EASA European Union Aviation Safety Agency	**CRI Consultation paper** **Special Condition SC GAS**	Doc. No. : **SC GAS** Issue : 1 Date : 11 February 2021 Proposed ☒ Final ☐ Deadline for comments: 14 Mar 2021

SUBJECT	:	**Special Condition SC GAS Gas Airships**
REQUIREMENTS incl. Amdt.	:	**SC GAS**
ASSOCIATED IM/MoC[1]	:	Yes☐ / No ☒
ADVISORY MATERIAL	:	

INTRODUCTORY NOTE:

The following Special Condition (SC) has been classified as important and as such shall be subject to public consultation in accordance with EASA Management Board decision 12/2007 dated 11 September 2007, Article 3 (2.) which states:

"*2. Deviations from the applicable airworthiness codes, environmental protection certification specifications and/or acceptable means of compliance with Part 21, as well as important special conditions and equivalent safety findings, shall be submitted to the panel of experts and be subject to a public consultation of at least 3 weeks, except if they have been previously agreed and published in the Official Publication of the Agency. The final decision shall be published in the Official Publication of the Agency.*"

IDENTIFICATION OF ISSUE:

Refer to explanatory note below.

[1] In case of SC, the associated Interpretative Material and/or Means of Compliance may be published for awareness only and they are not subject to public consultation.

Proposed Special Condition for Gas Airships

SC GAS

Contents

Explanatory note

EASA has received applications for the type certification of large airships while ithas not published Certification Specifications (CS) for these products. Three draft CS[2] had been made available to EASA by National Aviation Authorities from work performed in 2003.The drafts are entirely based on Airworthiness Requirements which have been legally effective[3] in some EASA Member States before.

In the absence of agreed and published certification specifications for this type of products, and pursuant to points 21.B.75 and 21.B.80 of Part-21, a complete set of dedicated technical specifications in the form of a Special Condition for Gas Airships has been developed. This Special Condition addresses the unique characteristics of these products and defines airworthiness specifications that may be used to demonstrate compliance with the essential requirements in Annex II of regulation (EU) 2018/1139 of the European Parliament and Council. This is required for the issuance of the type certificate, as well as the approval of changes to the type certificate.

The proposed Special Condition is a high-level set of performance-based requirements. It was developed in close cooperation with an industry working group. The Special Condition addresses two designs, one being a 260 000 m^3 rigid equilibrium airship for cargo operations, the other a 45 000 m^3 non-rigid hybrid airship for up to 55 passengers. However, the authors believe it is applicable to all manned airships with non-pressurized crew or passenger compartments. It is subject to EASA Certification Team agreement that the Special Condition is sufficient as a Certification Basis, for example unmanned designs are not sufficiently addressed by this proposal. Due to the low number of projects no categories have been established. The different safety levels for each specific airship design will be addressed through the Means of Compliance (MOC).

Due to the differences between the two projects (rigid equilibrium airship vs. non-rigid hybrid airship), EASA intends to develop in cooperation with the applicant specific Means of Compliance for each individual project. Once Means of Compliances are agreed EASA intends to make them available for public consultation. The legacy codes TAR, LBA LFLS, FAA-P-8110-2 ADC, CAP 471 BCAR Section Q, and the EASA drafts of CS-30T and CS-30N, as well as industry standards, may be considered Means of Compliance subject to agreement with the specific EASA Certification Team.

Ancillary ground equipment was a controversial discussion between EASA and the industry group. The final position is reflected in SC-GAS 2380. The main objective is to prevent unintended free flight and to protect people on the ground as well as crew on board. The ancillary ground equipment itself will not be covered by the Type Certificate, however the interface to moor the airship to the ground will be covered by the Type Certificate. Required performance, design requirements and procedures to assure the safe mooring of the airship must be established.

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[2] EASA inventory of draft CS:
- CS-30T - Certification Specifications for Transport Category Airships
- CS-30N - Certification Specifications for Normal and Commuter Airships
- CS-31HA - Certification Specifications for Hot Air Airships

[3] EASA draft CS based on:
- CS-30T - TAR Issue 2 (Transport Airship Requirements, Issue 1 notified i.a.w. 98/48/EG, published by CAA-NL/LBA (FAA inventory))
- CS-30N - LFLS (Lufttüchtigkeitsforderungen für Luftschiffe der Kategorien Normal und Zubringer), published by LBA (FAA inventory)
- CS-31HA - LFHLLS (Lufttüchtigkeitsforderungen für Heissluft-Luftschiffe) published by LBA

Considering all the above, the following Special Condition is proposed:

SUBPART A — GENERAL

SC GAS.2000 Applicability and Definitions

This specification prescribes airworthiness specifications for the issuance of type certificates, and changes to those certificates, for gas airships.

(a) For the purposes of this Special Condition, the following definition applies:

(1) Flight envelope means the combination of equivalent airspeed, altitude and normal acceleration within which the airship is permitted to operate for a given configuration.

(2) Flight phases means take-off or unmasting, en route, approach, landing or masting and safe transition to the balked-landing conditions or any phase based on the intended operation.

(3) Airship is a power-driven lighter-than-air aircraft.

(4) Ancillary equipment is considered the mooring mast and any ground equipment supporting safe operation.

(5) Static heaviness means the difference between airship mass and static lift, downwards positive and upwards will be negative

(6) 'Continued safe flight and landing' means that the airship is capable of continued controlled flight and landing, possibly using emergency procedures, without requiring exceptional pilot skill or strength. Upon landing, the airship and the procedures must reasonably mitigate risks of injuries for occupants while the airship may be damaged including hull loss which may be caused by deliberate actions.

(7) The following airspeeds (equivalent airspeed) are defined for all airships:

i. V_H is the maximum speed obtainable in level flight.

ii. V_{CD} is the design climb/dive airspeed which may not be less than the greater of:

- V_H; or
- The maximum airspeed obtainable in a climb with all forward thrust engines at maximum take-off power and the airship in the minimum drag configuration and with minimum approved static heaviness (or maximum approved static lightness), or
- The maximum airspeed obtainable in a dive with all engines at maximum continuous power and the airship in the minimum drag configuration and with maximum approved static heaviness.

(8) Masses relevant to the design of the airship will be defined in the associated MoC.

(9) Static lift or Buoyancy is the difference between the weight of air displaced by the airship and the weight of the lifting gas.

(10) Mooring means ground handling considered in flight until tying an airship to the ground. Flight and ground crew is typically required to perform the operation

(11) For Sub-Part B and its MoC, 'configuration' means the state of the following:

i. Static heaviness or lightness;

ii. Trim

iii. Mass

iv. Deceleration and/or lift devices

v. External movable surfaces (such as cowling etc)

vi. Undercarriage

vii. Thrust unit(s) tilt or vector

(b) This Special Condition applies to airships with non-pressurized crew or passenger compartments.

SC GAS.2010 Means of Compliance (MoC)

(a) An applicant must comply with this Special Condition using means of compliance accepted by EASA, which may include consensus standards.

(b) An applicant requesting EASA to accept a means of compliance must provide the means of compliance to EASA in an acceptable form and manner.

SUBPART B — FLIGHT

SC GAS.2100 Mass and Centre of Gravity

(a) Limits for mass, heaviness and centre of gravity that provide for the safe operation of the airship are to be determined.

(b) The design must comply with each airworthiness specification of this subpart at critical combinations of mass, heaviness, envelope, ballonet and gas cell pressure and centre of gravity within the airship's range of loading conditions using acceptable tolerances.

(c) The condition of the airship at the time of determining its empty mass and centre of gravity must be defined and repeatable.

(d) At any time, the flight crew must have means to determine, with sufficient accuracy to control the airship, the static heaviness of the airship.

SC GAS.2103 Flight Envelope

(a) The applicant must determine the flight envelope for each flight configuration.

(b) The determination of the flight envelope must account for the most adverse conditions for each flight configuration.

SC GAS.2105 Performance Data

(a) An airship must meet the performance requirements of this subpart

(1) still air and ambient atmospheric conditions within the operating envelope

(2) If applicable, humidity effects must be considered

(b) Unless otherwise prescribed, the applicant must develop the performance data required by this subpart for

(1) Airport or mooring site, and operating altitudes for which certification is requested.

(2) Atmospheric conditions above and below standard atmosphere that are within the range of operating limitations should be taken into account.

(c) The performance data must

(1) correspond to the vectored, propulsive thrust available under the particular ambient atmospheric conditions and the particular flight condition specified in subparagraph ( )

(2) account for losses due to installation , power or equivalent thrust absorbed by the accessories and services , cooling needs, and other demands on power source

(d) The applicant must select the procedures for all flight phases, including critical-loss of thrust procedures and related configurations and changes of configuration. The procedures must be established for all applicable conditions and configurations;

(e) The procedures used for determining performance must be executable consistently by flight crew of average skill in atmospheric conditions expected to be encountered in service.

(f) Performance data determined in accordance with paragraph (b) of this section must account for losses due to atmospheric conditions, the operation and the installation.

(g) Procedures and performance information of the airship at various levels of turbulence must be established for combinations of mass and static heaviness and be incorporated in the AFM.

SC GAS.2110 Minimum Steady Flight Speed

The following speeds must be determined:

(a) Minimum Control Speed (V_{MC})

(b) Minimum Aerodynamic Control Speed (V_{AM})

(c) Stall Speed determination (see SC GAS.2111)

SC GAS.2111 Stall Demonstration

(a) The stall characteristics (loss of aerodynamic lift) shall be investigated in straight and turning flight in all of the configurations defined for normal operation and at the most adverse trim and CG.

(b) If flight in icing conditions is required, then the influence of ice and precipitation on stall characteristics shall be investigated.

SC GAS.2112 Stall characteristics

Flight through the stall and recovery shall not require exceptional pilot skill, strength or alertness to safely enter and recover to controlled flight.

SC GAS.2113 Stall Warning

(a) A stall warning shall be installed:

(1) If the airship stalls; and,

(2) The inherent aerodynamic characteristics of the airship are not sufficiently compelling or do not provide sufficient margin to allow the pilot to prevent inadvertent stall.

(b) Stall warning shall be evaluated in icing conditions and precipitation, if flight in icing conditions is required.

(c) If an artificial stall warning is required then:

(1) It shall be assessed in all of the conditions required by GAS.2111;

(2) It shall be sufficiently compelling and provide sufficient margin to allow the pilot to prevent inadvertent stall.

SC GAS.2115 Take-off Performance

(a) The applicant must determine airship take-off performance accounting for:

(1) stall speed safety margins;
(2) minimum control speeds;
(3) climb gradients;
(4) the volume required to clear obstacles by a 15 m (50-ft) margin must be determined.

SC GAS.2120 Climb and Descent Requirements

(a) Minimum climb performance must be established:

(1) a minimum rate of climb at sea level of at least 1.5 m/s (300 ft/min) and a steady angle of climb of at least 1:12. If climb performance is only dependent on thrust, the minimum rate of climb must be demonstrated with critical-loss of thrust.

(b) The maximum rates of climb and descent, to be used for all operations, must be established for all conditions using maximum continuous forward thrust.

(c) It must be demonstrated that envelope and gas cell pressures remain within the maximum and minimum approved pressures during climbs and descents at maximum rates of ascent and descent

SC GAS.2122 Powerplant failure

(a) The airship must be capable of maintaining level flight and zero rate of descent following failure of one or more critical engine(s).

(b) in case of critical loss of thrust, Enroute Flight Path information must be provided to crew. Variations of mass due to fuel consumption, snow and rain accumulations need to be computed

SC GAS.2125 Loading and unloading

(a) For airships intended to load and unload cargo or other ballast when the airship is in flight, hovering, or on the ground but not masted, performance data must be established with the airship in the most critical configuration.

(b) During any cargo exchange or reballasting operation the airship must be capable of achieving a safe free flight condition within a time period short enough to recover from a potentially hazardous condition.

SC GAS.2130 Landing Data

The applicant must determine the following data, at critical combinations of flight phases within the operational limits:
Wind within the operational limits:

(a) The airspace volume, required to approach, land and stop, starting from a height of 15 m (50 ft) above the landing surface.

(b) Performance data must be established for each scheduled technique with the airship in the most critical configuration for landing.

(c) The airspace volume after a critical loss of thrust on multi-engine airships must be published if different than with all engines operating.

(d) The approach and landing speeds, configurations, and procedures, which allow the flight crew of average skill to land within the published landing airspace volume consistently and without causing damage or injury, and which allow for a safe transition to the balked landing conditions.

(e) If applicable performance data for loading changes in operational flight conditions.

SC GAS.2135 Controllability

(a) The airship must be controllable and manoeuvrable, without requiring exceptional piloting skills, alertness, or physical strength, within the flight envelope:

(1) At all loading conditions for which certification is requested;
(2) During all phases of the operation;
(3) With likely reversible flight control or propulsion system failure; and
(4) During configuration changes.
(5) In all degraded flight control system operating modes.
(6) At all airspeeds with various ballonet or gas cell levels.

(b) It shall be possible to make an emergency landing without assistance from ground personnel in the maximum surface wind speed in which operation is permitted with critical loss of thrust.

(c) No in-flight accumulation of precipitation on the airship shall adversely affect the controllability of the airship.

SC GAS.2140 Trim

It shall be possible to trim the airship by means of static and/or aerodynamic trim, in all conditions of loading, configuration, speed and power, such that the flight crew workload is commensurate with the safe handling of the airship during all flight phases. This applies during normal operations and at all cleared flight attitudes, and, if applicable:

(a) with any probable failure of the ballonet systems or other trim system;

(b) with a critical loss of thrust.

SC GAS.2145 Stability

(a) The airship must be sufficiently stable in both the pitch and yaw axes in steady un-accelerated flight during climb, descent and level flight, with consistent use of the thrust controls, at any given trim condition and configuration in the flight envelope such that the flight crew workload is commensurate with the flying task.

(b) Any oscillation within the operating envelope of the airship must be controllable with normal use of the controls and without requiring exceptional pilot skills. Long-period oscillations must not induce a flight crew workload prejudicial to safe operation.

SC GAS.2155 Ground Handling Characteristics

(a) Safe ground handling procedures and Mooring procedures must be developed assuming the specified minimum Airship flight and ground crew, and covering all cleared Airship configurations, ancillary equipment and wind conditions.

(b) Ancillary Ground Equipment, as defined by SC GAS.2380must be able to counteract ground gust conditions and wind shifts safely. Maximum wind values must be established in accordance with SC GAS.2180.

SC GAS.2160 Vibration, Buffeting, and High-Speed Characteristics

(a) Each part of the airship must be free from excessive vibration under any appropriate speed and power condition up to V_{CD} when the airship is flown with normal use of the controls (including deliberate small, sharp inputs) and in all permitted conditions of heaviness.

(b) In any normal flight condition, buffeting must not occur which is severe enough to interfere with the control of the airship, induce a flight crew workload prejudicial to safe operation, or result in loading beyond the limit load.

(c) Envelope or hull distortion and/or deflection must not interfere with flight path control throughout the range of speed, power and envelope pressure, within the flight envelope.

(d) Envelope or hull distortion and/or deflection must not interfere with flight path control throughout the range of speed, power and envelope pressure, within the flight envelope

(e) For non-rigid and semi-rigid airships the crew must be enabled to determine envelope pressure. If crew can control envelope pressure within limits, improper use of the procedure and the controls must not damage the envelope or the structure attached to it.

SC GAS.2165 Flight in icing conditions

(a) An applicant who requests certification for flight in icing conditions must demonstrate that the airship can be safely operated in continuous maximum and intermittent maximum icing conditions to be agreed with the Agency.

(b) The applicant must provide a means to detect any icing conditions for which the airship is not certified to operate and demonstrate the airship's ability to avoid or exit those conditions.

(c) The applicant must develop an operating limitation to prohibit intentional flight, including take-off and landing, into icing conditions for which the airship is not certified to operate.

(d) If certification for flight in snow is desired, the airship must be capable of safe operation in snow envelope to be agreed with the Agency.

FLIGHT — INFORMATION

SC GAS.2170 Operating Information

The following operating information must be established: Operating limitations, procedures and instructions necessary for the safe operation of the airship.

SC GAS.2180 Maximum Wind Velocities

Maximum surface wind velocities for both flight and ground handling operations shall be determined and scheduled in the Flight Manual and Ground Handling Manual. The maximum wind speed must be at least 10 kts and for shall not be greater than the lesser of:

(a) 75% of the maximum still-air speed of which the Airship is capable with a critical loss of thrust and the remaining thrust units at maximum continuous power; or
(b) The maximum surface winds in which the Airship may be handled by the minimum ground crew.

SC GAS.2190 Flight in Rough Air

(a) Procedures and relevant limitations for different levels of turbulence shall be determined for all cleared configurations and scheduled in the Flight Manual.
(b) The lifting gas pressure shall remain within safe limits during flight in rough air.

SUBPART C — STRUCTURES

SC GAS.2200 Structural Design Envelope

The structural design envelope must be determined, which describes the range and limits of airship design and operational parameters for which the applicant will show compliance with the specifications of this subpart. The design envelope must account for all airship design and operational parameters that affect structural loads, strength, durability, and aeroelasticity, including:

(a) Structural design airspeeds to be considered when determining the corresponding manoeuvring and gust loads must:

(1) Be sufficiently greater than the minimum flight speed of the airship to safeguard against loss of control in turbulent air; and

(2) Provide sufficient margin for the establishment of practical operational limiting airspeeds.

(b) Flight load conditions to be expected in service;

(c) Mass variations and distributions over the applicable mass, heaviness and centre of gravity envelope, within the operating limitations;

(d) Loads in response to all designed control inputs;

(e) Redistribution of loads if deflections under load would significantly change the distribution of external or internal loads;

(f) Effects of aerostatic loads;

(g) Loads associated with ground operations and when the airship is secured to the ground.

SC GAS.2205 Interaction of Systems and Structures

For airships equipped with systems that affect structural performance, either directly or as a result of failure or malfunction, the applicant must account for the influence and failure conditions of these systems when showing compliance with the requirements of this subpart.

STRUCTURAL LOADS

SC GAS.2210 Structural design loads

The applicant must:

(a) Determine structural design loads resulting from any externally or internally applied pressure, force or moment which may occur in flight, ground and water operations, ground and water handling, ditching and while the airship is parked or moored;

(b) Determine the loads required by paragraph (a) of this section at all critical combinations of parameters, on and within the boundaries of the structural design envelope, and

(c) the magnitude and distribution of these loads must be based on established physical principles within the structural design envelope.

SC GAS.2215 Flight Load Conditions

(a) Critical flight loads are established for symmetrical and asymmetrical loading from all combinations of flight parameters and load factors at and within the boundaries of the manoeuvre and gust envelope:

(1) at each altitude and temperature within the operating limitations;
(2) at each mass from the design minimum mass to the design maximum mass; and
(3) at any practical but conservative distribution of disposable load within the operating limitations for each altitude and heaviness;
(4) at each lift from the minimum design lift to the maximum design lift (static lift, aerodynamic lift, vectored thrust);
(5) when determining the loads, the influence of adverse environmental conditions, including the effects due to superheat, must be accounted for.

(b) Vibration or buffeting must not result in structural damage up to VCD.
(c) Flight Loads resulting from a likely failure of an airship system, component, or propulsion system must be determined.

SC GAS.2220 Ground and Water Load Conditions

Loads expected in service under the anticipated operating conditions and any transition between them, including when the Airship is moored, must be determined.

SC GAS.2225 Component Loading Conditions

The applicant must determine the loads acting upon all relevant structural components, in response to:

(a) Interaction of systems and structures;
(b) Structural design loads;
(c) Flight load conditions; and
(d) Ground and water load conditions.
(e) Propulsion system

SC GAS.2230 Limit and Ultimate Loads

(a) Unless special or other factors of safety are necessary to meet the specification of this subpart, the applicant must determine

(1) The limit loads, which are equal to the structural design loads; and
(2) The ultimate loads, which are equal to the limit loads multiplied by a 1.5 factor of safety, unless otherwise provided.

(b) Some strength specifications are specific in terms of ultimate loads only, when permanent detrimental deformation is acceptable

STRUCTURAL PERFORMANCE

SC GAS.2235 Structural Strength

The structure must support:

(a) Limit loads without:

(1) Interference with the safe operation of the airship; and
(2) Detrimental permanent deformation.

(b) Ultimate loads.

SC GAS.2240 Structural Durability

(a) The applicant must develop and implement inspections or other procedures to prevent structural failures due to foreseeable causes of strength degradation, which could result in serious or fatal injuries, or extended periods of operation with reduced safety margins. Each of the inspections or other procedures developed under this section must be included in the Airworthiness Limitations Section of the Instructions for Continued Airworthiness required by requirement .2630.

(b) The procedures developed for compliance with paragraph (a) of this section must be capable of detecting structural damage before the damage could result in a structural failure.

(c) The airship must be designed to minimise hazards to the airship due to structural damage caused by high-energy fragments from an uncontained engine or rotating machinery failure.

SC GAS.2245 Aeroelasticity

(a) The airship must be free from flutter, control reversal, and divergence:

(1) At all speeds within and sufficiently beyond the structural design envelope;
(2) For any configuration and condition of operation;
(3) Accounting for critical degrees of freedom; and
(4) Accounting for any critical failures or malfunctions.

(b) The design must account for tolerances for all quantities that affect flutter.

SC GAS.2250 Design and Construction Principles

(a) Each part, article, and assembly must be designed for the expected operating conditions of the airship.

(b) Design data must adequately define the part, article, or assembly configuration, its design features, and any materials and processes used.

(c) The suitability of each design detail and part having an important bearing on safety in operations must be determined.

(d) The control system must be free from jamming, excessive friction, and excessive deflection when the airship is subjected to expected limit air loads.

(e) Doors, canopies, hatches and access panels must be protected against inadvertent opening in flight, unless shown to create no hazard, when opened in flight.

(f) The airship must be designed to ensure that after a likely bird impact the capability remains to conduct continued safe flight and landing.

SC GAS.2255 Protection of Structure

(a) Each part of the airship, including small parts such as fasteners, must be protected against deterioration or loss of strength due to any cause likely to occur in the expected operational environment.

(b) Each part of the airship must have adequate provisions for ventilation and drainage.

(c) For each part that requires maintenance, preventive maintenance, or servicing, the applicant must incorporate a means into the airship design to allow such actions to be accomplished.

SC GAS.2260 Materials and Processes

(a) Materials used for parts, articles, and assemblies, the failure of which could prevent continued safe flight and landing must be suitable and durable, accounting for the effects of significant likely environmental conditions expected in service.

(b) The methods and processes of fabrication and assembly used must produce consistently sound structures. If a fabrication process requires close control to reach this objective, the applicant must define the process as part of the design data

(c) Except as provided in paragraphs (f) of this section, the applicant must select design values that ensure material strength with probabilities that account for the criticality of the structural element. Design values must account for the probability of structural failure due to material variability.

(d) If material strength properties are required, a determination of those properties must be based on sufficient tests of material meeting specifications to establish design values on a statistical basis.

(e) If environmental effects are significant on a critical component or structure under normal operating conditions, the applicant must account for those effects.

(f) Design values, greater than the minimums specified by this section, may be used, where only guaranteed minimum values are normally allowed, if a specimen of each individual item is tested before use to determine that the actual strength properties of that particular item will equal or exceed those used in the design.

SC GAS.2265 Special Factors of Safety

(a) A special factor of safety must be determined for each critical design value for each part, article, or assembly for which that critical design value is uncertain, and for each part, article, or assembly that is:

(1) likely to deteriorate in service before normal replacement; or

(2) subject to appreciable variability because of uncertainties in manufacturing processes or inspection methods.

(b) The applicant must determine a special factor of safety using quality controls and specifications that account for each:

(1) type of application;
(2) inspection method;
(3) structural test requirement;
(4) sampling percentage; and
(5) Process and material control.

(c) The applicant must multiply the highest pertinent special factor of safety in the design for each part of the structure by each limit and ultimate load, or ultimate load only, if there is no corresponding limit load, such as occurs with emergency condition loading.

STRUCTURAL OCCUPANT PROTECTION

SC GAS.2270 Emergency Conditions

(a) The airship, even when damaged in an emergency landing, must protect each occupant against injury that would preclude egress when:

(1) properly using safety equipment and features provided for in the design;
(2) the occupant experiences ultimate static inertia loads likely to occur in an emergency landing; and
(3) items of mass; including engines or auxiliary power units (APUs), within or aft of the crew and/or passenger compartment, that could injure an occupant, experience ultimate static inertia loads likely to occur in an emergency landing.

(b) The emergency landing conditions specified in paragraph (a) of this section, must:

(1) include dynamic conditions that are likely to occur in an emergency landing; and
(2) not generate loads experienced by the occupants, which would exceed established human injury criteria for human tolerance due to restraint or contact with objects in the airship.

(c) The airship must provide protection for all occupants, accounting for likely flight, ground, water and emergency landing conditions.

(d) Each occupant protection system must perform its intended function and not create a hazard that could cause a secondary injury to an occupant. The occupant protection system must not prevent occupant egress or interfere with the operation of the airship when not in use.

SUBPART D — DESIGN AND CONSTRUCTION

SC GAS.2300 Flight Control Systems

(a) The flight control systems must be designed to:

(1) Operate easily, smoothly, and positively enough to allow proper performance of their functions.
(2) Protect against likely hazards
(3) Allow flight crew to be aware of the control limits

(b) Trim systems, if installed, must be designed to:

(1) Protect against inadvertent, incorrect, or abrupt trim operation;
(2) Provide information that is required for safe operation.

SC GAS.2305 Landing gear and ground contact systems

(a) The landing gear or ground contact system must be designed to:

(1) provide stable support and / or control to the airship during ground operation; and
(2) account for probable system failures and the operation environment.

(b) The airship must be designed to absorb the kinetic energy of the landing performance.
(c) Adverse loading conditions must not cause damage to the essential systems of the airship, which could lead to a hazardous or catastrophic event if not detected.

SC GAS.2310 Water Buoyancy for Elective Water Operations

Airships intended for operations on water must:

(a) Provide buoyancy in excess of the buoyancy required to support the maximum heaviness of the airship in fresh water; and
(b) Have sufficient margin so that the airship will stay afloat at rest in wave conditions for which approval is requested, and account for the case of failure or flooding of a single element of the buoyancy system.

OCCUPANT SYSTEM DESIGN PROTECTION

SC GAS.2315 Means of Egress and Emergency Exits

(a) With the crew and/or passenger compartment configured for take-off or landing, the airship is designed to:

(1) Facilitate rapid and safe evacuation of the airship in conditions likely to occur following an emergency landing on land or water, external cargo must be considered if applicable;
(2) Have means of egress (openings, exits or emergency exits), that can be readily located and opened from the inside and outside. The means of opening must be simple and obvious.

(3) Have easy access to emergency exits when present.

SC GAS.2320 Occupant Physical Environment

(a) The airship design must:

(1) allow clear communication between the flight crew and all other occupants;
(2) protect the flight crew against serious injury due to hazards originating from high energy, associated with systems and equipment; and
(3) protect the occupants from serious injury due to breakage of windshields, windows, and canopies.
(4) minimse the possibility of injury to occupants during normal operation.

(b) The airship must provide each occupant with air at a breathable pressure, free of hazardous concentrations of gases, vapours and smoke during normal operations and likely failures.

(c) If an oxygen system is installed in the airship, it must:

(1) effectively provide oxygen to each user to prevent the effects of hypoxia; and
(2) be free from hazards in itself, in its method of operation, and its effect upon other components.

(d) Where required by the operating rules, protective breathing equipment must be installed for use of appropriate crew members. Such equipment must be located so as to be available for use in compartments accessible in flight

(e) For each openable compartment window there must be adequate provisions to prevent persons falling out.

FIRE AND HIGH ENERGY PROTECTION

SC GAS.2325 Fire Protection

(a) The design must minimise the risk of fire initiation caused by:

(1) Anticipated heat or energy dissipation or system failures or overheat that are expected to generate heat sufficient to ignite a fire;
(2) Ignition of flammable fluids, gases or vapours; and
(3) Fire propagating or initiating system characteristics (e.g. oxygen systems).

(b) The airship must minimise the risk of fire propagation by:

(1) Providing adequate fire or smoke awareness and extinguishing means when practical;
(2) Application of self-extinguishing, flame-resistant, or fireproof materials that are adequate to the application, location and certification level; or
(3) Specifying and designing designated fire zones that meet the specifications of requirement .2330.

SC GAS.2330 Fire Protection in Designated Fire Zones

(a) Within or adjacent to designated fire zones, the following items must be capable of withstanding the effects of a fire:

(1) Any system the failure of which can lead to a hazardous or catastrophic event at airship level.
(2) Any structural component the failure of which could result in serious or fatal injuries, extended periods of operation with reduced safety margins or loss of hull.

(b) A fire or other release of energy in a designated fire zone must not preclude continued safe flight and landing.
(c) Terminals, equipment, and electrical cables used during emergency procedures must be fire-resistant.

SC GAS.2335 Lightning Protection

For operations where the exposure to lightning is likely, the airship must be protected against catastrophic effects of lightning.

SC GAS.2340 Design and Construction Information

The following design and construction information must be established:

(a) Operating limitations, procedures and instructions necessary for the safe operation of the airship;
(b) The need for instrument markings or placards;
(c) Any additional information necessary for the safe operation of the airship; and
(d) Inspections or maintenance to assure continued safe operation.

SC GAS.2350 Airship envelope

The airship envelope or hull and its connecting structure must:

(a) withstand all loading conditions expected in operation to maintain aerodynamic shape
(b) be capable of protecting the airship from likely hazards in operation;

SC GAS.2355 Lifting gas system

(a) Lifting gas systems required for the safe operation of the airship must:

(1) withstand all loading conditions expected in operation;
(2) monitor and control lifting performance and degradation;

(b) If the lifting gas is toxic, irritant or flammable, adequate measures must be taken in design and operation to ensure the safety of the occupants and people on the ground in all envisaged ground and flight conditions.

SC GAS.2360 Payload & baggage accommodation

The provisions for accommodating payload and baggage internal or external (external limited to no human payload) of the airship must:

(a) Be designed for its maximum loading and for the critical load distributions at the maximum load factors corresponding to the flight and ground load conditions determined under this Special Condition;
(b) Have means to prevent payload or baggage from becoming a hazard;
(c) Protect adjacent structure or systems whose damage or failure would prevent continued safe flight and landing.
(d) Be designed to minimise the hazards to the airship from fire in that compartment.
(e) For external payload adequate means are provided to enable the release of payload quickly during flight throughout the approved operational envelope without causing hazards to the airship
(f) Ensure that payloads are not inadvertently released.

SC GAS.2370 Systems for Ballast which is Disposable in Flight

If a system is installed using in-flight disposable ballast, the following applies:

(a) the system must be designed and installed so as to ensure controlled disposal or transfer of the ballast intended for maintaining equilibrium of the airship under all normal and emergency operating conditions while preventing critical load distributions in the airship.
(b) the ballast must:

(1) not cause injury to persons or property on the ground during disposal and replenishment;
(2) not adversely impact the environment during disposal; and
(3) be usable when required.

SC GAS.2380 Ancillary Ground Equipment

(a) The applicant must determine the ancillary ground equipment and establish the performance, the design requirements and the procedures applicable for the safe operation of the airship.
(b) The airship must be designed to operate safely using the ancillary ground equipment under the anticipated operating conditions.
(c) The airship must be mored and prevented from unintended movement or free flight.

SUBPART E — PROPULSION SYSTEM

SC GAS.2400 Propulsion System Installation

(a) For the purpose of this subpart, the airship propulsion system installation must include each component that is necessary for propulsion, affects propulsion safety, or provides auxiliary power to the airship.

(b) Each airship engine, propeller and auxiliary power unit (APU) must be type certified, or meet accepted specifications.

(c) The applicant must construct and arrange each propulsion system installation to account for:

(1) All likely operating conditions, including foreign object threats;
(2) Sufficient clearance of moving parts to other airship parts and their surroundings;
(3) Likely hazards in operation, including hazards to ground personnel; and
(4) Vibration and fatigue.

(d) Hazardous accumulations of fluids, vapours or gases are isolated from the airship and personnel compartments and are safely contained or discharged.

(e) Installations of propulsion system components that deviate from the component limitations or installation instructions must be shown to be safe.

(f) For the purposes of this subpart, 'energy' means any type of energy for the propulsion system, including, for example, fuels of any kind or electric current.

SC GAS.2405 Propulsion System Integrity

The integrity of the propulsion system including mounting and accessory attachment must be demonstrated throughout the flight envelope of the airship.

SC GAS.2415 Propulsion System Ice Protection

(a) The airship design must prevent foreseeable accumulation or shedding of ice or snow that adversely affect Propulsion System operation.

(b) The Propulsion System installation design must prevent any accumulation of ice or snow that adversely affects Propulsion System operation in those icing conditions for which certification is requested.

SC GAS.2425 Propulsion System Operational Characteristics

The installed propulsion system must operate without any hazardous characteristics during normal and emergency operation within the range of operation limitations for the airship and propulsion system.

SC GAS.2430 Propulsion system installation, energy storage and distribution systems

(a) Each system must:

(1) be designed to provide independence between multiple energy storage and supply systems so that a failure, including fire, of any component in one system will not result in the loss of energy storage or supply of another system.
(2) be designed to prevent catastrophic events due to lightning strikes taking into account direct and indirect effects for airship unless it is shown that exposure to lightning is unlikely.
(3) provide energy to the propulsion system installation with adequate margins to ensure safe functioning under all permitted and likely operating conditions, and accounting for likely component failures.
(4) provide the relevant information established in SC GAS.2445 to the flight crew and provide uninterrupted supply of that energy when the system is correctly operated, accounting for likely energy fluctuations.
(5) provide a means to safely remove or isolate the energy stored within the system.
(6) be designed to retain the energy under all likely operating conditions and minimise hazards to the occupants and people on the ground during any survivable emergency landing. Failure due to overload of the landing system must be taken into account.
(7) prevent hazardous contamination of the energy supplied to each propulsion system installation.

(b) Each storage system must:

(1) withstand the loads under likely operating conditions without failure, accounting for installation;
(2) be isolated from personnel compartments and protected from likely hazards;
(3) be designed to prevent significant loss of stored energy due to energy transfer or venting under likely operating conditions;
(4) provide energy for a sufficient reserve based on a standard flight; and
(5) be capable of jettisoning energy safely if this functionality is provided.

(c) Each energy-storage-refilling or -recharging system must be designed to:

(6) prevent improper refilling or recharging;
(7) prevent contamination of the stored energy during likely operating conditions; and
(8) prevent the occurrence of any hazard to the airship or to persons during refilling or recharging.

(d) Likely errors during ground handling of the airship must not lead to a hazardous loss of stored energy.

SC GAS.2435 Propulsion Support Systems

(a) Propulsion support systems are all systems whose direct purpose is to support the Propulsion System or the energy storage device in its intended function as part of the propulsion system.
(b) Propulsion support systems that have a direct effect on the engine availability must be considered in the engine reliability.

(c) Propulsion support systems must be designed for the operating conditions applicable to the location of installation.
(d) Systems must be capable of operating under the conditions likely to occur.
(e) System function and characteristics that have an effect on the propulsion system performance must be established.
(f) Ingestion of likely foreign objects that would be hazardous to the engine must be prevented.
(g) The flight crew must be aware of the air intake configuration and able to influence it.
(h) Any likely single failures of propulsion support systems that result in a critical loss of thrust must be mitigated.

SC GAS.2445 Propulsion System Information

The following propulsion system information must be established:

(a) Operating limitations, procedures and instructions necessary for the safe operation of the airship;
(b) The need for instrument markings or placards;
(c) Any additional information necessary for the safe operation of the airship;
(d) Inspections or maintenance to assure continued safe operation;
(e) Information related to the air intake configuration;
(f) Techniques and associated limitations for engine operation, including design features when pilot error is likely to occur; and
(g) Energy level information, to support energy management, including consideration of a likely component failure within the system.

SUBPART F — SYSTEMS AND EQUIPMENT

SC GAS.2500 General Requirements on Systems and Equipment Function

(a) Requirements .2500, .2505 and .2510 are general specifications applicable to systems and equipment installed in the airship and should not be used to supersede any other specification in this document.

(b) Equipment and systems required to comply with type certification specifications, airspace requirements or operating rules, or whose improper functioning would lead to a hazard, must be designed and installed so that they perform their intended function throughout the operating and environmental limits for which the airship is certificated.

SC GAS.2505 General Requirements on Equipment Installation

(a) Each item of installed equipment must be installed according to limitations specified for that equipment.

(b) Engine-driven accessories essential to safe operation must be distributed among multiple engines.

SC GAS.2510 Equipment, Systems, and Installations

(a) The equipment and systems identified in requirement .2500, considered separately and in relation to other systems, must be designed and installed such that:

(1) Each catastrophic failure condition:
   i. is extremely improbable; and
   ii. does not result from a single failure;

(2) Each hazardous failure condition is extremely remote; and

(3) Each major failure condition is remote.

(b) The operation of equipment and system not covered by SC.GAS.2500, must not cause a hazard to the airship or its occupants throughout the operating and environmental limits for which the airship is certified.

SC GAS.2515 System lightning protection

For airships where exposure to lightning is likely:

(a) each system that performs a function, the failure of which would prevent continued safe flight and landing must be designed and installed such that:

(1) The function at the airship level is not adversely affected during and after the time the airship is exposed to indirect effect of lightning; and

(2) The system recovers normal operation of that function in a timely manner after the airship is exposed to indirect effect of lightning unless the system's recovery conflicts with other operational or functional requirements of the system.

(b) Each system that performs a function, the failure of which would significantly reduce the capability of the airship or the ability of the flight-crew to respond to an adverse operating condition, must be

designed and installed such that the system recovers normal operation of that function in a timely manner after the airship is exposed to lightning

SC GAS.2520 High-Intensity Radiated Fields (HIRF) Protection

(a) Each electrical and electronic system that performs a function, the failure of which would prevent the continued safe flight and landing of the airship, must be designed and installed such that:

(1) The function at the airship level is not adversely affected during and after the time the airship is exposed to the HIRF environment; and

(2) The system recovers normal operation of that function in a timely manner after the airship is exposed to the HIRF environment, unless the system's recovery conflicts with other operational or functional requirements of the system.

(b) For airship approved for IFR operations, each electrical and electronic system that performs a function, the failure of which would reduce the capability of the airship or the ability of the flight-crew to respond to an adverse operating condition, must be designed and installed such that the system recovers normal operation of that function in a timely manner after the airship is exposed to the HIRF environment.

SC GAS.2525 System Power Generation, Storage, and Distribution

The power generation, storage, and distribution for any system must be designed and installed to:

(a) Supply the power required for operation of connected loads during all intended operating conditions;

(b) Ensure no single failure or malfunction will prevent the system from supplying the essential loads required for continued safe flight and landing; and

(c) Have enough capacity, if the primary source fails, to supply essential loads, including non-continuous essential loads for the time needed to complete the function, required for safe flight and landing.

SC GAS.2530 External and Flight Deck Lighting

(a) External and internal lighting shall be designed and installed such that there are no unsafe effects on the performance of flight and ground crew duties

(b) The position and anti-collision lights rules must have the intensities, flash rate, colours, fields of coverage, and other characteristics to provide sufficient time for another aircraft or airship to avoid a collision.

(c) The anti-collision lights must be distributed in such a way that no aircraft or airship crossing the airship flight path might endeavour to fly between the bow and stern lights

(d) Any additional lights required for night operations, such as landing lights, must be installed on both airship and ground equipment

SC GAS.2535 Safety Equipment

Safety and survival equipment, must be reliable, readily accessible, easily identifiable, and clearly marked to identify its method of operation.

SC GAS.2540 Pressurised Systems Elements

Pressurised systems must withstand appropriate proof and burst pressures.

SC GAS.2555 Installation of Recorders (e.g. Cockpit Voice Recorders and Flight Data Recorders)

If recording is required by the operating rules, the system:

(a) Is installed so as to ensure accurate and intelligible recording and safeguarding of the required data also in conditions encountered during crash, water immersion or fire;

(b) Is powered by the most reliable power source and remains powered for as long as possible without jeopardising service to essential or emergency loads and emergency operation of the airship;

(c) Includes features to facilitate the localisation of memory medium after an accident; and

(d) Is installed so that it automatically records when the airship is capable of moving under its own power.

SUBPART G — FLIGHT CREW INTERFACE AND OTHER INFORMATION

SC GAS.2600 Flight Crew Compartment

(a) The flight crew compartment and its equipment must provide an adequate work environment and human machine interface to allow the flight crew to perform their duties within the operating envelope of the airship, such that the flight crew workload is commensurate with the safe handling of the airship.

(b) The design must provide all the necessary controls and displays so that a qualified flight crew can monitor and perform defined tasks associated with the intended functions of systems and equipment. The system and equipment design must minimise flight-crew errors, which could result in additional hazards.

(c) If for the operation of the airship any patrolling of the interior of the airship or working outside of the passenger or flight crew compartments is required then adequate safety provisions, including means of access, must be provided for flight crew members performing these activities.

(d) The flight crew interface design must allow for continued safe flight and landing after the loss of vision through any one of the windshield panels.

SC GAS.2605 Installation and Operation Information

(a) Each item of installed equipment related to the flight-crew interface must be labelled, as for its identification, function, or operating limitations, or any combination of these factors

(b) There must be a discernible means of providing system operating parameters required to operate the airship, including warnings, cautions, and normal indications to the responsible crewmember.

(c) Information concerning an unsafe system operating condition must be provided in a timely manner to the crew member responsible for taking corrective action. The information must be clear enough to avoid likely crew member errors.

(d) Information related to safety equipment is easily identifiable and its method of operation is clearly marked.

SC GAS.2610 Instrument Markings, Control Markings, and Placards

(a) Each airship must display in a conspicuous manner any placard and instrument marking necessary for operation.

(b) The design must clearly indicate the function of each flight deck control, other than primary flight controls.

(c) The applicant must include instrument marking and placard information in the Airship Flight Manual.

SC GAS.2615 Installed systems and equipment for use by the flight crew

This paragraph applies to installed equipment intended for flight-crew members' use in the operation of the aeroplane from their normally seated positions on the flight deck. This installed equipment must be shown, individually and in combination with other such equipment, to be designed so that qualified flight-crew

members trained in its use can safely perform their tasks associated with its intended function by meeting the following requirements:

(a) Flight deck controls must be installed to allow accomplishment of these tasks and information necessary to accomplish these tasks must be provided.

(b) Flight deck controls and information intended for flight crew use must:

(1) Be presented in a clear and unambiguous form, at resolution and precision appropriate to the task.

(2) Be accessible and usable by the flight crew in a manner consistent with the urgency, frequency, and duration of their tasks, and

(3) Enable flight crew awareness, if awareness is required for safe operation, of the effects on the aeroplane or systems resulting from flight crew actions.

(c) Operationally-relevant behaviour of the installed equipment must be:

(1) Predictable and unambiguous, and

(2) Designed to enable the flight crew to intervene in a manner appropriate to the task.

(d) To the extent practicable, installed equipment must enable the flight crew to manage errors resulting from the kinds of flight crew interactions with the equipment that can be reasonably expected in service, assuming the flight crew is acting in good faith. This subparagraph (d) does not apply to skill-related errors associated with manual control of the aeroplane.

(e) Flight crew alerts must:

(1) provide the flight crew with the information needed to:

(i) identify non-normal operation or aeroplane system conditions, and

(ii) determine the appropriate actions, if any;

(2) be readily and easily detectable and intelligible by the flight crew under all foreseeable operating conditions, including conditions where multiple alerts are provided;

(3) be removed when the alerting condition no longer exists.

(f) Alerts must conform to the following prioritisation hierarchy based on the urgency of flight crew awareness and response:

(1) Warning: For conditions that require immediate flight crew awareness and immediate flight crew response.

(2) Caution: For conditions that require immediate flight crew awareness and subsequent flight crew response.

(3) Advisory: For conditions that require flight crew awareness and may require subsequent flight crew response.

(g) Warning and Caution alerts must:

(1) be prioritised within each category, when necessary;

(2) provide timely attention-getting cues through at least two different senses by a combination of aural, visual, or tactile indications;

(3) permit each occurrence of the attention-getting cues required by subparagraph (c)(2) to be acknowledged and suppressed, unless they are required to be continuous.

(h) The alert function must be designed to minimise the effects of false and nuisance alerts. In particular, it must be designed to:

(1) prevent the presentation of an alert when it is inappropriate or unnecessary;
(2) provide a means to suppress an attention-getting component of an alert caused by a failure of the alerting function that interferes with the flight crew's ability to safely operate the aeroplane. This means must not be readily available to the flight crew so that it could be operated inadvertently or by habitual reflexive action.
(3) when an alert is suppressed, there must be a clear and unmistakable annunciation to the flight crew that the alert has been suppressed.

(i) Visual alert indications must:

(1) conform to the following colour convention:
(i) Red for Warning alert indications.
(ii) Amber or yellow for Caution alert indications.
(iii) Any colour except red or green for Advisory alert indications.
(2) use visual coding techniques, together with other alerting function elements on the flight deck, to distinguish between Warning, Caution and Advisory alert indications, if they are presented on monochromatic displays that are incapable of conforming to the colour convention in paragraph (e)(1).

(j) Use of the colours red, amber and yellow on the flight deck for functions other than flight crew alerting must be limited and must not adversely affect flight crew alerting.

SC GAS.2620 Airship Flight Manual and Ground Handling Manual

The applicant must provide an Airship Flight Manual and a Ground Handling Manual that contains the following information:

(a) Operating limitations, techniques and procedures for all flight phases, in particular critical flight phases such as close-to-ground operations.
(b) Performance information;
(c) Loading information;
(d) Instrument marking and placard information;
(e) Abnormal and emergency procedures following failure of systems or for events such as fire, smoke, noise;
(f) All necessary instructions, information and requirements for the safe and correct interface between the airship and such ancillary ground equipment must be provided in the Airship Flight Manual and / or in the Ground Handling Manual.
(g) Any other information necessary for the safe operation of the airship.

SC GAS.2625 Instructions for Continued Airworthiness (ICA)

(h) The applicant must prepare Instructions for Continued Airworthiness that are appropriate for the certification level and performance level of the airship.

(i) If instructions for continued airworthiness are not supplied by the manufacturer of an appliance or product installed in the airship, the instructions for continued airworthiness for the airship must include the information essential to the continued airworthiness of the airship.

(j) The instructions for continued airworthiness must contain a section titled 'Airworthiness Limitations' that is segregated and clearly distinguishable from the rest of the document. This section must set forth each mandatory replacement time, structural inspection interval, and related structural inspection procedure required for type certification. This section must contain a legible statement in a prominent location that reads: 'The airworthiness limitations section is approved and variations must also be approved.'

(k) The applicant must develop and implement procedures to prevent structural failures due to foreseeable causes of strength degradation, which could result in serious or fatal injuries, loss of hull, or extended periods of operation with reduced safety margins. The Instructions for Continued Airworthiness must include procedures developed under requirement .2255.