BOOK 2 - ACCEPTABLE MEANS OF COMPLIANCE (AMC)

1 General

1.1 Book 2 contains Acceptable Means of Compliance (AMC). They are non-requirements that are provided as joint interpretations, explanations and/or acceptable means of compliance and have been agreed for inclusion into the CS 30T.

1.2 A product for which compliance with requirements in accordance with published AMC material was shown is assured of the Agency's acceptance of such method.

2 Presentation

2.1 The AMC are presented in full page width on loose pages, each page being identified by the date of issue or the Amendment number under which it is amended or reissued.

2.2 The numbering system used is in accordance with AMC 11.050 para 4.1.

2.3 Explanatory notes not forming part of the AMC text appear in a smaller type face.

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SUBPART B - FLIGHT

AMC 30T.40
General
See CS 30T.40

The minimum ground handling crew should be specified in relation to the static heaviness or lightness and the maximum permitted surface wind speed (see CS 30T.237(b)).

AMC 30T.45
General
See CS 30T.45

(a) Conditions to be covered in the Flight Manual: - Performance data is determined and scheduled in the Flight Manual for ranges of conditions selected for the Airship, however at least that prescribed in (1), (2) and (3) below should be included.

Note: It is advisable to schedule performance data to cover the widest ranges of conditions in which the Airship is likely to operate. However, the graphical information need not be extended to the most favourable end of each range provided that where this is not done a statement is included in the Flight Manual stating what performance is to be assumed for the remainder of the range (e.g. for temperatures below I.S.A., the performance shall be taken as that appropriate to I.S.A.).

(1) Altitude

(i) For Take-off and Landing: - Aerodrome altitudes from sea-level to 2,440 m (8,000 ft) above sea-level, or to 305 m (1,000 ft) below the Ballonet Ceiling, whichever is the lesser.

Note: For Airships with normally aspirated engines the variation of performance with altitude may be shown by means of a pressure/density altitude correction.

(ii) For En-route: - From sea-level to the maximum likely operating altitude appropriate to the temperature or to the maximum altitude limit, whichever is the lesser.

(2) Temperature: - For all data, from I.S.A. -33.3 °C to I.S.A. +22.2 °C.

Note: For Airships with normally aspirated engines the variation of performance with temperature may be shown by means of a pressure/density altitude correction.

(3) Wind: - For Take-off Distance and Landing Distance, zero wind. Corrections for the effect of wind should be scheduled.

(b) Extrapolation: - In establishing the data for inclusion in the Flight Manual it is acceptable to extrapolate by calculation within the limits detailed below. In all cases an acceptable degree of conservatism shall be included; this may be less than that called for below, if evidence is offered to substantiate a reduced degree of conservatism.

(1) Altitude: - Take-off performance

(i) One Test Location: - Where performance is determined at one location only, the data may be extrapolated for altitudes not greater than 1,524 m (5,000 ft) above and below the test altitude, provided that:

(A) for altitudes below the test altitude a degree of conservatism equal to 0.5 times the calculated effect of altitude is applied,

(B) for altitudes above the test altitude a degree of conservatism equal to 1.5 times the calculated effect of altitude is applied.

(ii) Two Test Locations: - Where performance is determined at two locations separated by an altitude h of not less than 610 m (2,000 ft), the data may be extrapolated for altitudes not more than 5000 ft above the upper test altitude, and for altitudes not more than 1,524 m (5,000 ft) below the lower test altitude provided that:

(A) for altitudes more than h below the lower test altitude a degree of conservatism equal to 0.8 times the measured effect of altitude is applied,

(B) for altitudes between h below the lower test altitude and h above the upper test altitude no degree of conservatism needs to be applied,

(C) for altitudes more than h above the upper test altitude a degree of conservatism equal to 1.2 times the measured effect of altitude is applied.

(2) Temperature: Take-off and Climb Performance

(i) One Test Location: - Where performance is determined at one location only, the data may be extrapolated for temperature not more than 20°C above and below the mean test temperature, provided that:

(A) for temperatures below the test temperature a degree of conservatism equal to 0.5 times the calculated effect of temperature is applied,

(B) for temperatures above the test temperature a degree of conservatism equal to 1.5 times the calculated effect of temperature is applied.

(ii) Two Test Series: - Where performance is determined on two occasions or at two locations differing in ambient temperature by t°C, the data may be extrapolated for temperatures not more than 20°C below the lower test temperature, and for temperatures not more than 20°C above the higher test temperature provided that it is not less than 10°C, and

(A) for temperatures more than t°C below the lower mean test temperature a degree of conservatism equal to 0.8 times the measured effect of temperature is applied;

(B) for temperatures between t°C below the lower mean test temperature and t°C above the higher mean test temperature no degree of conservatism needs to be applied;

(C) for temperatures more than t°C above the higher mean test temperature a degree of conservatism equal to 1.2 times the measured effect of temperature is applied.

(3) Static Heaviness

(i) Take-off and Climb Performance

(A) One Test Heaviness: - Where performance is determined at one value of heaviness only, the data may be extrapolated without limit, provided that:

(1) the tests are carried out at not less than 95% of the maximum heaviness permitted for take-off, and

(2) for values of heaviness below that tested, a degree of conservatism equal to 0.5 times the calculated effect of heaviness is applied.

(A) Two Values of Test Heaviness: - Where performance is determined at two values of heaviness differing by an amount h, the data may be extrapolated without limit provided that:

(1) the higher of the values of test heaviness is not less than 95% of the maximum heaviness permitted for take-off; and

(2) for values of heaviness more than h kg below the lower test heaviness a degree of conservatism equal to 0.8 times the measured effect of heaviness is applied;

(3) for values of heaviness between h kg below the lower test heaviness and the maximum heaviness permitted for take-off, no conservatism need be applied.

(ii) Landing: - Performance data should normally be determined at not less than two values of test heaviness.

(A) The lower value should be within 10% of the minimum value of heaviness (maximum value of lightness) permitted for landing, and

(B) the higher value should not be less than 95% of the maximum value permitted for landing, and no conservatism need be applied to the measured effect of heaviness performance.

Where one extreme of the permitted range of heaviness can be shown to be clearly non-limiting, without testing, the proposed test programme and degree of extrapolation conservatism should be discussed with the Agency.

AMC 30T.51
Take-off
See CS 30T.51

(a) The take-off technique should permit adequate control at all points in the take-off, both with all engines operating and in the event of a power unit failure, in all wind speeds up to the maximum permitted for take-off. Adequate allowance should be made for pilot reaction times as well as for the necessity for the pilot to carry out such drills and procedures as may reasonably be used in operation. Appropriate allowance should also be made for any foreseeable failure or malfunction of the devices for which credit is taken (e.g. Vectored Thrust), and for variations in static heaviness within the permitted range.

(b) In establishing the measured take-off distance (see CS 30T.51(b)), the achievement of the 15 m (50 ft) screen height should be assessed on the basis of the lowest part of the Airship, or the lowest part of the handling ropes, whichever is the lower, clearing the screen.

(c) In establishing the measured accelerate-stop distance (see CS 30T.51(c)), the means of retardation for which performance credit may be taken should be discussed with the Agency.

(d) In establishing the minimum space required for take-off (see CS 30T.51(e)(2)), the width of the minimum space required for take-off defined in (e)(2) is based on the assumptions that:

(1) rectangular spaces will be used in condition of light cross-winds only, and

(2) the deviation from the centre-line due to engine failure in still air conditions will not exceed 10 m.

If either of these conditions is not met, the required width should be discussed with the Agency.

AMC 30T.65
Climb: all engines operating
See CS 30T.65

Information should be provided on the maximum rates of climb and descent to be used in the event of failures in the primary means of supplying air to, or controlling pressure in, the ballonets.

AMC 30T.255
Ground handling characteristics
See CS 30T.255

The ground handling of Airships is a classical problem area that needs to be notified with high importance. As Airships of this category have to deal with large numbers of passengers and/or considerable cargo weights, the definition of procedures and the necessary minimum-crew should also consider failure conditions (for example: engine failure and/or loss of control).

Further issues, that should be considered, are:

Ground crew co-ordination: ground crew chief and responsibility sharing/hand over between ground crew chief and pilot, Airship tie down or ballast procedure for loading and unloading, on-mast/off-mast responsibility, ground pressure control/ surveillance.

Appropriate wind limitations should be determined.

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SUBPART C - STRENGTH

AMC 30T.371
Gyroscopic effect
See CS 30T.371

For a two-bladed propeller the maximum yawing couple shall be $2 \cdot I \cdot \omega_1 \cdot \omega_2$. For three or more evenly spaced blades the yawing couple shall be $I \cdot \omega_1 \cdot \omega_2$, where:

I	kgm²	is the polar moment of inertia of a single propeller,
ω_1	radians/sec	is the propeller rotation, and
ω_2	radians/sec	is the rate of pitch or yaw.

AMC 30T.571
General
See CS 30T.571

The Agency shall be consulted at an early stage in the design in order that the procedure to establish safe fatigue characteristics may be determined. Account will be taken of the type of structure, stress and strain levels, materials of construction and, where relevant, proposed flight plans.)

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SUBPART D - DESIGN AND CONSTRUCTION

AMC 30T.603
Materials
See CS 30T.603

For this AMC please use the wording as laid down in AMC CS 25.603 Composite Aircraft Structure, Amdt. 16, 1. May 2003.

However, with the following additions (**bold**):

2.6 Environment. External, non-accidental conditions (excluding mechanical loading), separately or in combination, that can be expected in service and which may affect the structure (e.g. temperature, moisture, UV radiation, fuel, **lubricants, hydraulic and de-icing fluids, lifting gas and other airship specific substances**).

AMC 30T.613
Material strength properties and design values
See CS 30T.613

(Concerning ACJ JAR 25.603 please refer to published JAR Material.)

Design values could be those contained in or determined from the following publications (obtainable from the Superintendent of Documents, Government Printing Office, Washington, DC 20402) or other values approved by the Agency: MIL-HDBK-5, 'Metallic Materials and Elements for Flight Vehicle Structure'; MIL-HDBK-17, 'Plastics for Flight Vehicles'; ANC-18, 'Design of Wood Aircraft Structures'; ~~MIL-HDBK-23, 'Composite construction for Flight Vehicles'; and~~, Federal Requirement 191-A, 'Textile Test Methods'.

(a) Design properties outlined in MIL-HDBK-5 may be used subject to the following conditions.

(1) Where applied loads are eventually distributed through a single member within an assembly, the failure of which would result in the loss of the structural integrity of the component involved, the guaranteed minimum design mechanical properties ('A' values) when listed in MIL-HDBK-5 must be met.

(2) Redundant structures in which the partial failure of individual elements would result in applied loads being safely distributed to other load carrying members may be designed on the basis of the '0.90 probability' ('B' values) when listed in MIL-HDBK-5. Examples of these items are sheet-stiffener combinations and multi-rivet or multiple-bolt connections.

(b) Design values greater than the guaranteed minima required by subparagraph (a) of this paragraph may be used if a 'premium selection' of the material is made in which 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 design.

(c) Material correction factors for structural items such as sheets, sheet-stringer combinations, and riveted joints, may be omitted if sufficient test data are obtained to allow a probability analysis showing that 90% or more of the elements will equal or exceed allowable selected design values.

AMC 30T.619
Special factors
See CS 30T.619

Where the special factors of safety prescribed in CS 30T.621 through 628 are not pertinent the Agency will determine the appropriate measures that must be taken.

AMC 30T.621
Casting Factors
General Guidance For Use of Casting Factors and Background to the Requirement
See CS 30T.621

1. Purpose.

1.1 CS 30T.621 is an additional rule/requirement for structural substantiation of cast parts and components. It is used in combination with a number of other paragraphs, and does not replace or negate compliance with any other paragraph of CS 30T. The intent of this AMC is to provide general guidance on the use and background of "Casting Factors" as required by CS 30T.621.

2. General guidance for use of casting factors.

2.1 For the analysis or testing required by CS 30T.307, the ultimate load level must include limit load multiplied by the required factor required by CS 30T.619. The testing required in accordance with CS 30T.621 may be used in showing compliance with CS 30T.305 and CS 30T.307. These factors need not be considered in the fatigue and damage tolerance evaluations required by CS 30T.573.

2.2 The inspection methods prescribed by CS 30T.621(c) and (d) for all production castings must be such that 100% of the castings are inspected by visual and liquid penetrant techniques, with total coverage of the surface of the casting. With regard to the required radiographic inspection, each production casting must be inspected by this technique or equivalent inspection methods; the inspection may be limited to the structurally significant internal areas and areas where defects are likely to occur.

2.3 With the establishment of consistent production, it is possible to reduce the inspection frequency of the non-visual inspections required by the rule for non-critical castings, with the approval of the Authority. This is usually accomplished by an approved quality control procedure incorporating a sampling plan. [Refer to CS 30T.621(d)(5).]

2.4 The static test specimen(s) should be selected on the basis of the foundry quality control inspections, in conjunction with those inspections prescribed in CS 30T.621(c) and (d). An attempt should be made to select the worst casting(s) from the first batch produced to the production standard.

2.5 If applicable, the effects on material properties due to weld rework should be addressed. The extent and scope of weld rework should be detailed in the manufacturing specifications as well as on the design drawings.

3. Background.

3.1 Regulatory Background. CS 30T.621 ("Casting factors") requires classification of structural castings as either „critical" or „non-critical." Depending on classification, the requirement specifies the accomplishment of certain inspections and tests, and the application of special factors of safety for ultimate strength and deformation.

3.2 Application of Special Factors of Safety. The application of factors of safety applied to castings is based on the fact that the casting process can be inconsistent. Casting is a method of forming an object by pouring molten metal into a mould, allowing the material to solidify inside the mould, and removing it when solidification is complete. Castings are subject to variability in mechanical properties due to this casting process, which can result in imperfections, such as voids, within the cast part. Using certain inspection techniques, for example radiographic (X-ray), it is possible to detect such imperfections above a minimum detectable size, but accurate detection depends on the dimensions of the part, the inspection equipment used, and the skill of the inspector.

3.2.1 CS 30T.619 („Special factors") includes a requirement to apply a special factor to the factor of safety prescribed in CS 30T.303 for each part of the aeroplane structure whose strength is subject to appreciable variability because of uncertainties in the manufacturing processes or inspection methods. Since the mechanical properties of a casting depend on the casting design, the design values established under CS 30T.613 („Material strength properties and design values") for one casting might not be applicable to another casting made to the same specification. Thus, casting factors have been necessary for castings produced by normal techniques and methodologies to ensure the structural integrity of castings in light of these uncertainties.

3.2.2 Another approach is to reduce the uncertainties in the casting manufacturing process by use of a „premium casting process" (discussed in ACJ 25.621(c)(1)), which provides a means of using a casting factor of 1.0. CS 30T.621 („Casting factors") does permit the use of a casting factor of 1.0 for critical castings, provided that:

- the manufacturer has established tight controls for the casting process, inspection, and testing; and
- the material strength properties of the casting have no more variability than equivalent wrought alloys.

AMC 30T.621(c)(1)
Premium Castings
(Acceptable Means of Compliance)
See CS 30T.621(c)(1)

1. Purpose. This AMC details an acceptable means, but not the only means, for compliance with CS 30T.621 for using a casting factor greater than or equal to 1.0, but less than 1.25, for „critical" castings used in structural applications. A premium casting process is capable of producing castings with predictable properties, thus allowing a casting factor of 1.00 to be used for these components. Three major steps, required by CS 30T.621(c)(1)(i), are essential in characterising a premium casting process:

- qualification of the process,
- proof of the product, and
- monitoring of the process.

2. Definitions. For the purposes of this AMC, the following definitions apply:

2.1 Premium Casting Process: a casting process that produces castings characterised by a high quality and reliability

2.2 Prolongation: an integrally cast test bar or test coupon.

2.3 Test Casting: a casting produced specifically for the purpose of qualifying the casting process.

3. General. The objective of a premium casting process is to consistently produce castings with high quality and reliability. To this end, the casting process is one that is capable of consistently producing castings that include the following characteristics:

- Good dimensional tolerance
- Minimal distortion
- Good surface finish
- No cracks
- No cold shuts
- No laps
- Minimal shrinkage cavities
- No harmful entrapped oxide films
- Minimal porosity
- A high level of metallurgical cleanness
- Good microstructural characteristics
- Minimal residual internal stress
- Consistent mechanical properties

The majority of these characteristics can be detected, evaluated, and quantified by standard non-destructive testing methods, or from destructive methods on prolongation or casting cut-up tests. However, a number of them cannot. Thus, to ensure an acceptable quality of product, the significant and critical process variables must be identified and adequately controlled.

4. A Means of Qualification of Casting Process.

4.1 To prove a premium casting process, the applicant should submit it to a qualification program that is specific to a foundry/material combination. The qualification program should establish the following:

(a) The capability of the casting process of producing a consistent quality of product for the specific material grade selected for the intended production component.

(b) The mechanical properties for the material produced by the process have population coefficients of variation equivalent to that of wrought products of similar composition (i.e., plate, extrusions, and bar). Usage of the population coefficient of variation from forged products does not apply. In most cases, the coefficients of variation for tensile ultimate strength and tensile yield strength less than or equal to 3.5% and 4.0% respectively is adequate to demonstrate this equivalency of mechanical properties.

(c) The casting process is capable of producing a casting with uniform properties throughout the casting or, if not uniform, with a distribution of material properties that can be predicted to an acceptable level of accuracy.

(d) The (initial) material design data for the specified material are established.

(e) The material and process specifications are clearly defined.

4.2 For each material specification, a series of test castings from a number of melts, using the appropriate production procedures of the foundry, should be manufactured. The test casting produced should undergo a standardised inspection or investigation of non-destructive inspection and cut-up testing, to determine the consistency of the casting process.

4.3 The test casting should be representative of the intended cast product(s) with regard to section thicknesses and complexity, and should expose any limitations of the casting process. In addition, the test casting should be large enough to provide mechanical test specimens from various areas, for tensile and, if applicable, compression, shear, bearing, fatigue, fracture toughness, and crack propagation tests. If the production component complies with these requirements, it may be used to qualify the process. The number of melts sampled should be statistically significant. Typically, at least 10 melts are sampled, with no more than 10 castings produced from each melt. If the material specification requires the components to be heat-treated, this should be done in no fewer than 10 heat treatment batches consisting of castings from more than one melt. Reduction of qualification tests may be considered if the casting process and the casting alloy is already well known for aerospace applications and the relevant data are available.

4.4 Each test casting should receive a non-destructive inspection program which should include as a minimum:

- inspection of 100% of its surface, using visual and liquid penetrant, or equivalent, inspection methods; and
- inspection of structurally significant internal areas and areas where defects are likely to occur, using radiographic methods or equivalent inspection methods. The specific radiographic standard to be employed is to be determined, and the margin by which the test castings exceed the minimum required standard should be recorded.

4.4.1 The program of inspection is intended to;

(a) confirm that the casting process is capable of producing a consistent quality of product, and

(b) verify compliance with the stated objectives of a premium casting process with regard to surface finish, cracks, cold shuts, laps, shrinkage cavities, and porosity, (see paragraph 3), and

(c) ensure that the areas from which the mechanical property test samples were taken were typical of the casting as a whole with respect to porosity and cleanness.

4.4.2 Guidance on non-destructive inspection techniques and methods can be obtained from national and international standards. The standard listing below is not a comprehensive list but is given as an initial reference guide.

ASTM A802 Standard practice for steel castings, surface acceptance standards, visual examination.

ASTM A903 Standard specification for steel castings, surface acceptance standards, magnetic particle and liquid penetrant inspection.

ASTM E155 Standard Reference Radiographs for Inspection of Aluminum and Magnesium Castings.

ASTM E192 Standard Reference Radiographs for Investment Steel Castings of Aerospace Applications.

ASTM E433 Standard reference photographs for liquid penetrant inspection.

ASTM E1030 Standard test method for radiographic examination of metallic castings.

ASTM E1320 Standard Reference Radiographs for Titanium Castings.

ISO 4986 Steel castings -- Magnetic particle inspection

ISO 4987 Steel castings -- Penetrant inspection

ISO 4993 Steel castings -- Radiographic inspection

ISO 9915 Aluminium alloy castings -- Radiography testing

ISO 9916 Aluminium alloy and magnesium alloy castings -- Liquid penetrant inspection

ISO 10049 Aluminium alloy castings -- Visual method for assessing the porosity

ISO 11971 Visual examination of surface quality of steel castings

The test castings must show that the Foundry/Process combination is capable of producing product free of cracks, laps, and cold shuts. Ideally the test castings should be free of detectable shrinkage cavities and porosity. With regard to dimensional tolerance, distortion, and surface finish guidance for acceptance criteria can be gained from the standards cited above. Consideration that these standards are for general quality castings must be given when they are used.

4.5 All test castings should be cut up to a standardised methodology to produce the mechanical test specimens as detailed by paragraph 4.3 above. Principally, the tests are to establish the variability within the cast component, as well as to determine the variability between components from the same melt and from melt to melt. The data gathered also may be used during latter phases to identify deviations from the limits established in the process qualification and product proving programs.

4.6 All the fracture surfaces generated during the qualification program should be inspected at least visually for detrimental defects. Evidence of inclusions, oxide films, porosity or shrinkage cavities would indicate inadequate control of the casting process.

4.7 As part of the cut-up investigation, it is usually necessary to take metallographic samples for cleanness determination and microstructural characterisation.

4.9 When the process has been qualified, it should not be altered without completing comparability studies and necessary testing of differences.

5. Proof of Product

5.1 Subsequent to the qualification of the process, the production castings should be subjected to a production-proving program. Such castings should have at least one prolongation; however, large and/or complex castings may require more than one. If a number of castings are produced from a single mould with a single runner system, they may be treated as one single casting. The production-proving program should establish the following:

(a) The design values developed during the process qualification program are valid (e.g., same statistical distribution) for the production casting.

(b) The production castings have the same or less than the level of internal defects as the test castings produced during qualification.

(c) The cast components have a predictable distribution of tensile properties.

(d) The prolongation(s) is representative of the critical area(s) of the casting.

(e) The prolongation(s) consistently reflects the quality process, and material properties of the casting.

5.2 A number of (i.e., at least two) pre-production castings of each part number to be produced should be selected for testing and inspection. All of the selected castings should be non-destructively inspected in accordance with the qualification program.

(a) One of these castings should be used as a dimensional tolerance test article. The other selected casting(s) should be cut up for mechanical property testing and metallographic inspection.

(b) The casting(s) should be cut up to a standardised program to yield a number of tensile test specimens and metallographic samples. There should be sufficient cut-up tensile specimens to cover all critical („critical“ with respect to both the casting process and service loading) areas of the casting.

(c) All prolongations should be machined to give tensile specimens, and subsequently tested.

(d) The production castings should be produced to production procedures identical to those used for these pre-production castings.

5.3 On initial production, a number of castings should undergo a cut-up for mechanical property testing and metallographic inspection, similar to that performed for the pre-production casting(s). The cut-up procedure used should be standardised, although it may differ from that used for the pre-production casting(s). Tensile specimens should be obtained from the most critical areas.

(a) For the first 30 castings produced, at least 1 casting in 10 should undergo this testing program.

(b) The results from the mechanical property tests should be compared with the results obtained from the prolongations to further substantiate the correlation between prolongation(s) and the critical area(s) of the casting.

(c) In addition, if the distribution of mechanical properties derived from these tests is acceptable, when compared to the property values determined in the qualification program, the frequency of testing may be reduced. However, if the comparison is found not to be acceptable, the test program may require extension.

5.4 At no point in the production should the castings contain shrinkage cavities, cracks, cold shuts, laps, porosity, or entrapped oxide film, or have a poor surface finish, exceeding the acceptance level defined in the technical specifications.

6. Monitoring the Process

6.1 The applicant should employ quality techniques to establish the significant/critical foundry process variables that have an impact on the quality of the product. The applicant should show that these variables are controlled with positive corrective action throughout production.

6.2 During production, every casting should be non-destructively inspected using the techniques and the acceptance standards employed during the qualification program.

(a) Rejections should be investigated and process corrections made as necessary.

(b) Alternative techniques may be employed if the equivalence in the acceptance levels can be demonstrated.

(c) In addition, tensile tests should be taken from the prolongations on every component produced, and the results should comply with limits developed in the process qualification and product proving programs.

(d) Additionally, as previously mentioned, a periodic casting cut-up inspection should be undertaken, with the inspection schedule as agreed upon during the proof of product program.

(e) Deviations from the limits established in the process qualification and product proving programs should be investigated and corrective action taken.

7. Modifications to the Casting Design, Material, and Process.

7.1 Additional testing may be required when alterations are made to the casting geometry, material, significant/critical process variables, process, or production foundry to verify that the alterations have not significantly changed the castings' properties. The verification testing recommended is detailed in Table 1, below:

TABLE 1. Recommended Verification Testing

Modifications					Verification Testing		
Case	Geometry	Material	Process	Foundry	Qualification of Process	Proof of Product	Tests per CS 30T.621(c)(1)
1	yes	none	none	none	not necessary	yes	yes (b)
2	none	yes	none	none	yes (a)	yes	yes (b)
3	yes	yes	none	none	yes	yes	yes
4	none	none	yes	none	yes (a)	yes	yes (b)
5	none	none	none	yes	yes (a)	yes	yes (b)

(a) The program described in paragraph 4. of this AMC to qualify a new material, process, and foundry combination may not be necessary if the following 3 conditions exist for the new combination:

(1) Sufficient data from relevant castings to show that the process is capable of producing a consistent quality of product, and that the quality is comparable to or better than the old combination.

(2) Sufficient data from relevant castings to establish that the mechanical properties of the castings produced from the new combination have a similar or better statistical distribution than the old combination.

(3) Clearly defined material and process specifications.

(b) The casting may be re-qualified by testing partial static test samples (with larger castings, re-qualification could be undertaken by a static test of the casting's critical region only); this should be approved.

AMC 30T.628
Rope, wire, cable and chain factors
see CS30T.628

There is a whole range of very different uses for ropes. For example:

Control cables	– to constantly move the rudders and elevators in flight
Valve lines	– to occasionally control gas valves and ballast water tank valves in flight and on ground
Catenary curtain	– fixed length permanently loaded cables that attach the gondola to the envelope
Fin rigging	– to hold the fins steady and transmit side loads to the envelope with minimum drag
Handling lines	– to hold onto the Airship during construction and when in transit
Mooring lines	– that are dropped and used briefly to steady the Airship during landing
Nose connection line	– that pulls the Airship onto the mast
Lifting lines	– for winches or cranes to move heavy items such as engines on or off the Airship
Handrails and crew safety lines	– to allow access to all parts of the ship for inspection

Consequently the properties will also be very different and the applicant should be clear about their design, operation and maintenance. For ropes and cables proof needs to be furnished of the suitability, durability and reliability of the product (also in conjunction with CS 30T.899). The applicant should also be aware that this is a well researched and well regulated topic in other industries where peoples lives are similarly at risk, e.g. ships, cranes, elevators and lifts, and rock climbing. This might help showing compliance in case of a CRI or Special Condition procedure.

AMC 30T.631
Bird strike
See CS 30T.631

This requirement constitutes the minimum that must be demonstrated. The Agency may require a higher mass of bird depending on the likely operating environment of the Airship.

AMC 30T.723
Shock absorption tests
See CS 30T.723(a)

(1) Purpose. This AMC sets forth an acceptable means, but not the only means, of demonstrating compliance with the provisions of CS 30T.25 related to the use of landing gear shock absorption tests and analyses to determine landing loads for large transport Airships.

(2) Related CS 30T Paragraphs. CS 30T.723 ‘Shock Absorption Tests’ and CS 30T.473 ‘Ground Load Conditions and Assumptions’.

(3) Shock Absorption Tests

3.1 Validation of the landing gear characteristics: Shock absorption tests are necessary to validate the analytical representation of the dynamic characteristics of the landing gear unit that will be used to determine the landing loads. A range of tests should be conducted to ensure that the analytical model is valid for reasonable extrapolations to other design conditions and configurations expected in service. In addition, consideration should be given to ensuring that the range of test configurations are sufficient for justifying the analytical model for foreseeable future growth versions of the aeroplane.

3.2 Recommended test conditions for new landing gear units: The maximum take-off weight and the maximum landing weight conditions should both be included as configurations subjected to energy absorption tests. However, in cases where the manufacturer has previous experience in validating the analytical model using landing gear units of similar design concept, it may be sufficient to conduct a single shock absorption test of the new landing gear for the condition associated with maximum energy. The similar landing gear used to provide the additional supporting data may be from another model aircraft but the landing gear unit should be of approximately the same size with similar components.

3.3 Change to type designs: Subsequent changes to the landing conditions or to the landing gear units may be substantiated by analyses based on tests of the same basic landing gear unit with similar dynamic characteristics, provided the design concept has not changed and the results of the previous energy absorption tests are sufficient to realistically validate the analytical results for the design changes. For example, the following changes may be acceptable without further tests:

(a) Airship sprung mass (effective weight) variations, including extrapolation from maximum landing weight to maximum take-off weight conditions.

(b) Changes in shock absorber characteristics including pre-load, compression ratio and orifice sizes.

(c) Changes in tyre characteristics.

(d) Change in unsprung mass (e.g. brakes).

(e) Local strengthening, or minor sizing changes to the landing gear.

(4) Limit free drop tests

4.1 Compliance with CS 30T. 723(a) may be shown by free drop tests, provided they are made on the complete Airship, or on units consisting of a wheel, tyre, and shock absorber, in their proper positions, from free drop heights not less than:

(a) 475 mm (18.7 inches) for the maximum landing weight conditions; and

(b) 170.2 mm (6.7 inches) for the maximum take-off weight conditions.

4.2 If the Airship lift is simulated by air cylinders or by other mechanical means, the weight used for the drop must be equal to W. If the effect of aeroplane lift is represented in free drop tests by a reduced weight, the landing gear must be dropped with an effective weight equal to:

$$We = W (h+(1- L) d)/(h+ d)$$

Where

We = the effective weight to be used in the drop test (kg);

h = specified free drop height (mm);

d = deflection under impact of the tyre (at the approved inflation pressure) plus the vertical component of the axle travel relative to the drop weight (mm);

W = *Wm* for main gear units (kg), equal to the static weight on that unit with the Airship in the level attitude (with the nose wheel clear in the case of nose wheel type Airships);

W = *WT* for tail gear units (kg), equal to the static weight on the tail unit with the Airship in the tail-down attitude;

W = *WN* for nose wheel when units (kg), equal to the vertical component of the static reaction that would exist at the nose wheel, assuming that the weight of the Airship acts at the centre of gravity and exerts a force of 1.0 *g* downward and 0.25 *g* forward; and

L = ratio of the assumed Airship lift to the Airship weight, but not more than 1.0.

4.3 The drop test attitude of the landing gear unit and the application of appropriate drag loads during the test must simulate the Airship landing conditions in a manner consistent with the development of a rational or conservative limit loads.

4.4 The value of d used in the computation of We in paragraph 4.2 of this AMC may not exceed the value actually obtained in the drop test.

(5) Reserve Energy Free Drop Tests.

5.1 Compliance with the reserve energy absorption condition specified in CS 30T. 723(b) may be shown by free drop tests provided the drop height is not less than 685.8 mm (27 inches).

5.2 If aeroplane lift is simulated by air cylinders or by other mechanical means, the weight used for the drop must be equal to W. If the effect of Airship lift is represented in free drop tests by an equivalent reduced weight, the landing gear must be dropped with an effective weight equal to:

$$We = Wh/(h+ d)$$

where the symbols and other details are the same as in paragraph (4) above.

AMC 30T.773
Pilot compartment view
See CS 30T.773

Where the Airship is under the effective control of ground crew, the pilots' view need only be sufficient for them to fulfil their own responsibilities.

AMC 30T.807
Emergency exits
See CS 30T.807

(a) Types: for the purpose of this code the types of exits are defined as follows:

(1) Type I: This type is a floor level exit with a rectangular opening of not less than 24 in (609.6mm) wide by 48 in (1.219 m) high, with corner radii not greater than one-third the width of the exit.

(2) Type II: This type is a rectangular opening of not less than 20 in (508 mm) wide by 44 in (1.12 m) high, with corner radii not greater than one-third the width of the exit. Type II exits must be floor level.

(3) Type III: This type is a rectangular opening of not less than 20 in (508 mm) wide by 36 in (914.4 mm) high, with corner radii not greater than one-third the width of the exit, and with a step-up inside the Airship of not more than 20 in (508 mm).

(4) Type IV: This type is a rectangular opening of not less than 19 in (482.6 mm) wide by 26 in (660.4 mm) high, with corner radii not greater than one-third the width of the exit.

(5) Type A: This type is a floor level exit with a rectangular opening of not less than 42 in (1.067 m) wide by 72 in (1.829 m) high with corner radii not greater than one-sixth of the width of the exit.

(b) Operation: Each emergency exit must

(1) Be readily accessible, requiring no exceptional agility when used in emergencies;

(2) Have a method of opening that is simple and obvious;

(3) Be arranged and marked for easy location and operation, even in darkness;

(4) Have reasonable provisions against jamming by car, compartment or cabin deformation

(c) The proper function of each emergency exit must be shown by tests.

(d) Step down distance: Step down distance, as used in this paragraph, means the actual distance between the bottom of the required opening and a usable foot hold, extending out from the gondola, car or passenger compartment, that is large enough to be effective without searching by sight or feel.

(e) Over-sized exits: Openings larger than those specified in this paragraph, whether or not of rectangular shape, may be used if the specified rectangular opening can be inscribed within the opening and the base of the inscribed rectangular opening meets the specified step-up and step-down heights.

(f) Passenger emergency exits: Except as provided in subparagraphs (f)(3) to (5) of this paragraph, the minimum number and type of passenger emergency exits is as follows:

(1) For passenger seating configurations of 1 to 299 seats:

Passenger seating (crewmember seats not included)	Emergency exits for each side			
	Type I	Type II	Type III	Type IV
1 to 9				1
10 to 19			1	
20 to 39		1	1	
40 to 79	1		1	
80 to 109	1		2	
110 to 139	2		1	
140 to 179	2		2	

Additional exits are required for passenger seating configurations greater than 179 seats in accordance with the following table:

Additional emergency exits for each side	Increase in passenger seating configuration allowed
Type A	110
Type I	45
Type II	40
Type III	35

(2) For passenger seating configurations greater than 299 seats, each emergency exit in the side of the gondola, car or passenger compartment must be either a Type A or a Type I. A passenger seating configuration of 110 seats is

allowed for each pair of Type A exits and a passenger seating configuration of 45 seats is allowed for each pair of Type I exits.

(3) An alternate emergency exit configuration may be approved in lieu of that specified in subparagraph (f)(1) or (2) of this paragraph provided the overall evacuation capability is shown to be equal to or greater than that of the specified emergency exit configuration.

(4) The following must also meet the applicable emergency exit requirements of CS 30T.809 to 813:

(5) Each emergency exit in the passenger compartment in excess of the minimum number of required emergency exits.

(6) Any other floor level door or exit that is accessible from the passenger compartment and is as large or larger than a Type II exit, but less than 46 in (1.168 m) wide.

(7) For an Airship that is required to have more than one passenger emergency exit for each side of the gondola, car or passenger compartment, no passenger emergency exit shall be more than 18 m (60 ft) from any adjacent passenger emergency exit on the same side of the same deck, as measured parallel to the Airship's longitudinal axis between the nearest exit edges.

(g) Location: Emergency exits must be located to allow escape without crowding in any probable crash attitude.

(1) If the pilot compartment is separated from the passenger compartment with a door that is likely to block the pilot's escape in a minor crash, there must be an exit in the pilot's compartment;

(2) The number of exits required by subparagraph (1) must then be separately determined for the passenger compartment, using the seating capacity of that compartment.

(3) Every area which is accessible for the crew in flight must be equipped with an openable window, which meets the criteria for type IV emergency exits.

AMC 30T.810
Emergency egress assist means and escape routes
See CS 30T.810

Each emergency exit more than 1.8 m (6 ft) from the ground with the Airship on the ground and the landing gear extended must have an approved means to assist the occupants in descending to the ground.

(a) The assisting means for each passenger emergency exit must be a self-supporting slide or equivalent; and, in the case of a Type A exit, it must be capable of carrying simultaneously two parallel lines of evacuees. In addition, the assisting means must be designed to meet the following requirements.

(1) It must be automatically deployed and deployment must begin during the interval between the time the exit opening means is actuated from inside the Airship and the time the exit is fully opened. However, each passenger emergency exit which is also a passenger entrance door or a service door must be provided with means to prevent deployment of the assisting means when it is opened from either the inside or the outside under non-emergency conditions for normal use.

(2) It must be automatically erected within 10 seconds after deployment is begun.

(3) It must be of such length after full deployment that the lower end is self-supporting on the ground and provides safe evacuation of occupants to the ground after collapse of one or more legs of the landing gear.

(4) It must have the capability, in 46 km/h (25 knot) winds directed from the most critical angle, to deploy and, with the assistance of only one person, to remain usable after full deployment to evacuate occupants safely to the ground.

(5) For each system installation (mock-up or Airship installed), five consecutive deployment and inflation tests must be conducted (per exit) without failure, and at least three tests of each such five-test series must be conducted using a single representative sample of the device. The sample devices must be deployed and inflated by the system's primary means after being subjected to the inertia forces specified in Table 7 of Appendix A. If any part of the system falls or does not function properly during the required tests, the cause of the failure or malfunction must be corrected by positive means and after that, the full series of five consecutive deployment and inflation tests must be conducted without failure.

(b) The assisting means for flight crew emergency exits may be a rope or any other means demonstrated to be suitable for the purpose. If the assisting means is a rope, or an approved device equivalent to a rope, it must be:

(1) attached to the structure at or above the top of the emergency exit opening, or, for a device at a crew's emergency exit window, at another approved location if the stowed device, or its attachment, would reduce the pilot's view in flight.

(2) able (with its attachment) to withstand a 1785 N static limit load.

AMC 30T.899(f)
Hoists and suspended loads
See CS 30T.899(f)

Compliance with the requirement of CS 30T.899(f) can be proved by a certificate from an expert body. This certificate also contains the conditions for safe operation of the device.

SUBPART F - EQUIPMENT

AMC 30T.1499
General
See CS 30T.1499

1. Heated Domestic Appliances (Galley Equipment)

(a) The design and installation of heated domestic appliances should be such that no single failure (e.g. welded thermostat or contactor, loss of water supply) can result in dangerous overheating and consequent risk of fire or smoke or injury to occupants. An acceptable method of achieving this is by the provision of a means independent of the normal temperature control system, which will automatically interrupt the electrical power supply to the unit in the event of an overheat condition occurring. The means adopted should be such that it cannot be reset in flight.

(b) The design and installation of microwave ovens should be such that no hazard could be caused to the occupants or the equipment of the Airship under either normal operation or single failure conditions.

(c) Heated liquid containers, e.g. water boilers, coffee makers should, in addition to overheat protection, be provided with an effective means to relieve overpressure, either in the equipment itself or in its installations.

Notes: Due account should be taken of the possible effects of lime scale deposit both in the design and maintenance procedures of water heating equipment. The design of galley and cooking appliance installations should be such as to facilitate cleaning to limit the accumulation of extraneous substances which may constitute a fire risk.

2. Electric Overheat Protection Equipment, Including those Installed in Domestic Systems

Unless it can be shown that compliance with CS 30T.1499(a) is provided by the circuit protective device required by CS 30T.1357(a), electric motors and transformers etc., installed in domestic systems, should be provided with a suitable thermal protection device if necessary to prevent them overheating such as to create a smoke or fire hazard under normal operation and failure conditions.

The following should be taken into consideration:

(a) Failures of any automatic control systems, e.g. automatic timer systems, which may cause the motor to run continuously;

(b) Short circuit failures of motor windings or transformer windings to each other or to the motor or transformer frame;

(c) Open circuit of one or more phases on multi-phase motors;

(d) Motor seizures;

(e) The proximity of flammable materials or fluids;

(f) The proximity of other Airship installations;

(g) Spillage of fluids, such as toilet waste;

(h) Accumulation of combustible material; and

(i) Cooling air discharge under normal operating or failure conditions.

3. Water systems

Where water is provided in the Airship for consumption or use by the occupant, the associated system should be designed so as to ensure that no hazard to the Airship can result from water coming into contact with electrical or other systems. Service connections (filling points) should be of a different type from those used for other services, such that water could not inadvertently be introduced into the systems for other services.

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SUBPART G - OPERATING LIMITATIONS AND INFORMATION

AMC 30T.1601
Airworthiness Airship Cabin Manual (AACM)
See CS 30T.1601
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APPENDICES

AMC Appendix C
General Definitions
See Appendix C

Conventional landing gear

A landing gear arrangement is considered as conventional if it consists of a single wheel, or twin co-axial wheels, or laterally separated wheels with or without shock absorbers with wheels and brakes located at the bottom of the Airships hull or keel or car structure.

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