European Aviation Safety Agency

3 Dec 2012

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')

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EXECUTIVE SUMMARY

This NPA introduces specific Certification Specification (CS) for Tethered Gas Balloons (TGB). The technical content has been 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. When published, this CS will create a certification standard that is publicly available and will aid designers of tethered gas balloons in meeting their legal obligations.

As the technical content is based on existing practice, it is not expected that the issuance of the new CS will create major differences for the certification of tethered gas balloons. However, by providing publicly available CSs the certification costs are expected to decrease and thus positive economic effect is expected.

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

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A. Procedural information

I. How to read this NPA

This NPA contains the following chapters:

A = Procedural information addressing the legal requirements and the consultation process
B = Explanatory note to support the draft rules
C = Regulatory Impact Assessment
D = Draft rules

Book 1 on Certification Specifications
Book 2 on Acceptable Means of Compliance

II. The rule development procedure

The European Aviation Safety Agency (hereafter referred to as the 'Agency') developed this Notice of Proposed Amendment (NPA) in line with Regulation (EC) No 216/2008 (hereafter referred to as the 'Basic Regulation') and the Rulemaking Procedure MB 01-2012 established by the EASA Management Board.

This rulemaking activity is included in the Agency's Rulemaking Programme for 2013-2016. It creates the Certification Specifications for Tethered Gas Balloons (CS-31TGB) that is part of the rulemaking task RMT.0081 (31.003/004).

The text of this NPA has been developed by the Agency, based on the input from the 31.003/004 drafting group. It is submitted for consultation of all interested parties in accordance with Article 52 of the Basic Regulation and Articles 5(3) and 6 of the Rulemaking Procedure.

III. How to comment on this NPA

1. Comments on this NPA may be submitted to the Agency within 3 months as of the date of publication.
2. Please submit your comments using the **automated Comment-Response Tool (CRT)** available at **http://hub.easa.europa.eu/crt/**.[1]
3. The deadline for submission of comments is **6 March 2013.**

IV. The next steps in the procedure

Following closure of the NPA consultation period, the Agency will review all comments and if required conduct a focussed consultation on specific remaining open issues.

The outcome of the NPA consultation as well as the focussed consultation will be reflected in a Comment-Response Document (CRD). The Agency will publish the Decision introducing CS-31TGB together with the CRD. The publication of the Decision is expected in quarter 2 of 2013.

[1] In case the use of the Comment-Response Tool is prevented by technical problems please report them to the CRT webmaster (crt@easa.europa.eu).

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B. Explanatory Note

I. Legal framework

As part of the legislative process leading to Agency establishment, the Basic Regulation requires the Commission to adopt a comprehensive framework of rules for the implementation of the essential requirements. In the field of initial airworthiness, the Implementing Rules are contained in the Commission Regulation (EC) No 748/2012, (hereinafter referred to as 'Part 21').

Pursuant to the Basic Regulation the Agency shall, where appropriate, issue Certification Specifications, Acceptable Means of Compliance, and Guidance Material for the application of the Basic Regulation and its Implementing Rules.

Certification Specifications (CS) are technical standards adopted by the Agency indicating means to show compliance with the Basic regulation and its Implementing Rules and which can be used by organisations for the purpose of certification.

II. Issue to be addressed: The need for a CS for tethered gas balloons

JAA work towards a CS-31TGB

Prior to the creation of EASA, a subgroup of the JAA (Joint Aviation Authorities) Core Group 9 (CG9) for 'Lighter-than-air aircraft requirements' had started the development of a CS for Tethered Gas Balloons.

Between 2003 and 2006, an advisory group of certification experts (BAPE (Balloon and Airships Panel of Experts)) reviewed these CG9 draft CSs in order to include the latest certification developments. In this NPA the draft CS from that review is referred to as the 'CG9/BAPE draft'.

The EASA 31.003/004 drafting group used the CG9/BAPE draft as the starting point for the development of CS-31TGB contained in this NPA. Initially, a comparison was made between the CG9/BAPE draft and the already published CS-31GB for Free Gas Balloons. This was done to achieve a consistent wording and structure between CSs, where possible, and includes lessons learned from the development of CS-31GB.

Different characteristics of tethered gas balloon and free flying gas balloons

It became clear during the drafting process that the loading and operational characteristics of a tethered gas balloon are very much different from a free flying gas balloon. For that reason, consistency with CS-31GB was only kept when appropriate and new wording was developed for the typical loading, definitions, and operations of a tethered gas balloon. Since 28 September 2003 the Agency has issued six Type Certificates for TGB using various certification requirements and Special Conditions for the certification basis.

High burden to certify TGBs with SCs

The issuance of a TC based on Special Conditions is a burden for stakeholders and the Agency when these common requirements could be defined to avoid the Special Conditions.

Who is affected

Introduction of Certification Specifications for TGB will mainly affect designers of TGB. There are three major manufacturers in EU Member States.

Safety risks

There are no safety issues in relation with the scope of the task. When the current rules are not appropriate, special conditions are developed by EASA to meet the Essential Requirements of the Basic Regulation.

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III. Objectives

The general objectives of the Basic Regulation are to establish and maintain a high uniform level of civil aviation safety in Europe while promoting cost-efficiency and level playing in the regulatory and certification processes.

The specific objective of this NPA is to create common Certification Specifications for tethered gas balloons that set an acceptable level of safety, are cost-effective, and provide a level playing field throughout Europe.

IV. Summary of proposed new CS-31TGB

In order to address the issues and achieve the objectives outlined in sections BII. and BIII. above, a new CS is proposed with the below key elements. For a justification and discussion of detailed impacts of this proposal, see section D. This proposal was analysed as 'Option 1'.

CS-31TGB — Subpart A — General

The scope of these CS is for manned tethered gas balloons. Manned tethered gas balloons are predominantly operated at moderate altitudes above the ground and for that reason, these Certification Specifications have a limited applicability and are not adequate for unmanned tethered gas balloons (e.g. aerostats) operated at far greater heights. The applicability of this CS is limited to TGB operated below 500 m because the requirements do not cover specific issues that start to play a role i.e. cable oscillation caused by wind forces. These will be addressed by Special Conditions.

The definitions for CS-31TGB include the typical components applicable for a tethered gas balloon. In order to clarify these definitions, an illustration is provided in the AMC.

CS-31TGB — Subpart B — Flight

Subpart B is different from CS-31GB for free flight because in tethered operation the lift plays a dominant role instead of the mass. Therefore, a definition is introduced for maximum lift instead of a definition for maximum mass. In a tethered gas balloon system the maximum, lift needs to be defined in order to determine the maximum loads. Different from free flight, a maximum mass would not typically result in a high loading.

Service experience has taught that it is possible that situations can develop that could result in operations outside of the normal operating envelope e.g. when the operation is terminated because wind speeds have increased beyond the limitations. For that reason, the requirement for controllability of a TGB introduces a number of specific emergency conditions for which mitigation by design or procedures needs to be established.

CS-31TGB — Subpart C — Structure

Subpart C is different from CS-31GB for free flight because the loads acting upon a TGB are fundamentally different. e.g. lift plays a dominant role in the loads in the tethered operation. It is the lift force that acts against the weight and tether cable forces. Loads due to decelerations of the winch system and wind loading because the gas balloon is tethered, result in specific TGB load scenarios. Also, the different type of operation with a far higher number of flight cycles results in typical TGB requirements.

CS-31TGB — Subpart D — Design and Construction

The Subpart D contains the generic requirements (materials, fabrication method, fasteners, protection of parts, and inspection provisions) which are technically consistent with the CS-31GB with the exception of CS 31TGB.36 Stress concentrations. This requirement is specific for TGB because of the higher number of cycles in the operation.

Consideration was given to the fitting factor, but after further review it was found sufficiently covered by the factors of safety in Subpart C and, therefore, removed from the CS.

The composition of this Subpart D has been changed considerably when compared to the Certification Specifications for gas balloons. It is organised into requirements for the balloon

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system (CS 31TGB.43 – CS 31TGB.51), tether system (CS 31TGB.53), gondola (CS 31TGB.59) and other parts and systems. Because tethered gas balloon systems often make use of industrial winches that are modified for this application, use is made of references and standards of acceptable industrial winches, as much as practically possible.

CS-31TGB — Subpart F — Systems and Equipment

The Subpart F does not introduce fundamental changes compared to currently used certification basis.

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.

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)

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C. Regulatory Impact Assessment (RIA)

This RIA analyses two options to address the issue and objectives identified in the previous chapter.

I. Options considered to address the main issue

Option 0 – Do nothing

The identified options for this subject would be to continue using the presently available Certification Specifications with special conditions as a certification basis.

Option 1 – Establish common Certification Specifications

Develop rules reflecting the present state-of-the-art and the best practices in this field (see section IV. Summary of proposed new CS-31TGB).

II. Analysis of impacts

Safety

The introduction of a Certification Specification for TGB will have no direct effect on present safety levels since it is based on existing standards used for certification up till now. It will, on the other hand, provide a better understanding and implementation due to standardised specifications, improved wording of the paragraphs, and more detailed and extended AMC material.

Environmental and social impacts

Not relevant.

Economic

Option 0

The lack of specific Certification Specifications will require the certification basis for each application to be set on an ad hoc basis. This will lead to a lack of cost-effective regulations, and lack of level playing field, and also lack of transparency.

Option 1

Administrative costs

A positive economic impact can be expected by developing an Agency CS that will become the normal means of gaining type certification in the EU. By this way, the necessity to use Special Conditions will be limited to novel or unusual design features.

Furthermore, as this proposed CS is based on the CG9/BAPE draft that is similar to the applied certification bases, and the CS was developed with involvement of the European industry, no adverse economic impact is expected.

Level playing field

The publication of new Certification Specifications will ensure full transparency for the benefit of all applicants.

Regulatory coordination and harmonisation

The proposals are based on the CG9/BAPE draft that took several European Certification bases and Special Conditions into account. The proposals in this NPA are aiming for a consistent standard and a level playing field. TGB are not regulated by FAA and there is, therefore, no harmonisation issue.

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III. Conclusion and preferred option

Based on this RIA, the CS proposed in this NPA (Option 1) is considered as having no safety, social or environmental impact. The uniform high level of safety is currently ensured by the Special Conditions process to certify TGBs. However, providing specific Certification Specifications for TGBs will lead to a better understanding and consistency across type-certification projects, and to reduced certification costs and a positive economic impact. The obligation from the Basic Regulation Article 19 justifies progression of this rulemaking task.

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D. Proposed Certification Specifications

The text of the draft CS-31TGB is arranged in the regular order of Certification Specifications; the Certification Specifications in Book 1 and Acceptable Means of Compliance (AMC) in Book 2.

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.

(h) 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.

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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 CS 31 TGB.81(b)(2))

CS 31TGB.20 Controllability

(a) The balloon is safely controllable and manoeuvrable without requiring exceptional piloting skill. Associated operational limitations are established and included in the Flight Manual. (See CS 31TGB.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 limitations 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 CS 31TGB.23; and

(b) ultimate loads that are limit loads multiplied by factors of safety defined in CS 31TGB.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; and
- 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.

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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 or 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))

(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 AND CONSTRUCTION

CS 31TGB.31 General

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

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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 methods 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 minimise 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.

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(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))

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(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.

(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

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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))

V. BOOK 1 SUBPART F — SYSTEMS AND 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))

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.

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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 AND 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 is 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 CS-31TGB.

(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;

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(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 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.

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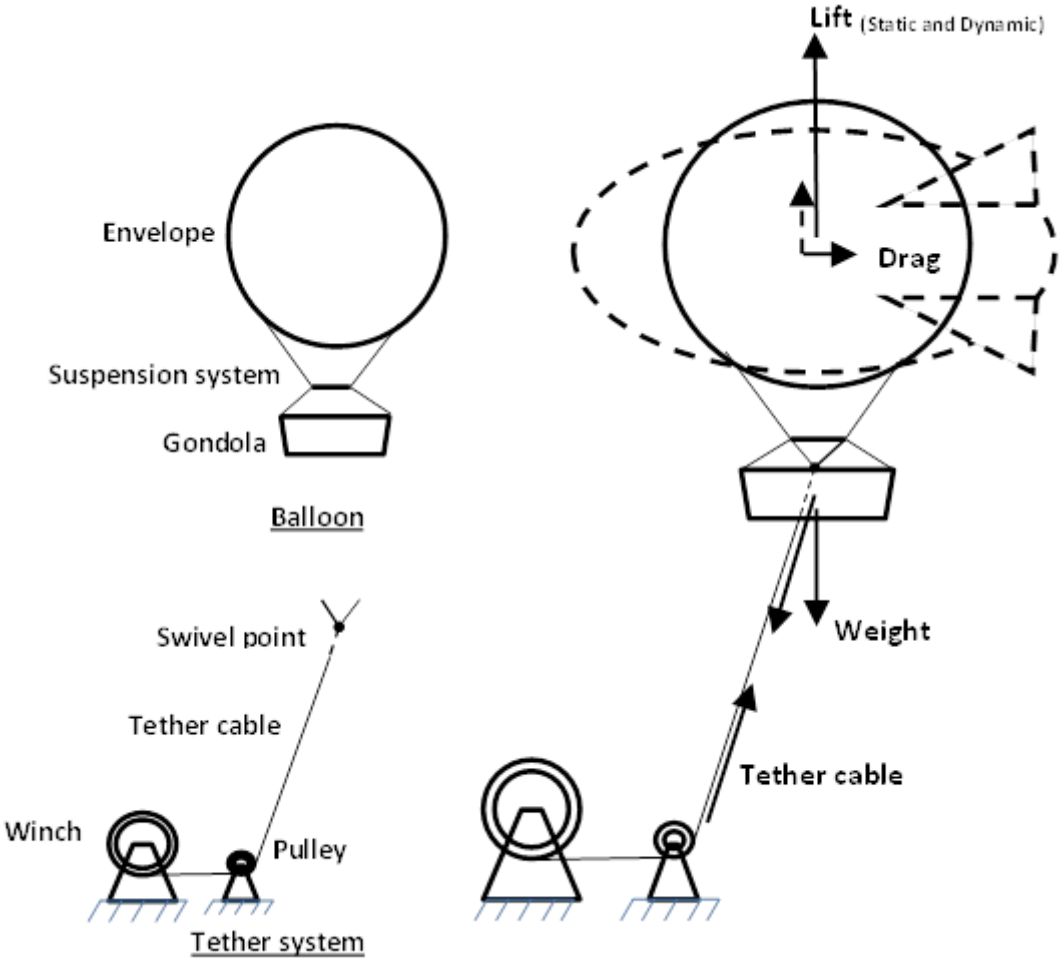
VII. BOOK 2 SUBPART A — GENERAL

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.



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VIII. BOOK 2 SUBPART B — FLIGHT

AMC1 31TGB.14 Mass limits

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.

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.

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.

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

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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.

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 CS 31TGB.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 AND 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

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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).

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).

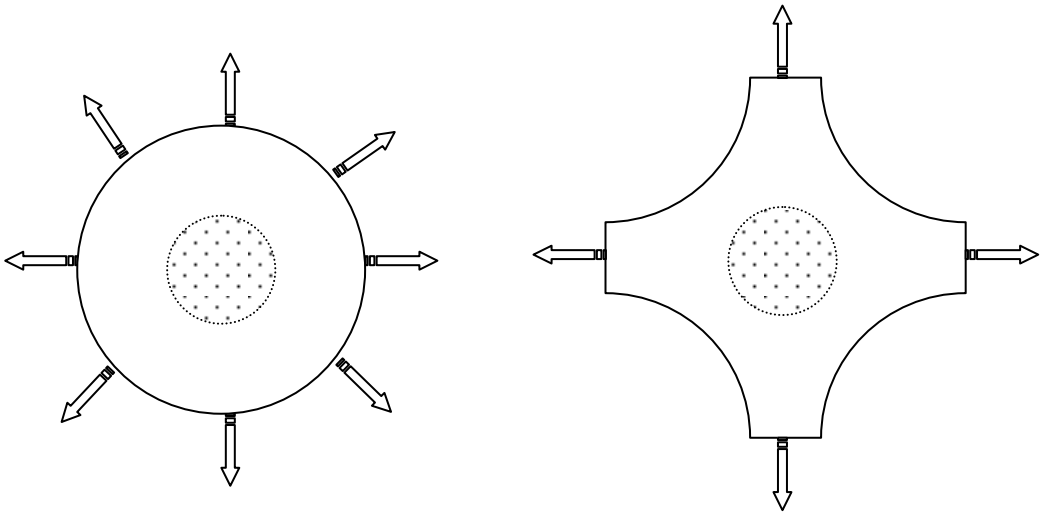
In cases where deterioration or loss of strength is unavoidable during the life of the product, details of appropriate mandatory replacement lives or in-service testing are provided in the maintenance programme (CS 31TGB.82).

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.

A typical test set-up is provided below.



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

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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.

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 CS 31TGB.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.

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, 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:

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(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 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 is 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.

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

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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.

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(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.

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(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.

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.

XI. BOOK 2 SUBPART F — SYSTEMS AND 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.

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 AND 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; and

(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.

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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;

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(e) weather;

(f) maintenance; and

(g) record keeping.

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