

**SUBJECT** : **Special Condition SC GAS Gas Airships**

**REQUIREMENTS incl. Amdt.** : **SC GAS**

**ASSOCIATED IM/MoC<sup>1</sup>** : 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.

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<sup>1</sup> 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.

**Special Condition for Gas Airships**


**SC GAS**

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### Explanatory note

EASA has received applications for the type certification of large Airships but has not yet published Certification Specifications (CS) for these products. Three draft CS<sup>2</sup> are available in the EASA inventory, which are based on the codes previously used by National Aviation Authorities prior to September 2003.

In the absence of agreed and published certification specifications for Airships by EASA, 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 Airships 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. That is required before the issuance of the EASA type certificate, as well as for the approval of later changes to type certificate.

The Special Condition is a high-level set of objective driven and performance-based requirements. It was developed in close cooperation with the industry working group. The Special Condition addresses two designs, one being a 260 000 m<sup>3</sup> rigid equilibrium Airship for cargo operations, the other one a 45 000 m<sup>3</sup> non-rigid hybrid Airship for up to 100 passengers. However, the authors believe the SC can be applied to all manned Airships with non-pressurized crew or passenger compartments. It will be subject to EASA Certification Team agreement whether this Special Condition can be deemed 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 applicable to specific Airship designs 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. EASA intends to make them available for public consultation once agreed with the applicants. The legacy codes TAR, LBA LFLS, FAA-P-8110-2 ADC, FAA HCC Hybrid Certification Criteria for Transport Category Hybrid Airships, CAP 471 BCAR Section Q, and the EASA drafts of CS-30T and CS-30N, as well as industry standards, may be considered as Means of Compliance subject to agreement with the relevant EASA Certification Team.

The discussion about ancillary ground equipment between EASA and the industry group was rather controversial. The final EASA position is reflected in SC-GAS 2380. Its main objective is to prevent unintended free flight and to sufficiently protect people on the ground as well as occupants on board. In conclusion only the interface to moor the Airship to the ground will be covered by the Type Certificate, but not the entire ancillary ground equipment. The applicant is required to establish the performance, design requirements and procedures to assure the safe mooring of the Airship.

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

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<sup>2</sup> 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




**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 apply:

- (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 either take-off or unmastering, climb, en route, descent, approach, landing or mastering and safe transition to the balked-landing conditions or any other phase based on the intended operation.
- (3) Airship is a power-driven lighter-than-air aircraft.
- (4) Ancillary equipment is any ground equipment (e.g. mooring mast) required for safe operation.
- (5) Static heaviness means the difference between the Airship mass and the static lift, positive downwards and negative upwards.
- (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 design and 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) Critical loss of thrust: means a failure of a combination of engine(s), or power cluster, which would most adversely affect the performance or handling qualities of an Airship. In case of no specific difference, the critical loss of thrust is defined as the one which is affecting more correlated systems.
- (8) The following airspeeds (equivalent airspeed) are defined for all Airships:
  - i.  $V_H$  is the maximum airspeed obtainable in level flight.
  - ii.  $V_{CD}$  is the maximum airspeed achievable in any flight condition.
- (9) Masses relevant to the design of the Airship as defined in the associated MoC.
- (10) Aerostatic lift or Buoyancy is equivalent to the weight of air displaced by the Airship.
- (11) Mooring means ground handling in flight until securing an Airship to the ground. Flight and ground crew is typically required to perform the operation
- (12) For Sub-Part B and its MoC, 'configuration' means any combination of the state of the following:
  - i. Static heaviness or lightness
  - ii. Ballonet, gas cell pressure
  - iii. Center of gravity
  - iv. Trim
  - v. Mass
  - vi. Deceleration and/or lift devices
  - vii. External movable surfaces (such as cowling etc)
  - viii. Landing gear
  - ix. Thrust unit(s), tilt or vector

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(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 must be determined.
- (b) The design must comply with all airworthiness specification of this subpart at the critical combinations of the Airship configuration parameters 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) The flight crew must be able to control the Airship and determine the static heaviness and trim with sufficient accuracy.

**SC GAS.2103 Flight Envelope**

- (a) The applicant must determine the flight envelope for each flight configuration.
- (b) 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 performance data required in this subpart for
  - (1) Airport or mooring site, and operating altitudes for which certification is requested.
  - (2) Atmospheric conditions above and below standard atmosphere, which are within the range of operating limitations must 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 conditions specified in subparagraph (a)
  - (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 procedures for all flight phases, including critical-loss of thrust procedures and related configurations and their changes. The procedures must be established for all applicable conditions and configurations;
- (e) The procedures used to determine 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, operation and installation.
- (g) Procedures and performance information of the Airship at various levels of turbulence must be established for relevant combinations of mass and static heaviness and be incorporated in the Airship Flight Manual.

**SC GAS.2110 Minimum Steady Flight Speed**

The following speeds must be determined:

- (a) Minimum Control Speed ( $V_{MC}$ )
- (b) Minimum Aerodynamic Control Speed ( $V_{AM}$ )

**SC GAS.2113 Stall**

In case the Airship can stall, the following applies:

- (a) The stall speed must be determined
- (b) The stall characteristics in straight and turning flight must be investigated in all configurations defined for normal operation and at the most adverse trim and centre of gravity.
- (c) Stall and its recovery must not require exceptional pilot skill, strength or alertness necessary for a safe entry and subsequent return to a controlled flight.
- (d) If flight in icing conditions is required, then the influence of ice and precipitation on the stall characteristics must be investigated.
- (e) If the inherent aerodynamic characteristics of the Airship are not sufficiently compelling or do not provide sufficient margin to allow the pilot to prevent an inadvertent stall, a stall warning must be installed.
- (f) If a stall warning is required, it must provide a clear and timely warning to the pilot to prevent an inadvertent stall, in the applicable operating conditions (e.g. icing).

**SC GAS.2115 Take-off Performance**

The applicant must determine Airship take-off performance accounting for:

- (a) stall speed safety margins;
- (b) minimum control speeds;
- (c) climb gradients;
- (d) the airspace 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 2 m/s (400 ft/min) and a steady angle of climb of at least 1:12. In case of critical-loss of thrust a minimum rate of climb at sea level of 0.76 m/s (150 ft/min) must be demonstrated.
- (b) The maximum rate of climb and descent envelope, to be used for all operations, must be established for all possible Airship flight conditions.
- (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 below  $V_{mc}$ , following a failure of one or more critical engine(s). The disposable ballast may be dropped or lifting gas valved to achieve these conditions.
- (b) In case of the critical loss of thrust, Net Flight Path information must be provided to the crew. Variations of mass due to fuel consumption, snow and rain accumulations need to be determined.

**SC GAS.2125 Loading and unloading**

- (a) For Airships designed to be loaded or unloaded off the mast, 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 continued safe flight and landing following a potentially hazardous condition.

**SC GAS.2130 Landing Data**

The applicant must determine the following data within the operational limits:

- (a) The airspace, 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 required airspace following a critical loss of thrust on multi-engine Airships must be published if different to the required airshpace when all engines are 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 pilot skills, alertness, or physical strength, within the flight envelope:
- (1) At all loading conditions for which certification is requested;
  - (2) During all phases of operation and transition between the phases;
  - (3) With a likely failure of reversible flight control or propulsion system;
  - (4) During configuration changes;
  - (5) In all degraded flight control system operating modes;
  - (6) At all airspeeds and within the range of ballonnet or gas cell levels the Airship is designed for.
  - (7) With the expected accumulated amount of mass (e.g. due to precipitation, bird excrements, ice/frost)
- (b) An emergency landing with critical loss of thrust and without assistance from ground personnel must not require exceptional pilot skills, alertness, or physical strength.

**SC GAS.2140 Trim**

- (a) It must be possible to trim the Airship by means of static and/or aerodynamic trim, in all conditions of loading, configuration, airspeed and power, such that the flight crew workload is commensurate with the safe handling of the Airship during all flight phases. This applies for normal operations and at all cleared flight attitudes.
- (b) In case of probable failure of the ballonnet systems, critical loss of thrust or other trim system failure it must be possible to control the Airship and land safely.

**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. Consistent use of thrust and lift controls, at any given trim condition and configuration in the flight envelope, must ensure a flight crew workload commensurate with the flying task.
- (b) Any oscillation within the operating envelope of the Airship must be controllable with a normal use of the controls and without requiring exceptional pilot skills. Long-period oscillations must not induce a flight crew workload, which could compromise 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 approved Airship configurations, ancillary equipment, environmental conditions including wind conditions.
- (b) Ancillary Ground Equipment, as defined by SC GAS.2380 must be able to safely counteract ground gust conditions and wind shifts. 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 that is severe enough to interfere with the control of the Airship, induce a flight crew workload, compromises safe operation, or result in loading beyond the limit load must not occur.
- (c) Envelope or hull distortion and/or deflection must not interfere with flight path control throughout the range of airspeed, power and envelope pressure, which are within the flight envelope.
- (d) For non-rigid and semi-rigid Airships the crew must be enabled to determine envelope pressure. If the crew can control envelope pressure within limits, an improper use of the procedure and the controls must not damage the envelope or the attached structure.
- (e) For rigid Airships the crew must be enabled to determine the gas cell pressure(s). If the crew can control the gas cell pressure(s) within limits, an improper use of the procedure and the controls must not damage the gas cell(s) or the attached structure.

**SC GAS.2165 Flight in icing conditions**

- (a) An applicant requesting the certification for flight in icing conditions must demonstrate that the Airship can be safely operated in continuous maximum and intermittent maximum icing conditions agreed with the Agency.
- (b) The applicant must provide a means to detect any icing conditions. In case the Airship is not certified for icing conditions it must be demonstrated that the Airship is able 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 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 safe operation of the Airship.

**SC GAS.2180 Maximum Wind Velocities**

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

- (a) 75% of the maximum still-air speed of which the Airship is capable of achieving 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 and aerodynamic 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 any transition between them including when 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 loads, the influence of adverse environmental conditions, including effects due to superheat, must be accounted for.
- (b) Vibration or buffeting must not result in structural damage up to  $V_{CD}$ .
- (c) Flight Loads resulting from a likely failure of an Airship system, component, or propulsion system 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;
- (d) Ground and water load conditions;
- (e) Propulsion system load conditions;
- (f) Crew, Personnel and load conditions resulting from maintenance.

**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 .2625.
- (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 unsafe flutter characteristics, control reversal, and divergence:
- (1) At all airspeeds 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 unsafe flutter characteristics.

**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 paragraph (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**

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

- (a) provide stable support and / or control to the Airship during ground operation; and
- (b) account for probable system failures and the operation environment; and
- (c) absorb the kinetic energy of the landing, taking into account the Airship's spring/mass system and virtual inertia; and
- (d) 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 the critical element of the buoyancy system.

**OCCUPANT SYSTEM DESIGN PROTECTION****SC GAS.2315 Means of Egress and Emergency Exits**

With the crew and/or passenger compartment configured for take-off or landing, the Airship is designed to:

- (a) Facilitate rapid and safe evacuation of the occupants in conditions likely to occur following an emergency landing;
- (b) 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.

- (c) 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) minimise 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); and
  - (4) A survivable emergency landing
- (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 at least fire-resistant.

**SC GAS.2335 Lightning Protection**

- (a) The Airship must be protected against catastrophic effects from lightning.
- (b) Components must be designed to minimise the effects of a lightning strike such, that a lightning strike will not endanger the Airship.

**SC GAS.2340 Electrostatic Discharge**

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

**AIRSHIP DESIGN****SC GAS.2350 Airship envelope**

The Airship envelope or hull and its connecting structure must:

- (a) withstand all loading conditions expected in normal 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 including emergency conditions;
  - (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 including emergency conditions.

**SC GAS.2360 Systems for Disposable Ballast in Flight**

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

- (a) the system must be designed and installed so as to ensure controlled disposal or transfer of the ballast intended while maintaining equilibrium of the Airship under all normal and emergency operating conditions and 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.2370 Payload & baggage accommodation**

The provisions for accommodating internal or external payload (external human payload not permitted) and baggage 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) provide adequate means 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.2380 Ancillary Ground Equipment**

- (a) The applicant must identify the ancillary ground equipment required for safe operation.
- (b) The applicant must establish the performance, design requirements and procedures applicable to the ancillary ground equipment required for safe operation.
- (c) The Airship must be designed to operate safely using the ancillary ground equipment under the anticipated operating conditions.
- (d) While moored, the Airship must be prevented from unintended movement or free flight.

**SC GAS.2390 Design and Construction Information**

The following design and construction information must be established:

- (a) Equipment and systems, 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.

**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 ability and 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 must be isolated from the Airship and personnel compartments and be safely contained or discharged.
- (e) Propulsion system component installations 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 used by 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 under all permitted and likely operating conditions, including likely failures.

**SC GAS.2415 Propulsion System Ice Protection**

- (a) The Airship design must prevent foreseeable accumulation or shedding of ice or snow that adversely affects 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 operating 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 Airships.
- (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 energy 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 the direct purpose of which 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 directly affect engine availability must be considered in the engine reliability.

- (c) Propulsion support systems must be designed for the operating conditions applicable to the installation's location.
- (d) Propulsion support systems must be capable of operating under the conditions likely to occur.
- (e) Propulsion support systems 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; 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 that 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, where incorrect functioning could lead to a hazard, must be designed and installed so that they will perform their intended function properly throughout the operating and environmental limits for which the Airship is certificated.

**SC GAS.2505 General Requirements for 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**

- (a) Each system performing a function, the failure of which would prevent continued safe flight and landing must be designed and installed such that:
  - (1) The function at 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 performing 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 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 Airships 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 must have the intensities, flash rate, colours, fields of coverage, and other characteristics to provide sufficient time for other aircraft to avoid a collision.
- (c) The anti-collision lights must be distributed along the Airship such that other aircraft can identify the full dimension of the Airship from bow to stern in a timely manner.
- (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.2545 Pressurised System 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) Must be installed to ensure accurate and intelligible recording that safeguards the required data, including under conditions encountered during crash, water immersion and fire;
- (b) Must be 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) Must include features to facilitate the localisation of memory medium after an accident; and
- (d) Must be installed to automatically record 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 systems 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, if applicable, 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 crew member.
- (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 must be easily identifiable and the equipment's method of operation must be clearly marked.

**SC GAS.2607 Minimum Crew**

The minimum crew must be established so that it is sufficient for safe operation.

**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 crew members**

This paragraph applies to installed systems and equipment intended to be used by the crew members when operating the Airship from their normal seating positions in the cockpit or their operating positions in the cabin. The installed systems and equipment must be shown, individually and in combination with other such systems and equipment, to be designed so that trained crew members can safely perform their tasks associated with the intended function of the systems and equipment by meeting the following requirements:

- (a) The controls and information necessary for the accomplishment of the tasks must be provided.
- (b) The controls and information required by paragraph (a), which are intended for use by the crew members, must:
  - (1) Be presented in a clear and unambiguous form, at a resolution and with a precision appropriate to the crew member tasks;
  - (2) Be accessible and usable by the crew members in a manner appropriate to the urgency, frequency, and duration of their tasks; and
  - (3) Make the crew members aware of the effects their actions may have on the Airship or its systems, if they require awareness for the safe operation of the Airship.
- (c) Operationally relevant behaviour of the installed systems and equipment must be:
  - (1) Predictable and unambiguous, and
  - (2) Designed to enable the crew members to intervene in a manner that is appropriate to accomplish their tasks.
- (d) The installed systems and equipment must enable the crew members to manage the errors that result from the kinds of crew member interactions with the system and equipment that can be reasonably expected in service, assuming the crew member acts in good faith. Paragraph (d) does not apply to skill-related errors associated with the manual control of the Airship.

**SC GAS.2617 Flight crew alerting**

- (a) Flight crew alerts must:
  - (1) provide the flight crew with the information needed to:
    - (i) identify non-normal operation or Airship 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.
- (b) 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.
- (c) 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.
- (d) 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 airship. 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.
- (e) 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 (i)(1).
- (f) 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 safe operation of the Airship.

**SC GAS.2625 Instructions for Continued Airworthiness (ICA)**

- (a) The applicant must prepare Instructions for Continued Airworthiness that are appropriate for the certification level and performance level of the Airship.
- (b) 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.
- (c) 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.'
- (d) 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.