of the tether cable are the lowest.
For an ascent speed below 1 m/sec, an ascent load factor of 2 is acceptable.

AMC1 31TGB.23(c) Gust load factor

A gust load factor is applicable to balloons that due to the shape of the envelope generate aerodynamic lift forces in gust conditions. The gust load for spherical balloons is, therefore, 1 and is considered to have no influence on the loads.

Comment [SC9]: What is that factor? Based on tables? Based on wind reports? Factor for helium tethered balloon?
EASA: The gust load factor needs to be determined by the applicant but is 1 when the shape of the envelope does not create aerodynamic lift.

AMC1 31TGB.25 (b) Factors of safety

The dynamic loads on a balloon system are difficult to evaluate because metal or textile parts behave quite different.
In absence of a more suitable method or as replacement of a load test, the failure of the load bearing component shall be shown by the following method:
Multiply the limit load in the failing load path by two and distribute it as a static load among the remaining load paths.
For conventional designs, this is an appropriate method which is based on good service experience.

AMC1 31TGB.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 CS31TGB.45 for specific tear propagation requirements.

AMC1 31TGB.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.

X. BOOK 2 SUBPART D - DESIGN & CONSTRUCTION

AMC1 31TGB.33 (b) Materials

Approved specifications here are taken as being those produced by the applicant or those meeting internationally recognised standards as defined applicable in the type design data. Material specifications are 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 are 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, are taken into account.

AMC1 31TGB.35 Fabrication methods

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

AMC1 31TGB.37 (a) Fasteners

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

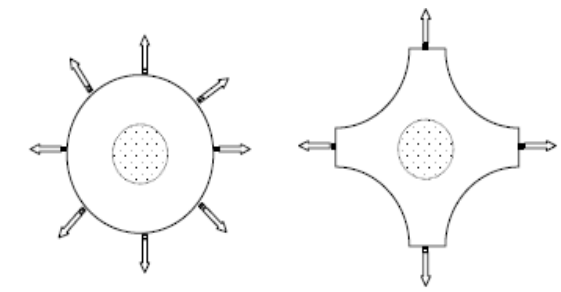
Comment [SC10]: AMC1
EASA: Accepted

AMC1 31TGB.39 Protection of parts

Suspension system cables and components manufactured from stainless steels (corrosion resistant steels) are considered compliant with this requirement.
To ensure the protection of parts, it is permissible to rely on recommended inspections (details in the Maintenance Manual).
In cases where deterioration or loss of strength is unavoidable during the life of the product, details of appropriate mandatory replacement lives or in-service testing are provided in the maintenance programme (CS31TGB.82).

AMC1 31TGB.45 Protection of envelope against tearing

The resistance of envelope fabric to damage propagation is determined by test.
It is shown by test that a crosswise slit of at least 5 cm in the most unfavourable direction to the envelope fabric at the maximum tension experienced in service does not propagate. Test results from tests on similar fabric at the equal or higher tension and damage equal or larger than 5 cm are considered compliant.



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

A typical test set-up is provided below.

If the balloon is equipped with a net to distribute and reduce the loads in the envelope, the net is regarded as a tear-prevention device.

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C

AMC1 31TGB.49 Limiting of operating pressure

The envelope pressure is limited to prevent the envelope from bursting. However, the definition of the envelope's maximum operating pressure depends on the design of the tethered gas balloon system. For inflated balloon systems the operating conditions are not limited to flight but also include the parking conditions if the balloon system stays inflated for a prolonged period between the flight operations. Thus, different cases need to be considered:

(a) Balloon systems staying inflated above maximum wind speed for flight operation
These balloon systems ensure envelope tautness by a ballonet or other means of feeding/discharging gas into the envelope when moored on the ground in parking position to withstand the dynamic pressure of considerably high wind speeds. Here the maximum operating pressure is the maximum pressure established by the designer for high wind speeds whilst moored in parking condition to the ground. Under this condition, the safety factors less the ascent factor in CS31TGB.23 (b) should be fully maintained. The response pressure of the automatic lifting gas release valve usually is higher than the maximum operating pressure to prevent the envelope from getting pumped out below dynamic pressure of the wind by unexpected gusts. A factor of not less than 1·4 times the maximum operating pressure during mooring has been shown by practical experience to be applicable.

(b) Balloon systems other than described in (1)
These balloon systems are usually smaller and ensure envelope tautness by means other than described under (1), i.e. by flexible parts in the envelope. They are designed for maximum wind speed during flight operation and will normally be deflated during high wind speed weather conditions. Here the maximum operating pressure is the pressure for flight operation established by the designer. The response pressure of the automatic lifting gas release device is not less than 1·15 times the maximum operating pressure.
For clarification, it should be noted that in a strict sense the automatic pressure release device can only prevent the further rise of pressure for the very moment. After release the device should close again in order to minimise the loss of lifting gas. If after a while the pressure increases again for any reason, the device will also open again. This behaviour is intended and does not impair safety.

Comment [SC11]: (a)
EASA: Accepted

Comment [SC12]: (a)
EASA: Accepted

AMC1 31TGB.51 Rapid deflation means

Rapid deflation means are used to deflate the envelope in cases like e.g. when:

- Wind speeds increase above the wind speed limitations for low mooring;
- Required during inflation before attachment of the tether cable; or
- Included in emergency procedures for unintended free flight.

AMC1 31TGB.53 (a) Tether system

The suitability, durability, and reliability of the tether system, including the tether control systems, are determined by a Failure Mode Effect Analyses (FMEA) covering all phases of operation.
For components of the tether system (i.e. the winch) compliance with the requirement of CS31TGB.53 (a) can be shown by a certificate from an expert body provided that:

(a) this certificate specifies the conditions for safe operation of the winch that cover the conditions for safe operation of the balloon;

(b) the winch system is capable of safely fulfilling the task of a tethered gas balloon winch;

(c) compliance with the Machinery Directive 2006/42/EC (or equivalent (US) requirements) is the basis for the tethered gas balloon winch system;

(d) Modifications to the winch design do not invalidate the applicable requirements from the certificate that remain applicable after the modification.
Note: The overload protection of industrial winches is not applicable in the TGB application because overload cannot occur in a TGB application;

(e) The expert body is an EC-notified organization which has a certified structure and a proven capability and experience. 'Certified' means an approval by the government which requires an organizational structure and entails extended liability. 'Proven capability' means successfully managed projects that are reasonably comparable to the balloon winch case. Usually these are cranes, elevators or similar winch technology;

(f) The final report complies with the Annex II of the Machinery Directive 2006/42/EC (or equivalent (US) requirement); and

(g) There is an alternative retrieve system which is able to cover a major winch failure.

AMC1 31TGB.59 Gondola

The requirements for a gondola carrying multiple free-standing persons are complied with when the applicable requirements for the 'carrier' provided in the Machinery Directive 2006/42/EC are met.

AMC1 31TGB.59 (c) Gondola

A holding grip provides an obvious means for the occupants of the gondola to stabilise themselves during flight. The location or design of occupant securing devices (refer to CS 31TGB.59 (f)(1)) is such that they do not invite occupants to use them as holding grip.

AMC 131TGB.59 (d) Gondola

For gondola providing standing space for the occupant, a minimum plan area of 0.3 m² is provided for each occupant.

Comment [SC13]: Must be AMC1 31TGB.59
EASA: Accepted

Comment [SC14]: Light equipped? Without parachute ? area for passenger with equipment?
EASA: This is the minimum space for civil use without parachute.

AMC1 31TGB.65 (a) Night lighting

A means to provide illumination of the instruments, equipment and controls that are essential for the safe operation of the balloon may be instrument lighting, local lighting or any independent portable (non-handheld) light of sufficient capacity.
It is acceptable that lights can be switch on and off provided that the operator, without undue burden or ambiguity, can switch on the lighting in night conditions.

AMC1 31TGB.65 (c) Night lighting

The light from the Anti-Collision light does not directly shine on the operator and passengers and does not create a reflection on the balloon or flare that disturbs the operators' performance.
Lighting level of controls, equipment and instruments are compatible with the crew night vision. This prevents untimely fatigue of the eyesight due to frequent adaptation when looking from bright light into dark night and vice versa.

AMC1 31TGB.67 On-board power units

For this AMC, it is assumed that only power units are used which conform to the state-of-the-art industrial standard. The safe operation of the balloon is not directly dependent on the proper function of the power unit. For all other designs, the Agency is consulted for more detailed requirements.
Power units of industrial standard used on-board of the balloon in addition comply with the following:

(a) General

The power unit is designed and installed so that under all normal operating conditions and reasonably foreseeable in service emergency situations, it does not endanger the aircraft, its occupants, or third parties.

(b) Ventilation

The occupants are accommodated in adequately ventilated areas where:

(1) The carbon monoxide partial pressure does not exceed 1/20,000; and
(2) Fuel vapour is not present in harmful concentrations.

(c) Fire extinguishers

(1) Unless the power unit has a fire extinguishing system by itself, there is at least one manual fire extinguisher within reach of an occupant.
(2) The following applies to manual fire extinguishers. The type and quantity of the fire extinguishing substance is appropriate to the fire extinguisher's application area. Fire extinguishers:
(i) Conform to EN3 or an equivalent specification acceptable to the Agency;
(ii) Have a minimum capacity of 2 kg when using dry powder, unless the capacity is otherwise determined by the applicant; and
(iii) Be at least of comparable effect when the extinguishing means is other than 'dry powder'.
(3) Fire extinguishers in compartments intended for persons are designed to minimise the risk of toxicity caused by use of the fire extinguishing substance

(d) Gondola

The following applies to the gondola when an on-board power unit is carried:

(1) The material used is at least fire retardant.
(2) Pipes, tanks or equipment that carries fuel, oil or flammable liquids are not to be placed in the gondola unless they are reasonably shielded, insulated, or otherwise protected so that fracture or failure of such parts causes no danger.

(e) Electrical earth connection

(1) In order to prevent the occurrence of potential differences between components of the power unit and other electrically conductive parts of the balloon which cannot be ignored on account of their mass, such conductive parts are conductively interconnected.
(2) The cross-sectional area of bonding connectors, if made from copper, is not less than 1.33 mm^2.

(f) Fire protection for control system and structure

Control systems, suspension units or other structures in the power unit compartment which are added to the design by the applicant are made of fireproof material or shielded to withstand the effect of a fire.

(g) Fire protection

(1) The power unit is adequately separated from the balloon's structure by fireproof bulkheads or ventilated bays.
(2) Areas in which combustible liquids can accumulate as a result of a leaking tank have an adequate drain pipe. Collected leaking liquids cannot reach other locations in and under the craft which pose a potential risk of fire.
(3) Precautionary measures are to be taken to reduce as far as possible the risk of fire as a result of a hard landing of the gondola.

(h) Power unit installation
(1) Each power unit is supported so that the loads resulting from the weight of the unit are not concentrated.
(2) There are pads, if necessary, to prevent chafing between each unit and its supports.
(3) Materials employed for supporting the unit or padding the supporting members are non-absorbent or treated to prevent the absorption of fuel.
(4) Each installation is ventilated and drained to prevent accumulation of flammable fluids and vapours.

(i) Fuel tank expansion space
(1) Each external fuel tank added to the design by the applicant has an expansion space of sufficient capacity, but of not less than 2 % of the tank capacity, to prevent spillage of fuel onto the surfaces of the power unit and the balloon's structure due to thermal expansion or manoeuvre unless the design of the venting system precludes such spillage.
(2) It is not possible to fill the expansion space inadvertently with the power unit in any normal ground attitude.

(j) Exhaust system, general
(1) The exhaust system ensures safe disposal of exhaust gases without fire hazard or carbon monoxide contamination in any personnel compartment.
(2) Each exhaust system part with a surface hot enough to ignite flammable fluids or vapours is located or shielded so that leakage from any system carrying flammable fluids or vapours will not result in a fire caused by impingement of the fluids or vapours on any part of the exhaust system, including shields for the exhaust system.
(3) All parts of the exhaust system are located sufficiently far from or separated from adjacent parts of the balloon's structure by fireproof shielding.
(4) No exhaust gases will discharge dangerously near any oil or fuel system drain.
(5) Each exhaust system component added to the design by the applicant is ventilated to prevent points of excessively high temperature.

(k) Firewalls
(1) The power unit is isolated from the rest of the balloons structure by a firewall, shroud, or equivalent means.
(2) The firewall or shroud is constructed so that no hazardous quantity of liquid, gas or flame can pass from the power unit compartment to other parts of the balloon.
(3) The firewall and shroud is fireproof and protected against corrosion or deterioration. The following materials are accepted as fireproof, when used in firewalls or shrouds, without being tested:
(i) Stainless steel sheet, 0.38 mm thick;
(ii) Mild steel sheet (coated with aluminium or otherwise protected against corrosion) 0.5 mm thick;
(iii) Steel or copper base alloy firewall fittings.
(4) Other materials such as fire protection paint and/or putty are only used if they conform to the FAA Advisory Circular No. 20-135 or equivalent accepted specifications.

Comment [SC15]: I don't think this is foreseen on tethered balloon (see CS 31 TGB.1)
EASA: This is related to on-board power unit (Generators).

Comment [SC16]: I don't think this is foreseen with tethered gas balloon (see CS 31 TGB.1)
EASA: This is related to on-board power unit (Generators).

Comment [SC17]: I don't think there is a form of combustion on tethered balloon (see CS 31 TGB.1)
EASA: This is related to on-board power unit (Generators).

AMC1 31TGB.69 (c) Electric cables and equipment

This is normally achieved by limiting unprotected battery to master switch cables, of an adequate capacity, to a maximum length of 0.5 m.
In any event the capacities of protected cables are such that no hazardous damage will occur to the balloon and its occupants, nor its effects to the occupants from the generation of noxious fumes, due to electrical overloading of cables before a circuit protective device will operate.

Comment [SC18]: Does dis refers to 31TGB69 (a) en (b)?
EASA: This AMC addresses the protection of the cable length between the battery and the master switch or circuit breaker from CS 31TGB.69(c). The AMC text is changed to clarify this.

XI. BOOK 2 SUBPART F - SYSTEMS & EQUIPMENT

AMC1 31TGB.71 (c) Function and installation

An instrument, in the classical sense, houses the sensor and the indicator (e.g. altimeter). However, it should be noted that for tethered gas balloons the sensor and the indicating display may be mounted far away from each other (e.g. sensor on the top; display in the gondola or at the winch). Hence, the word 'instrument' may not necessarily mean an integrated system.

The 'most appropriate place' for the instruments required by subparagraph (c) (2) and (c) (3) shall be established in view of accuracy for measuring the values.

Comment [SC19]: AMC1 31TGB.71?
EASA: This is a reference to CS 31TGB.71. The AMC has been changed to clarify this.

AMC1 31TGB.71 (d) Function and installation

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

When ATC equipment is installed, it is shown that the electrical system is such that the operation of this equipment is not adversely affected.

The operating instructions provide information regarding systems and equipment essential for safe operation. Restrictions or mitigating actions for inoperative systems or equipment are included in the operating instructions to support continued safe operation if applicable.

XII. BOOK 2 SUBPART G - OPERATING LIMITS & DETAILS

AMC1 31TGB.81 (b)(5) Flight Manual

Site preparation and installation information

(a) The site preparation instructions include:
  (1) the magnitudes and x-, y- and z-directions of each load carrying interface between the tether system and the ground;
  (2) dimensions and categories of safety areas on the ground and in the air;
  (3) the ground condition and its permitted maximum mean slope;
  (4) any additional safety area required by the emergency descent procedure, if applicable.

(b) The installation information includes:
  (1) a list of the minimum installation crew and their necessary skills;
  (2) a checklist of the necessary tools and devices for installing/de-installing; and
  (3) a checklist describing the necessary sequential steps for installation/de-installation. The list highlights the safety critical phases including precautions and mitigating measures.

AMC1 31TGB.82 Instructions for continued airworthiness

Note: The paragraph numbering of this AMC relates to the paragraph numbering of CS 31TGB.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:
  (1) a description of the systems including the assembly and disassembly instructions;
  (2) 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; and
  (3) 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 where 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 needs to be included in the principal manual.

AMC1 31TGB.83 Operator training and training information

The operator training and training information contains the following aspects when applicable to the operation of the balloon:

(a) general information on the training syllabus (theoretical and practical training) and examination;
(b) description of the system in sufficient detail to understand the principles of the balloon and systems;
(c) environmental conditions and their impact on safe operation;
(d) procedures for:
  (1) mooring (high and low);
  (2) flying;
  (3) inflation and deflation; and

(4) emergency procedures;

(e) weather;

(f) maintenance; and

(g) record keeping.