Safety Regulation Group

Civil Aviation Authority

CAP 471

British Civil Airworthiness Requirements

Section Q - Non-Rigid Airships

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February 2001

ISBN 0 86039 098 5

First published December 1979
Reprinted April 1984
Reprinted May 1986
Second edition February 2001
Reprinted May 2002 (incorporating new house style cover)

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BCAR SECTION Q EXPLANATORY NOTE

1 INTRODUCTION

The purpose of this Issue 2 is to consolidate Blue Paper Nos. Q790, Q819, Q843, Q858, Q862, Q864 and Paper No. Q895 together with editorial corrections convenient to be incorporated at this time.

2 TECHNICAL CHANGES

The following Chapters have been amended as shown:

Chapter	Q2–2	As amended by Blue Paper Q819
	Q2–2 Appendix	As added by Blue Paper Q819
	Q2–3	As amended by Blue Papers Q819 and Q843
	Q2–3 Appendix	As added by Blue Paper Q819
	Q2–4	As amended by Blue Paper Q819
	Q2–4 Appendix	As added by Blue Paper Q819
	Q3–2	As amended by Blue Paper Q864
	Q3–3	As amended by Paper No. Q895
	Q4–1 Appendix	As amended by Blue Paper Q858
	Q4–6	As amended by Blue Paper Q858
	Q4–9	As amended by Blue Paper Q862
	Q4–9 Appendix	As added by Blue Paper Q862
	Q5–1	As amended by Blue Paper Q790
	Q5–2	As amended by Blue Paper Q858
	Q5–8	As amended by Blue Paper Q858
	Q5–9	As added by Blue Paper Q790
	Q6–1	As amended by Blue Paper Q858
	Q6–12 and Appendices 1–4	As amended by Blue Paper Q858
	Q6–13 and Appendices 1–4	As amended by Blue Paper Q858
	Q7–1	Revision to cross-reference
	Q7–5	As amended by Blue Paper Q819

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CONTENTS

SECTION Q – NON-RIGID AIRSHIPS

SUB-SECTION Q7 OPERATING LIMITATIONS AND INFORMATION

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FOREWORD – SECTION Q

1 **PURPOSE** British Civil Airworthiness Requirements (herein after referred to as the 'Requirements') of which Section Q is a constituent part, are published by the Civil Aviation Authority (hereinafter referred to as the 'CAA'). They comprise minimum requirements and constitute the basis of approvals and certificates required by the Air Navigation Order 2000.

2 DERIVATION

2.1 The requirements of this Section Q have been based on the applicable requirements of BCAR Section K, Light Aeroplanes, and account has been taken of the Canadian Ministry of Transport and Civil Aeronautics Provisional Requirements for Airships.

2.2 Since the CAA has not yet had the opportunity of gaining experience in the certification and continued airworthiness of Airships, these Requirements should be regarded as being of a provisional nature. It may be necessary to revise the Requirements as certification experience is gained; in particular the performance and handling requirements of Sub-section Q2 may be subject to amendment.

3 APPLICABILITY

3.1 The requirements of BCAR Section Q are applicable to non-rigid airships equipped with two or more piston engines and manually-operated control systems, the maximum inflated envelope volume of which is not greater than 42 450m^3 (1·5 million cubic feet).

3.2 Subsequent amendments may be made to extend the applicability of these Requirements to cover rigid or semi-rigid structures, the installation of gas turbine powerplants, powered control systems or other features as necessary to provide for an application for certification of a specific airship project.

4 INTERPRETATION

4.1 The Requirements, with or without explanatory matter, should not be regarded as constituting a text book of current aeronautical knowledge; interpretation of the Requirements against a background of such knowledge is essential.

4.2 Where necessary the Requirements are supplemented by Appendices, and generally these Appendices take the form of acceptable interpretations of requirements, or state recommended practices, or give supplementary information.

4.3 Mandatory clauses are invariably denoted by the use of 'shall'; 'should' or 'may' are used in the text to introduce permissive or recommended clauses.

4.4 It is implicit in requirements expressed qualitatively (e.g. 'readily visible', 'adequately tested') that the CAA will adjudicate in cases where doubt exists.

5 PRESENTATION

5.1 **Arrangement of Requirements** This Section Q is so arranged that requirements of general applicability are presented at the beginning of the appropriate parts of the Section. (For example Q1–1 'General' states 'Adequate notice of intention to make tests shall be given to the

CAA, and whenever the CAA requires to witness the test, suitable facilities shall be provided', Chapter Q5–1 'Powerplant Installations – General' states 'Pipes and ducts connected to components of the airship between which relative motion might occur shall incorporate provisions for flexibility.'). This arrangement avoids the need for frequent repetition of such generally applicable requirements (which would necessitate an increase in the size of this Section) and simplifies the amendment process. Thus:–

(a) Sub-section Q1, General and Definitions (Chapters Q1–1 and Q1–2) are applicable to the whole of Section Q.

(b) The first Chapter of each Sub-section is a General Chapter which serves not only to introduce the Sub-section but contains requirements generally applicable to the subject matter thus avoiding the need for repetition in the various Chapters.

(c) Where the subject matter does not prevent it, general requirements are placed at the beginning of each Chapter, thus avoiding the need for repetition in the various paragraphs.

Hence, to avoid any oversight and to obtain full benefit of the presentation, a reader, even though only concerned with a specific subject, should be familiar with the Foreword, the requirements and definitions of Sub-section Q1 and at least the General Chapter for the Sub-section in which the particular requirements in which he is interested appear.

NOTE: The General Chapter to Sub-section Q4 'Design and Construction' has applicability wider than its Sub-section, and it is advisable for the reader to be familiar with the general requirements of this Chapter as well.

5.2 **Editorial**

5.2.1 Section Q is divided by subjects into Sub-sections numbered consecutively. The Sub-sections are further dived into Chapters, the number of each Chapter being associated with its Sub-section (e.g. Sub-section Q2 contains Chapters Q2–1, Q2–2, etc, up to Q2–8).

5.2.2 A list of the subjects covered by the Sub-sections and Chapters is given in the CONTENTS.

5.2.3 A system of progressive paragraph numbering is used but the number of digits is kept to a maximum of three by associating the system with paragraph headings. A paragraph heading applies to all succeeding paragraphs until another titled paragraph with the same, or a smaller number of digits occurs.

5.2.4 In the absence of any indication to the contrary, requirements and recommendations are applicable to all Airships.

5.2.5 Where for the purposes of the requirements, terms must carry a particular meaning, definitions are given in the appropriate places throughout this Section Q. Thus where the defined meanings apply throughout the Section, the definitions appear in Chapter Q1–2; where they apply only in a particular Sub-section, they appear in the General Chapter of the Sub-section, and so on, in accordance with the arrangement described in 5.1. Definitions of other terms are, in the main, consistent with the Glossary of Aeronautical Terms published by the British Standards Institution as BS 185. Those terms a definition of which appears in this Section Q are distinguished by initial capital letters, e.g. Maximum Weight.

NOTE: Definitions associated with engine limitations (e.g. Take-off Power and/or Thrust) are contained in BCAR Section C, Chapter C1–2.

5.2.6 References to other BCARs which have since been superseded by JARs will be incorporated by the use of Special Conditions.

5.2.7 All Chapters revised after 17th December 1979 have marginal lines to indicate material differences between the text of the current Chapters and Appendices and those dated previously.

5.3 **S.I. Units**

5.3.1 S.I. Units, i.e. the accepted symbol for 'Système International d'Unités' (International System of Units) are used in these Requirements.

NOTE: Strict observance of the S.I. system is not compatible with current international practice for units in which the data are scheduled in Flight Manuals. Consequently, variations from the S.I. system will be found in Chapter Q7–5.

5.3.2 An equivalent value in Imperial Units is also given, e.g. '10 m (33 ft)'.

5.3.3 Imperial units in the Air Navigation Order, Air Navigation (General) Regulations and other Statutory Instruments have been replaced by S.I. Units but in a number of cases not by a direct equivalent. Where in the Requirements a discriminant derived from a Statutory Instrument is used this will be expressed in S.I. Units and an equivalent Imperial Unit will not be shown.

6 **EFFECTIVE DATE** The requirements become effective on the date of issue printed on them.

7 **APPLICATIONS AND ENQUIRIES** Applications for further copies of this Section should be addressed to Westward documedia Ltd, 37 Windsor Street, Cheltenham, Glos GL52 2DG. Applications for permission to reproduce any part of the Requirements and any enquiries regarding their technical content should be addressed to the Civil Aviation Authority, Requirements and Policy Unit, 1E, Aviation House, Gatwick Airport South, West Sussex RH6 0YR.

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SUB-SECTION Q1 – GENERAL AND DEFINITIONS

CHAPTER Q1–1

GENERAL

1 **INTRODUCTION**

1.1 The requirements of this Sub-section are those of a general nature applicable to Section Q as a whole.

1.2 General technical requirements relating to the design and construction of the Airship as a whole are given in **Q4–1** and, except where obviously inappropriate, refer to all other Sub-sections.

1.3 Reference to features, such as controllable pitch propellers, does not necessarily imply that such features are expected to be incorporated in the Airship; the method of applying each requirement in cases where such devices are not fitted is, in general, self-evident. In doubtful cases, however, reference shall be made to the CAA at an early stage in the design.

2 **APPLICABILITY** The requirements of Section Q are applicable to Multi-piston-engined Non-rigid Airships, the maximum inflated envelope volume of which is not greater than 42 450m^3 (1·5 million cubic feet).

NOTE: Until experience has been gained in the operation of multi-engined Airships, single-engined Airships will not be eligible for certification in the Transport Category (Passenger). For certification in other than the Transport Category (Passenger), reference should be made to the CAA for variations in the requirements necessary to render them applicable to single-engined Airships.

3 **ALTITUDE AND TEMPERATURE RANGES** The Applicant shall choose the ranges of altitude and temperature in which the Airship is to operate.

4 **WEIGHT LIMITATIONS***

4.1 The Maximum Weight shall be established, and shall:–

(a) be not greater than the greatest weight for which compliance with the relevant structural and engineering requirements has been shown; and

(b) be not less than the greater of (i) and (ii):–

(i) that weight which is the sum of:–

the Weight Empty (see **Q1–2**, 2.5);
the total weight of the occupants of maximum authorised number of seats;
the weight of oil at full tank capacity less the weight of undrainable oil;
the weight of fuel in the tanks necessary for at least 30 minutes operation at Maximum Continuous Power at sea-level, less the weight of unusable fuel;
the weight of disposable ballast.

*See **Q1–2**, 2 for definitions

(ii) that weight which is the sum of:–

the Weight Empty (see **Q1–2**, 2.5);
the weight of the minimum crew;
the weight of oil at full tank capacity less the weight of undrainable oil;
the weight of fuel at full tank capacity less the weight of unusable fuel;
the weight of disposable ballast.

NOTES: (1) A weight of 77 kg (170 lb) for the occupant of each seat should be assumed, unless otherwise placarded for a given seat.

(2) Unless the design of the Airship is such as to indicate otherwise, the minimum crew for the purposes of this requirement may be assumed to be one pilot.

4.2 The maximum Static Heaviness and the maximum Static Lightness, if applicable, shall be established and shall be not greater than the value for which compliance with the relevant flight, structural and engineering requirements has been shown.

5 VARIATIONS FROM REQUIREMENTS

5.1 The Requirements have been written in the main in terms of Multi-piston-engined Non-rigid Airships of conventional design, and thus, in certain cases, will only be directly applicable to particular types of design; in some cases this restriction of applicability is recognised in the text. However, in other cases the subject is such that it will be clear that the requirements can be applied to foreseeable future developments. In the case of the former type of requirement, the CAA should be consulted regarding its applicability to any design which is 'unconventional' in relation to the way in which the requirement has been written. Such consultations should be made at a sufficiently early stage for due account to be taken of any revised or additional requirements which are agreed.

5.1.1 In addition to cases where the design incorporates unconventional features, revised or additional requirements would be necessary where the design incorporates features catered for in Section D but not in Section Q (e.g. combustion heaters, pressure cabins). Revised or additional requirements will normally be based on the corresponding requirements of Section D.

5.2 When the issue of a Certificate of Airworthiness is sought, it is necessary to comply with the relevant requirements of this Section Q or with variations therefrom which, taking account of compensating factors, are agreed by the CAA to give at least the intended level of safety.

5.3 The CAA shall be informed of each case where compliance with a variation of a requirement is claimed. In a few instances an indication is given in the text of the kind of variation acceptable to the CAA.

5.4 Since this Section Q has been developed from aeroplane requirements, in certain cases it has not yet been possible to prescribe requirements, compliance with which would necessarily establish that an Airship had safe characteristics under all conditions likely to be encountered. The CAA, therefore, reserves the right to vary these requirements as experience is gained in their application and to withhold approval when, in its opinion, an Airship has unsafe characteristics, even though the Airship complies literally with the text of the requirements. The CAA may also limit approval until sufficient experience of the Airship has been accumulated to establish that the Airship will have safe qualities in service.

6 **CALCULATIONS AND TESTS** Calculations and tests shall be to the satisfaction of the CAA. Full details of the methods of calculation, the design criteria employed, and the grounds on which it is claimed that these are reliable, shall be available to the CAA for examination. Adequate notice of intention to make tests shall be given to the CAA, and whenever the CAA requires to witness the tests, suitable facilities shall be provided.

7 **RELATIONSHIP TO AIR NAVIGATION ORDER AND REGULATIONS** Attention is drawn to the Air Navigation Order and Regulations, which, by virtue of regulations relating to performance operating limitations and minimum scales of equipment, impose limitations on the uses to which an Airship may be put in particular circumstances.

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SUB-SECTION Q1 – GENERAL AND DEFINITIONS

CHAPTER Q1–2

DEFINITIONS

NOTE: This Chapter gives definitions essential to the accurate interpretation of the requirements of Section Q as a whole. Other definitions appropriate to particular Sub-sections or Chapters are given at appropriate places. Definitions of other terms are, in the main, consistent with the Glossary of Aeronautical Terms published by the British Standards Institution as BS 185.

1 **GENERAL**

1.1 **Airship.** A power-driven, lighter-than-air aircraft.

1.2 **Non-rigid Airship.** An Airship in which the shape of the envelope is maintained by the pressure of the contained gas.

1.3 **Ballonet.** A compartment within the envelope which may be inflated with air or deflated in order to maintain the desired pressure differential between the gas and the external atmosphere or to alter trim.

1.4 **Pressure Ceiling.** The altitude above which the pressure differential between the gas and the external atmosphere can no longer be maintained constant by deflation of the Ballonets.

1.5 **Ballonet Ceiling.** The Pressure Ceiling obtained when the Ballonets are fully inflated at sea level.

1.6 **Applicant.** A person applying for approval of an Airship or any part thereof.

1.7 **Approved.** Accepted by the CAA as suitable for a particular purpose.

1.8 **Atmosphere, International Standard.** An atmosphere defined as follows:–

the air is a perfect dry gas;
the temperature at sea-level is 15°C;
the pressure at sea-level is $1{\cdot}013250 \times 10^5 N/m^2$ (29·92 in. Hg) (1013·2 mba)
the temperature gradient from sea-level to the altitude at which the temperature becomes –56·5°C is 3·25°C per 500 m (1·98°C/1000 ft);
the density at sea-level, ρ_0, under the above conditions is 1·2250 kg/m^3 (0·002378 $slugs/ft^3$); for the density at altitudes up to 15 000 m (50 000 ft) see Table 1 (**Q1–2**).

NOTE: ρ is the density appropriate to the altitude and ρ/ρ_0 the relative density is indicated by σ.

1.9 **Climates, Standard (see Q1–2 App., 1)**

NOTE: This paragraph defines three standard climates – Temperate, Tropical and Arctic – by stating the envelope conditions applicable to each. The conditions thus represented are acceptable as giving suitable design criteria for Airships intended for operation in the United Kingdom and other places in which similar conditions are experienced, Tropical Regions and Arctic Regions respectively. They are drawn up on the basis of conditions unlikely to be exceeded more often than on one day per year except that they do not cover the extremes of temperature occasionally reached in tropical deserts or in Siberia in winter.

1.9.1 The Temperate, Tropical and Arctic climates are defined by:–

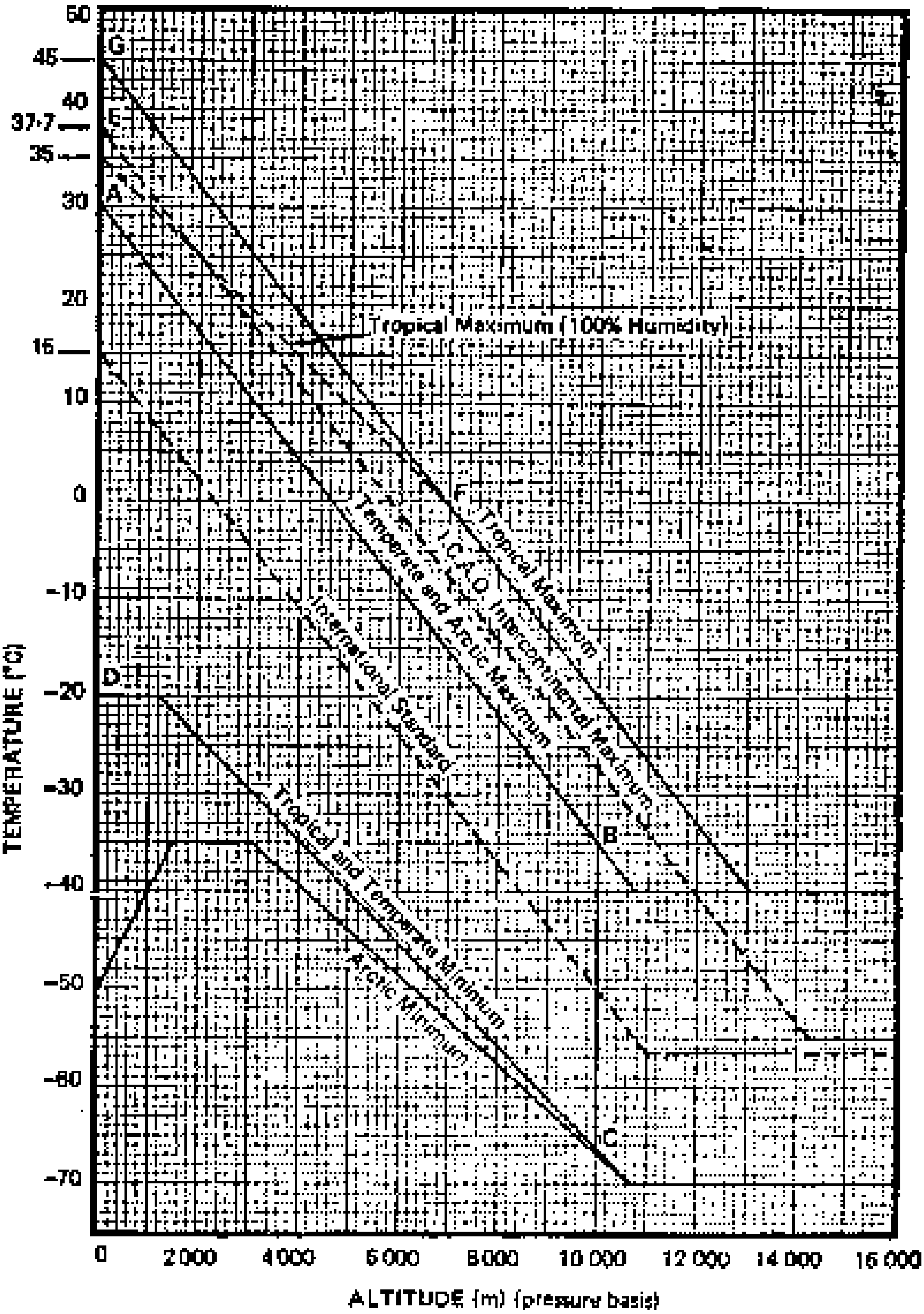
the temperature envelopes enclosed by the appropriate maximum and minimum temperature lines of Fig. 1 (**Q1–2**), from zero metres (feet) to the selected height (e.g. the temperatures appropriate to 0–10 000 m (0–30 000 ft) in the Standard Temperate Climate are those within the envelope A, B, C, D, in Fig. 1 (**Q1–2**));

every point included in these envelopes being associated with a relative humidity range of 20% to 100%; except that in the conditions represented by the area E, F, G in Fig. 1 (**Q1–2**) the relative humidities shall be assumed to vary from 100% maximum and 20% minimum respectively at the line EF to the value appropriate to the height at the line GF. The value of relative humidity on the line GF shall be taken to vary linearly from 100% maximum and 20% minimum at F to some lower values at G (given here as 10% maximum and 2% minimum);

every point included in these envelopes being associated with the International standard pressure (ICAO) appropriate to the height, as shown in Table 1 (**Q1–2**);

every point included in these envelopes being associated with the density corresponding to the temperature, pressure and humidity; extreme values are given in Table 1 (**Q1–2**).

1.9.2 These conditions do not cover variation of pressure from the International standard. This shall be allowed for by assuming a variation of pressure 5% above and below the International standard pressure (ICAO) associated with the International standard temperature (ICAO).

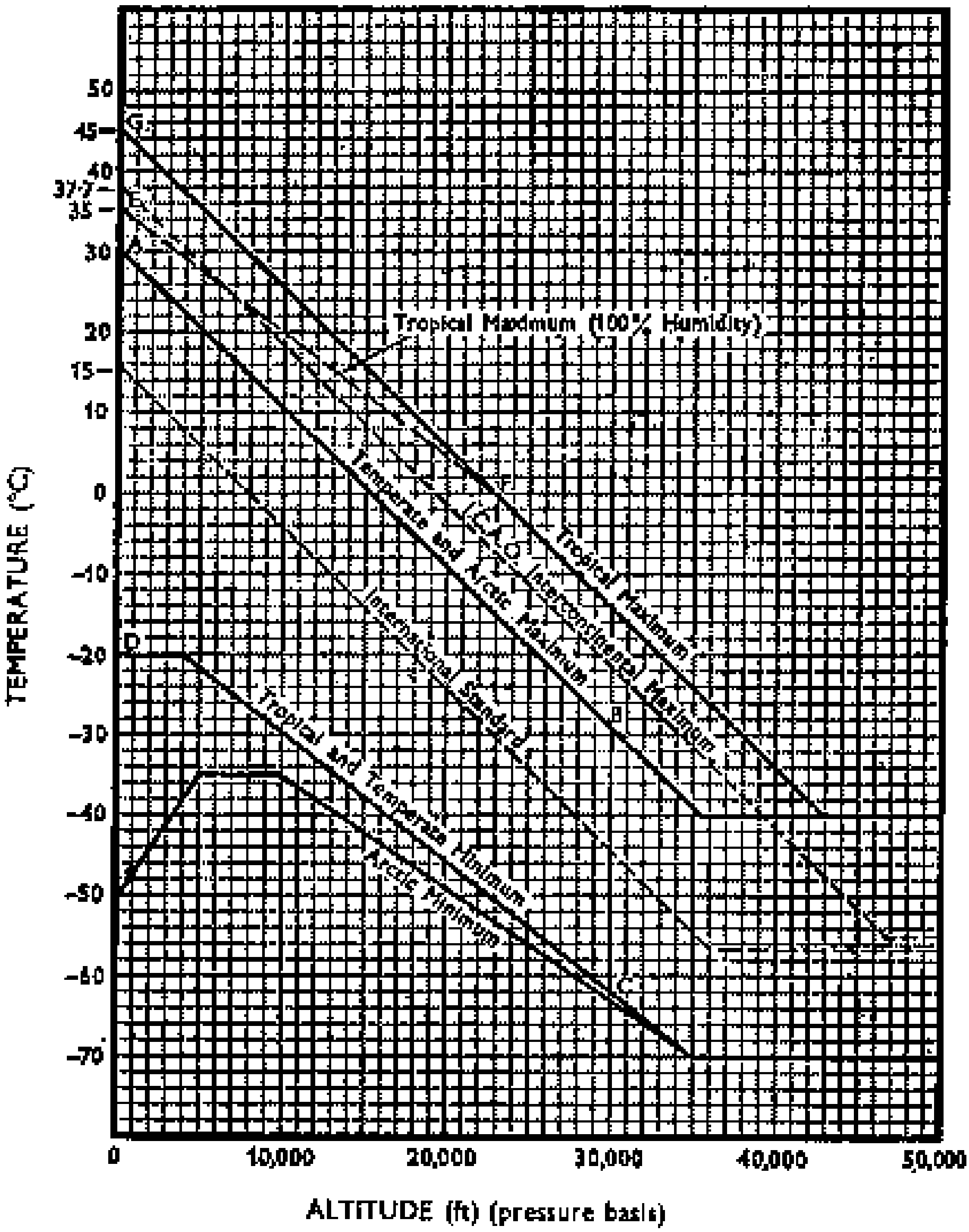


STANDARD CLIMATES – S.I. UNITS

Fig. 1 (Q1–2)

NOTES: (1) This diagram gives envelope conditions for design purposes; it does not constitute an accurate representation of any particular climate.

(2) The line BC has no significance other than as illustrating the text.



STANDARD CLIMATES – NON S.I. UNITS

Fig. 1 (Q1–2)

NOTES: (1) This diagram gives envelope conditions for design purposes; it does not constitute an accurate representation of any particular climate.

(2) The line BC has no significance other than as illustrating the text.

TABLE 1 (Q1–2)

RELATIVE PRESSURES AND DENSITIES – S.I. UNITS

Air density at sea-level (barometer $1{\cdot}013250 \times 10^5$ N/m^2 temp 15°C) is $1{\cdot}2250$ kg/m^3

Altitude (Pressure Basis) m	Relative Pressures (I.C.A.O.)	Relative Densities Associated with Conditions Stated				
		International Standard (I.C.A.O.)	Tropical Maximum	Temperate and Arctic Maximum	Tropical and Temperate Minimum	Arctic Minimum
0	1·000	1·000	0·906	0·951	1·138	1·291
500	0·942	0·953	0·862	0·905	1·072	1·190
1000	0·887	0·907	0·820	0·862	1·010	1·097
1500	0·835	0·864	0·780	0·820	0·955	1·011
2000	0·785	0·822	0·741	0·779	0·908	0·949
2500	0·737	0·781	0·703	0·740	0·862	0·892
3000	0·692	0·742	0·668	0·703	0·818	0·837
3500	0·649	0·705	0·633	0·667	0·776	0·792
4000	0·608	0·669	0·600	0·632	0·735	0·750
4500	0·570	0·634	0·568	0·599	0·696	0·709
5000	0·533	0·601	0·538	0·568	0·659	0·670
5500	0·498	0·569	0·509	0·537	0·623	0·633
6000	0·466	0·539	0·481	0·508	0·589	0·597
6500	0·435	0·509	0·454	0·480	0·556	0·563
7000	0·405	0·481	0·428	0·453	0·525	0·531
7500	0·378	0·454	0·404	0·428	0·495	0·500
8000	0·351	0·429	0·380	0·403	0·466	0·470
8500	0·327	0·404	0·358	0·380	0·439	0·442
9000	0·303	0·381	0·337	0·357	0·412	0·415
9500	0·282	0·358	0·316	0·336	0·388	0·389
10000	0·261	0·337	0·297	0·316	0·364	0·365
10500	0·242	0·317	0·279	0·296	0·341	0·341
11000	0·223	0·297	0·261	0·276	0·317	
11500	0·206	0·275	0·244	0·255	0·293	
12000	0·191	0·254	0·229	0·236	0·271	
12500	0·176	0·235	0·214	0·218	0·250	
13000	0·163	0·217	0·201	0·201	0·231	
13500	0·151	0·200	0·186		0·214	
14000	0·139	0·185	0·172		0·197	
14500	0·129	0·171	0·159		0·182	
15000	0·119	0·158	0·147		0·169	

TABLE 1 (Q1–2)

RELATIVE PRESSURES AND DENSITIES – NON S.I. UNITS

Air density at sea-level (barometer 29·92 in (1013·2 mbar) temp 15°C) is 0·002378 slugs/ft^3

Altitude (Pressure Basis) Ft.	Relative Pressures (I.C.A.O.)	Relative Densities Associated with Conditions Stated				
		International Standard (I.C.A.O.)	Tropical Maximum	Temperate and Arctic Maximum	Tropical and Temperate Minimum	Arctic Minimum
0	1·000	1·000	0·906	0·951	1·138	1·291
1,000	0·964	0·971	0·879	0·923	1·098	1·229
2,000	0·930	0·943	0·853	0·896	1·058	1·169
3,000	0·896	0·915	0·827	0·869	1·020	1·112
4,000	0·864	0·888	0·802	0·843	0·983	1·058
5,000	0·832	0·862	0·778	0·818	0·953	1·007
6,000	0·801	0·836	0·754	0·793	0·923	0·970
7,000	0·772	0·811	0·731	0·769	0·895	0·934
8,000	0·743	0·786	0·708	0·745	0·868	0·899
10,000	0·688	0·738	0·664	0·699	0·814	0·832
12,000	0·636	0·693	0·623	0·656	0·763	0·779
14,000	0·587	0·650	0·583	0·615	0·714	0·728
16,000	0·542	0·609	0·545	0·575	0·668	0·680
18,000	0·499	0·570	0·509	0·538	0·624	0·634
20,000	0·460	0·533	0·475	0·502	0·583	0·590
22,000	0·422	0·498	0·443	0·469	0·543	0·550
24,000	0·388	0·464	0·413	0·437	0·504	0·511
26,000	0·355	0·432	0·384	0·407	0·470	0·474
28,000	0·325	0·403	0·357	0·378	0·437	0·440
30,000	0·297	0·374	0·331	0·351	0·405	0·407
32,000	0·271	0·347	0·306	0·326	0·375	0·377
33,000	0·259	0·334	0·295	0·313	0·361	0·362
34,000	0·247	0·322	0·283	0·302	0·347	0·348
35,000	0·235	0·310	0·273	0·290	0·334	
36,000	0·224	0·298	0·262	0·277	0·318	
37,000	0·214	0·284	0·252	0·264	0·303	
38,000	0·204	0·271	0·242	0·252	0·289	
39,000	0·194	0·258	0·232	0·240	0·275	
40,000	0·185	0·246	0·223	0·229	0·263	
41,000	0·176	0·235	0·214	0·218	0·250	
42,000	0·168	0·224	0·206	0·208	0·238	
44,000	0·153	0·203	0·189		0·217	
46,000	0·139	0·185	0·171		0·197	
48,000	0·126	0·168	0·156		0·179	
50,000	0·114	0·152	0·141		0·162	

1.10 **Powerplant.** A Powerplant is the complete system of engines, systems parts and associated protective devices installed in an Airship for the purpose of propulsion.

1.11 **Critical Engine.** The engine the failure of which gives the most adverse effect on the Airship characteristics relative to the case immediately under consideration.

1.12 **Re-starting Altitude.** An altitude up to which it has been demonstrated to be possible, safely and reliably, to re-start an engine in flight (see **Q5–1**).

1.13 **Essential Equipment, Services, etc.** A term indicating that the item under consideration is essential to the airworthiness of the Airship or the safety of its occupants.

1.14 **Resistance to Fire**

1.14.1 **Fireproof.** Capable of withstanding for a period of at least 15 minutes the application of heat by the Standard Flame (see 1.14.3).

1.14.2 **Fire-resistant.** As for Fireproof but the period of application to be 5 minutes instead of 15 minutes.

1.14.3 **Standard Flame.** A flame the characteristics of which are similar to those produced by the sources described in BS 3G.100, Part 2, Section 3, Sub-section 3–13.

1.15 **Flammable.** That which will ignite readily or explode.

1.16 **Anticipated Operating Conditions.** (See **Q1–2** App., 2) Those conditions which are known from experience or which can be reasonably envisaged to occur during the operational life of the Airship taking into account the type of operations for which the Airship may be used, the conditions so considered being relative to the meteorological state of the atmosphere, to the configuration of terrain, to the functioning of the Airship, to the efficiency of personnel and to all the factors affecting safety in flight. Anticipated Operating Conditions do not include:–

(a) those extremes which can be effectively avoided by means of operating procedures, and

(b) those extremes which occur so infrequently that to require the Requirements to be met in such extremes would give a higher level of airworthiness than the CAA has agreed to be necessary and practical.

2 WEIGHTS

2.1 **Weight.** The weight of an Airship is its weight with the envelope deflated.

2.2 **Maximum Weight.** The maximum weight at which take-off and landing is permitted.

2.3 **Design Maximum Weight.** The maximum weight for which compliance has been shown with the relevant structural and engineering requirements.

2.4 **Design Minimum Weight.** The lowest Airship weight for which compliance has been shown with structural requirements.

2.5 **Weight Empty.** The weight empty is precisely defined for each particular Airship. For the purpose of this Section it excludes crew, payload and droppable ballast, but includes fixed ballast; unusable fuel; undrainable oil; total quantity of engine coolant.

2.6 **Static Heaviness.** The amount by which the weight of an Airship and the weight of its lifting gas exceeds the displacement buoyancy.

2.7 **Static Lightness.** The amount by which the displacement buoyancy exceeds the weight of an Airship and the weight of its lifting gas.

2.8 **Virtual Inertia.** The apparent additional inertia of a body moving in a fluid due to the motion imposed on the Fluid by the motion of the body.

3 SPEEDS

NOTE: Throughout the requirements wherever comparative values are prescribed, care will be necessary to ensure that values are corrected to EAS.

3.1	TAS	The true speed of the Airship relative to undisturbed air.
3.2	EAS	Equivalent air speed. TAS $(\rho/\rho_0)^{1/2}$ or TAS $(\sigma)^{1/2}$.
3.3	IAS	Indicated air speed. The readings of the pitot-static air-speed indicator as installed in the Airship, corrected only for the instrument error.
3.4	ASIR	The uncorrected readings on a specified air-speed indicator.
3.5	V_B	The Design Speed for Maximum Gust Intensity, EAS.
3.6	V_C	The Design Cruising Speed, EAS.
3.7	V_D	The Design Diving Speed, EAS.
3.8	V_{DF}	The Demonstrated Flight Diving Speed, EAS.
3.9	V_{RA}	The recommended Speed for Flight in Rough Air, IAS.
3.10	V_{MO}	The Maximum Operating Speed, IAS.

4 STRUCTURAL

4.1 **Primary Structure.** Those portions of the structure, the failure of which would seriously endanger the Airship.

4.1.1 **Safe Fatigue Life.** The operational period expressed in terms of number of flying hours, number of flights or number of applications of loads during which the possibility of fatigue failure of the part concerned under the action of the repeated loads of variable magnitude in service is estimated to be extremely remote.

4.1.2 **Fail-Safe Structure.** A structure which is so designed that after the failure in operation of a part of the Primary Structure, there is sufficient strength and stiffness in the remaining Primary Structure to permit continued operation of the Airship for a limited period.

NOTE: This period will depend upon the nature of the failure and the facilities provided for inspecting such a failure, but in no case will the residual strength be less than that which will enable a flight to be completed at a lower but acceptable level of safety.

4.2 **Limit Load.** The maximum load anticipated in normal conditions of operation.

4.3 **Proof Load.** The product of the Limit Load and the Proof Factor of Safety.

4.4 **Ultimate Load.** The product of the Limit Load and the Ultimate Factor of Safety.

4.5 **Factors of Safety (for static strength)**

4.5.1 **Proof Factor and Ultimate Factor.** Design factors (proof or ultimate) to provide for the possibility of loads greater than those expected in normal conditions of operation, uncertainties in design and variations of structural strength, including variation of strength resulting from deterioration in service.

4.6 **Factors of Safety (for fatigue strength)**

4.6.1 **Life Factor.** A design factor, used where a Safe Fatigue Life is estimated, to provide for the scatter of fatigue strength of structures, for the effects of possible deterioration of strength in service resulting from corrosion, damage and repair, and for the possible inadequacy of the assumed pattern of repeated loading. The estimated mean fatigue life is divided by this factor to obtain the Safe Fatigue Life.

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APPENDIX TO CHAPTER Q1–2

DEFINITIONS

1 CLIMATIC CONDITIONS (see Q1–2, 1.9)

1.1 The standard climate conditions are intended primarily for use in designing Airship structure (including the envelope) and equipment, which should remain airworthy when subjected to the appropriate conditions. Environmental conditions for aircraft equipment are prescribed in British Standard Specification 3G-100.

1.2 Airship performance will vary considerably within the defined climates. It is not intended that any one stated performance should be achievable throughout the whole envelope of conditions but rather that sufficient performance data should be scheduled for an operator to determine the performance which will be achieved in particular conditions.

1.3 The climatic conditions given are conditions of the free atmosphere. The temperatures achieved in the Airship car and envelope in these atmospheric conditions may be considerably higher.

2 ATMOSPHERIC UP AND DOWN DRAUGHTS (see Q1–2, 1.16)

2.1 **General.** The information provided in Fig. 1 (**Q1–2**, App) has been derived from the small amount of published data on measured draught velocities in storms and from theoretical work undertaken by the Meteorological Office. Since the data are related mainly to velocity measurements at high altitudes e.g. 6 km and above, and since the CAA has knowledge of only one measured velocity at low (2 km) altitude, a fair shape has been assumed for the low altitude portion of the draught velocity/altitude graph, and velocities in this area should be considered solely as provisional guidance values.

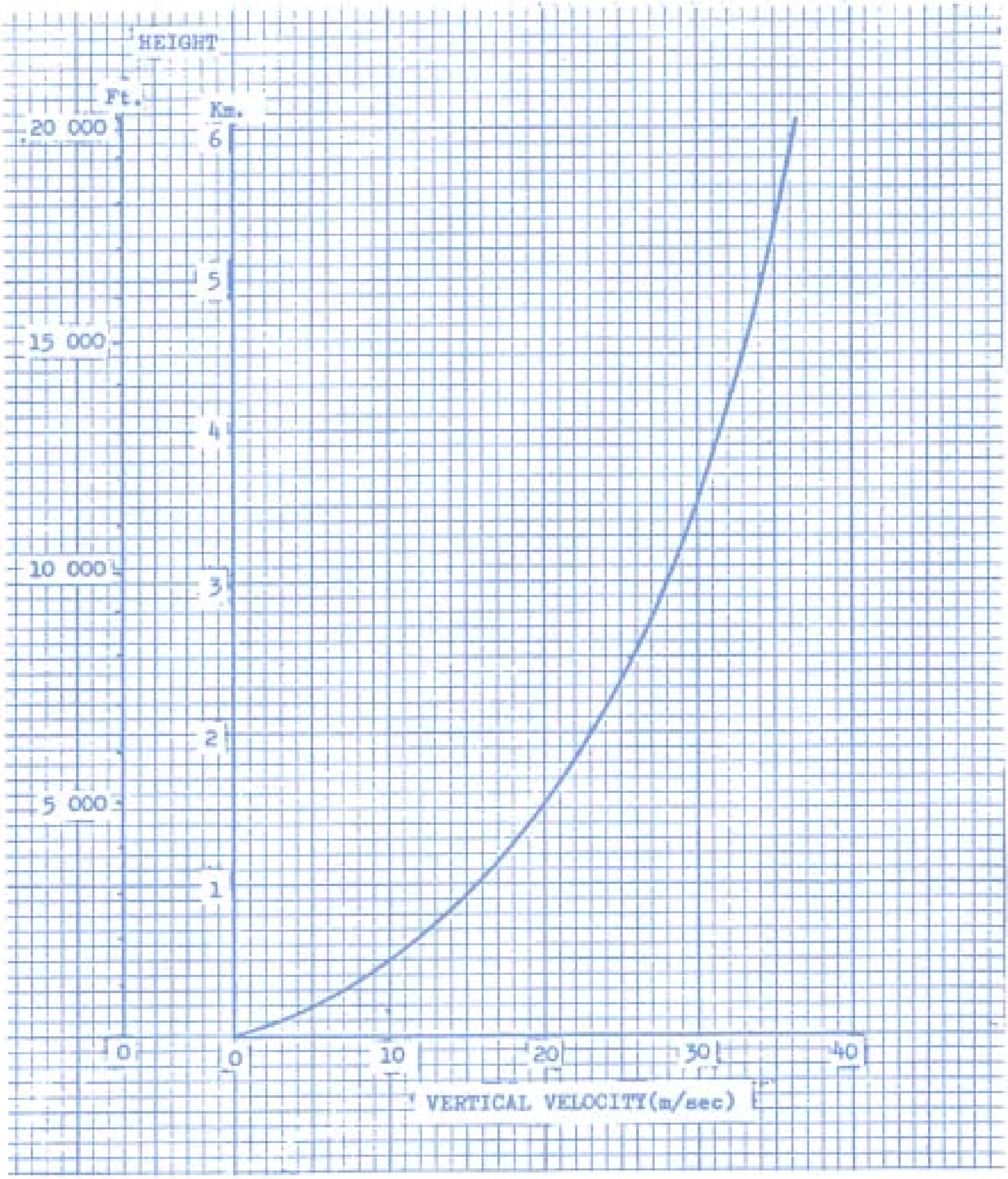
2.2 **Velocities**

2.2.1 The probable maximum vertical velocities of up and down draughts associated with severe storms are plotted as a function of altitude in Fig. 1 (**Q1–2**, App). The idealised assumed distribution of velocity across the extent of the draught is shown in Fig. 2 (**Q1–2**, App) but, in practice, the maximum velocity can occur anywhere within the width of the draught, and may be closely associated with a strong draught of opposite sign.

2.2.2 Since certain points on Fig. 1 (**Q1–2**, App) related to actual measured velocities, the probability of encountering storms in which such velocities are reached cannot be regarded as remote and more than one encounter is likely to occur during the life of an Airship for which no measures are taken to avoid storms.

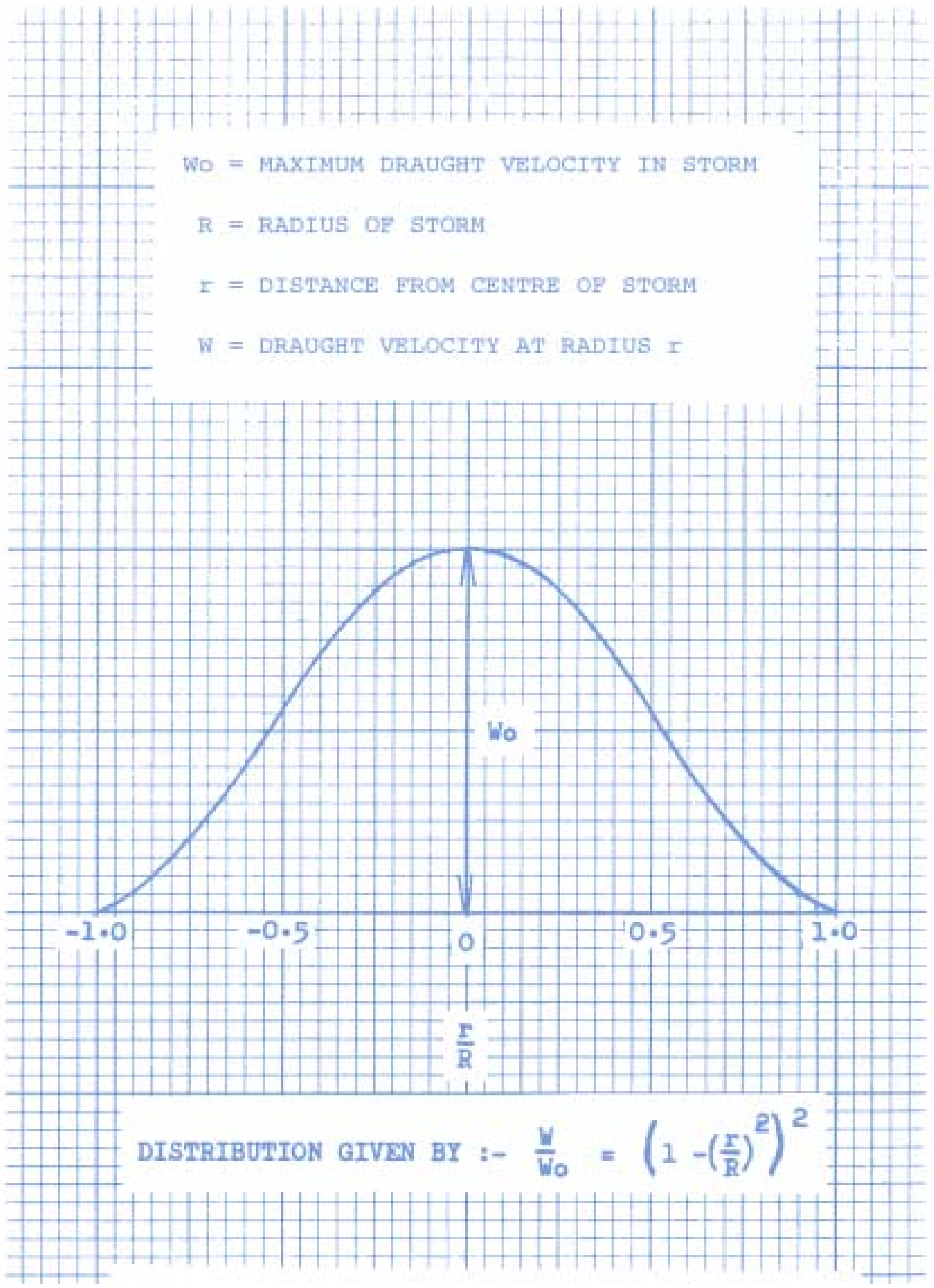
2.2.3 For Airships operated to rules which prohibit intentional flight through areas for which storms are predicted, the maximum draught velocities indicated by Fig. 1 (**Q1–2**, App) may be factored by 0·75, and where an approved weather radar is installed as an additional means of storm avoidance, the velocities may be factored by 0·5.

2.3 **Draught Width.** In severe storms with maximum draught velocities indicated by Fig. 1 (**Q1–2**, App), the horizontal extent of the draught (2R in Fig. 2 (**Q1–2**, App)) may be assumed to be 7 km, and for less severe storms associated with the factors of 0·75 and 0·5 suggested in 2.2.3, the draught widths may be taken as 3 km and 1·75 km respectively.



PROBABLE MAXIMUM VERTICAL VELOCITIES IN STORM CLOUDS

Fig. 1 (Q1–2, App)



HORIZONTAL DISTRIBUTION OF DRAUGHT IN STORM CLOUD

Fig. 2 (Q1–2, App)

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SUB-SECTION Q2 – FLIGHT

CHAPTER Q2–1

GENERAL

1 **INTRODUCTION** The requirements of this Chapter are those of a general nature applicable to the Flight Requirements as a whole. In view of the fact that the CAA has not yet obtained experience of flight testing and operation of Non-rigid Airships, the status of these requirements should be considered as preliminary, and applicants may propose alternative methods of meeting the intent of the requirements.

2 **STANDARD CONDITIONS**

2.1 **Atmospheric Conditions.** Except where otherwise specified, compliance with the requirements of this Sub-section shall be shown for conditions of no appreciable atmospheric turbulence.

2.2 **Technique.** In the absence of specific requirements, controls shall be assumed to be used in all manners likely to be adopted by the pilot when confronted by the operational situation for which the requirement caters.

2.3 **Engine Failure.** Engine failure shall be assumed to result in complete and immediate loss of propulsive power from the affected engine except for that momentarily supplied by the inertia of moving parts.

3 **ENGINE POWER CONDITIONS** Where requirements specify the use of a particular rating, e.g. Maximum Take-off Power, the engine shall be operated within all the limitations appropriate to that power.

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SUB-SECTION Q2 – FLIGHT

CHAPTER Q2–2

PERFORMANCE – GENERAL

1 **INTRODUCTION** This Chapter contains general performance requirements, detailed requirements and definitions which are applicable to both Chapter **Q2–3** and Chapter **Q2–4**. The detailed requirements have been included here for convenience of presentation to avoid the need to repeat them at each appropriate point in the later Chapters. There may be cases where a general requirement given in this Chapter has to be overridden by a detailed requirement in a particular Chapter; the text used in the particular Chapter will make this clear.

2 **THE PURPOSE OF THE PERFORMANCE REQUIREMENTS** The purpose of the performance requirements is to ensure that the flight crew are furnished with adequate information on the operating characteristics of the Airship to enable them to operate it safely. The intended level of safety will only be achieved in practice if the Airship is operated in accordance with the Limitations, Procedures and Operating Rules contained in the Flight Manual and the Air Navigation Order, as amended.

3 **CONDITIONS TO BE COVERED IN THE FLIGHT MANUAL** The performance shall be determined and shall be scheduled in the Flight Manual for ranges of conditions selected by the Applicant, however at least that prescribed in 3.1 to 3.3 shall 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.).

3.1 **Altitude**

3.1.1 **For Take-off and Landing.** Aerodrome altitudes from sea-level to 2440 m (8000 ft) above sea-level, or to 305 m (1000 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.

3.1.2 **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.

3.2 **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.

3.3 **Wind.** For Take-off Distance and Landing Distance, zero wind. Corrections for the effect of wind shall be scheduled.

4 **EXTRAPOLATION** (see **Q2–2** App., 1) In establishing the data for inclusion in the Flight Manual it is acceptable to extrapolate by calculation within the limits detailed in **Q2–2**, App., 1. In all cases an acceptable degree of conservatism shall be included; this may be less than that called for in **Q2–2** App., 1, if evidence is offered to substantiate a reduced degree of conservatism.

Where it is desired to schedule data for conditions beyond the stated extrapolation limits, reference shall be made to the CAA.

NOTE: A sufficient number of tests will be required to be conducted under one or more conditions of weight, altitude and temperature to provide a satisfactory basis for extrapolation.

5 DETAILED GENERAL CONDITIONS

5.1 **Atmospheric Conditions.** The Measured Performance shall be related to conditions of zero free-water content, Reference Humidity (see 6.4.2) and, except where the effect on performance of horizontal component of wind velocity is being scheduled, still air.

5.2 **Loading.** Details of the manner and extent to which variations of weight and buoyancy of the Airship are to be taken into account in establishing compliance with the performance requirements, and in scheduling performance data, shall be agreed in consultation with the CAA. Normally the airship should be loaded to the maximum weight compatible with the test heaviness and buoyancy.

5.3 **Compliance with Limitations**

5.3.1 **General.** The Measured Performance shall be consistent with compliance with all airworthiness limitations established for the Airship.

5.3.2 **Cooling.** The configuration and speeds used in establishing the Measured Performance, shall be consistent with maintaining engine temperatures within the limits established for power conditions used in each flight stage, and where relevant, flight stages subsequent to the stage under consideration (see **Q5–4**).

5.4 **Handling Techniques**

5.4.1 **Assumed Handling Information.** The information needed by a qualified flight crew in order readily to reproduce the assumed operational technique, shall be included in the Flight Manual.

5.4.2 **Piloting Technique During Tests.** This shall be readily repeatable and as close as possible to the assumed operational standard.

6 DEFINITIONS

6.1 **Take-off or Landing Surface.** The Take-off or Landing Surface for the purposes of performance determination is regarded as a plane of infinite extent and of uniform slope.

6.2 **Altitude and Height**

6.2.1 **Altitude.** The pressure altitude, i.e. the expression of atmospheric pressure in terms of altitude, according to the inter-relation of these factors in the International Standard Atmosphere. (This would be obtained by setting the sub-scale of an accurate pressure type altimeter to 1013·2 millibars.)

6.2.2 **Height.** The true vertical clearance distance between the lowest part of the Airship and the relevant datum.

6.2.3 **Screen Height.** The height of an imaginary screen which the Airship would just clear when taking-off or landing.

6.3 **Atmospheric Temperature***

6.3.1 **Temperature.** Unless otherwise qualified, the temperature of the free air stream expressed in °C.

6.3.2 **I.S.A.** The temperature of the International Standard Atmosphere appropriate to a particular altitude (see **Q1–2**).

6.3.3 **Maximum Temperature.** The maximum atmospheric temperature, appropriate to the altitude, at which all requirements are met.

6.3.4 **Minimum Temperature.** The minimum atmospheric temperature, appropriate to the altitude, at which all requirements are met.

6.4 **Atmospheric Humidity**

6.4.1 **Humidity.** Unless otherwise qualified, the moisture content, excluding free water, of the free air stream.

NOTE: Humidity may be expressed as a relative humidity or as an absolute humidity.

6.4.2 **Reference Humidity.** The relationship between altitude, temperature and Reference Humidity is defined as follows:–

(a) At temperatures at and below I.S.A., 80% relative humidity.

(b) At temperatures at and above I.S.A. +28°C, 34% relative humidity.

(c) At temperatures between I.S.A. and I.S.A. +28°C, the relative humidity varies linearly between the humidities specified for those temperatures.

6.5 **Performance**

6.5.1 **Gradient.** For deriving and applying Flight Manual information, gradient is the tangent of the angle of climb expressed as a percentage.

6.5.2 **Measured Performance.** The average performance of an Airship or group of Airships being tested by an acceptable method in the specified conditions.

6.6 **Miscellaneous**

6.6.1 **Starting Point.** A term used in connection with the determination of take-off performance; it is the point on the Take-off Surface from which a stationary Airship commences the take-off manoeuvre.

6.6.2 **Pressure Rate of Climb.** For the purposes of performance measurements, Pressure Rate of Climb is the measured rate of change of atmospheric pressure expressed as a rate of climb in the International Standard Atmosphere.

6.6.3 **Decision Point.** For the determination of take-off performance, the latest point at which, as a result of power unit failure, the pilot is assumed to decide to discontinue a take-off.

*For the presentation of performance data in the Flight Manual, aerodrome and en-route temperatures are expressed relative to I.S.A.

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APPENDIX TO CHAPTER Q2–2

PERFORMANCE – GENERAL

1 **EXTRAPOLATION (see Q2–2, 4)**

1.1 **Altitude: Take-off performance**

1.1.1 **One Test Location.** Where performance is determined at one location only, the data may be extrapolated for altitudes not greater than 5000 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.

1.1.2 **Two Test Locations.** Where performance is determined at two locations separated by an altitude h of not less than 2000 ft, the data may be extrapolated for altitudes not more than 5000 ft above the upper test altitude, and for altitudes not more than 5000 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.

1.2 **Temperature: Take-off and Climb Performance**

1.2.1 **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.

1.2.2 **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.

1.3 **Static Heaviness**

1.3.1 **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:–

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

(ii) for values of heaviness below that tested, a degree of conservatism equal to 0·5 times the calculated effect of heaviness is applied.

(b) **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:–

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

(ii) 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;

(iii) 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.

1.3.2 **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 CAA.

SUB-SECTION Q2 – FLIGHT

CHAPTER Q2–3

PERFORMANCE – TAKE-OFF AND LANDING

1 GENERAL

1.1 The Applicant shall establish and schedule the minimum space required for take-off and for landing, and the appropriate take-off and landing techniques. The techniques shall be such that the take-off and landing manoeuvres can be conducted safely without requiring exceptional skills and, when they are used in tests to establish Measured Take-off and Landing Distances, the results of the tests are reasonably repeatable.

1.2 The take-off technique shall 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 shall 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 shall 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.

1.3 The landing technique shall be such that the landing may be discontinued without significant loss of height at any point down to touch-down and, thereafter, the flight path associated with an established take-off technique may be rapidly attained. Landing techniques shall be appropriate to all-engines-operating and Critical-Engine-inoperative configurations, and to all permitted values of static heaviness and lightness.

1.4 The established techniques shall include the procedures to be followed by the ground handling crew and shall specify the composition and duties of the minimum crew. The minimum crew shall be specified in relation to the static heaviness or lightness and the maximum permitted surface wind speed (see **Q2–6**, 5(b)).

1.5 The established techniques shall include, for take-off, the recommended pitch attitudes appropriate to the initial steady climb and the associated speeds, and for landing the final steady approach speeds, appropriate to the number of operating engines and the static heaviness (or lightness).

These initial climb and approach speeds shall be not less than:–

(a) the speed at which the climb performance minimum of **Q2–4**, 2.1, appropriate to the number of engines can be met, and

(b) 1·10 times the minimum speed at which the requirements of **Q2–6**, 2(a) can be met with a transient heading change of no more than 20° and with the ability to subsequently regain and maintain the original heading.

1.6 The all engines operating initial climb and approach speeds may not be less than the one engine inoperative steady initial climb speed.

2 MEASURED DISTANCES

2.1 **Take-off Distance** (see **Q2–3** Appendix). For each scheduled take-off technique, the horizontal distance from the Starting Point to the point at which a screen height of 50 ft is attained shall be measured when taking off at maximum weight:–

(a) with all engines operating throughout, and

(b) with all engines operating up to the Decision Point then with the critical engine inoperative from the Decision Point onward.

In both cases the speed at the screen height must be not less than the initial steady climb speed appropriate to the number of operating engines and to the static heaviness.

2.2 **Accelerate-stop Distance –** (see **Q2–3** Appendix). For each scheduled take-off technique the horizontal distance to accelerate from the Starting Point to the Decision Point with all engines operating then to come to a complete stop with the critical engine inoperative.

2.3 **Measured Landing Distance** (see **Q2–3** Appendix)

2.3.1 For each scheduled landing technique, the horizontal distance from a screen height of 50 ft to land and come to a complete stop shall be measured when landing with the critical engine inoperative at maximum weight and with varying values of static heaviness ranging from the minimum permitted value to the maximum permitted value.

2.3.2 The speed at the screen height shall be not less than the scheduled final steady approach speed.

3 **MINIMUM SPACE REQUIRED FOR TAKE-OFF** (see **Q2–3** Appendix)

The minimum space required for take-off shall be:–

(a) a circle of diameter not less than the length of the Airship plus whichever is the greater of:–

(i) 100 m plus the measured take-off distance with all engines operating established in accordance with **Q2–3**, 2.1(a),

(ii) 1·33 times the measured take-off distance with all engines operating established in accordance with **Q2–3**, 2.1(a),

(iii) 60 m plus the measured take-off distance with one engine inoperative established in accordance with **Q2–3**, 2.1(b),

(iv) 1·15 times the measured take-off distance with one engine inoperative established in accordance with **Q2–3**, 2.1(b) and, where the decision point is later than the point where the ship is released by the ground crew,

(v) the accelerate-stop distance determined in accordance with **Q2–3**, 2.2,

or

(b) a rectangle of length equal to the diameter of the circle defined in **Q2–3**, 3(a) and a width not less than the width of the airship plus 200 m.

4 **MINIMUM SPACE REQUIRED FOR LANDING** (see **Q2–3** Appendix)

The minimum space required for landing shall be:–

(a) a circle of diameter not less than the length of the Airship plus whichever is the greater of:–

(i) 200 m plus the measured landing distance established in accordance with **Q2–3**, 2.3, and

(ii) the measured landing distance determined in accordance with **Q2–3**, 2.3 multiplied by 1·33, or

(b) a rectangle of length equal to the diameter of the circle defined in **Q2–3**, 4(a) and a width not less than the width of the airship plus 200 m.

5 **CROSSWIND COMPONENT** (see **Q2–3** Appendix). Where the Minimum Space Required for Take-off or for Landing is scheduled as a rectangle, in accordance with **Q2–3**, 3(b) or 4(b), the maximum permitted wind component at right angles to the major axis of the rectangle must be scheduled.

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APPENDIX TO CHAPTER Q2–3

PERFORMANCE – TAKE-OFF AND LANDING

1 **MEASURED TAKE-OFF DISTANCE** (see **Q2–3,** 2.1) **AND LANDING DISTANCE** (see **Q2–3,** 2.3). The achievement of the 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.

2 **MEASURED ACCELERATE-STOP DISTANCE** (see **Q2–3,** 2.2). The means of retardation for which performance credit may be taken should be discussed with CAA.

3 **MINIMUM SPACE REQUIRED FOR TAKE-OFF AND LANDING** (see **Q2–3,** 3(b) and 4(b). The widths of the minimum spaces required for take-off defined in **Q2–3**, 3(b) and for landing defined in **Q2–3**, 4(b) are based on the assumptions that:–

- rectangular spaces will be used in condition of light cross-winds only, and
- 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 CAA.

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SUB-SECTION Q2 – FLIGHT

CHAPTER Q2–4

PERFORMANCE – CLIMB AND LEVEL FLIGHT

1 **INTRODUCTION** This Chapter prescribes the determination of take-off and en-route climb and level flight performance.

2 **TAKE-OFF CLIMB**

2.1 At the altitude of the Take-off Surface, when the Airship is operated in accordance with the take-off technique established in accordance with **Q2–3**, 1, the measured rate of climb shall be not less than:–

(a) 400 ft/min with all engines operating at not more than Maximum Take-off Power and at the initial all-engines-operating climb speed of **Q2–3**, 1.5;

(b) 150 ft/min with the Critical Engine inoperative, operating engines operating at not more than Maximum Take-off Power and at the initial one-engine-inoperative climb speed of **Q2–3**, 1.5.

2.2 (See **Q2–4,** Appendix.) Where the take-off technique of **Q2–3**, 1 involves the use of 'Vectored Thrust', the airship must meet the following requirements when operated in accordance with the established take-off technique:–

(a) The measured rate of climb in ground effect, between lift-off and transition to forward thrust, shall be not less than:–

(i) 200 ft/min with all engines operating at not more than maximum take-off power;

(ii) 120 ft/min with the Critical Engine inoperative and operating engines operating at not more than Maximum Take-off Power.

(b) The transition to forward thrust must be made without any loss of height, in a manner which enables the Initial Steady Climb Speed, appropriate to the number of operating engines, to be achieved within the appropriate Measured Take-off Distance of **Q2–3**, 2.1(a) or (b).

3 **EN-ROUTE CLIMB**

3.1 **All-Engines-Operating En-route Climb.** The measured rate and gradient of climb with all engines operating shall be determined in the following conditions:–

(a) The recommended pitch attitude and associated climb speed.

(b) All engines operating at not more than Maximum Continuous Power.

3.2 **One-Engine-Inoperative En-route Climb.** The measured rate and gradient of climb (or descent) with one engine inoperative shall be determined in the following conditions:–

(a) The recommended pitch attitude and associated climb speed.

(b) The Critical Engine inoperative; the operating engines operating at not more than Maximum Continuous Power.

4 **LEVEL FLIGHT PERFORMANCE** The maximum level flight speed shall be not less V_{Bmin} (see **Q3–2**, 2.3) in the following conditions:–

(a) **Buoyancy.** Maximum permitted Static Heaviness or Static Lightness, whichever affects speed more adversely.

(b) **Power.** All engines operating at not more than Maximum Continuous Power.

APPENDIX TO CHAPTER Q2–4

PERFORMANCE – CLIMB

1 **TAKE-OFF CLIMB** Compliance with the initial rate of climb after take-off requirements of **Q2–4**, 2.2 for vectored thrust airships should be demonstrated in actual continued take-offs. It should normally be acceptable to measure the rate of climb of the ships centre of gravity between lift-off and the start of transition, provided this is reasonably well defined.

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SUB-SECTION Q2 – FLIGHT

CHAPTER Q2–5

HANDLING – GENERAL

1 **INTRODUCTION** This Chapter contains general requirements, detailed requirements and definitions applicable to the Handling Requirements as a whole. There may be cases where a general requirement given in this Chapter has to be overridden by a detailed requirement in a particular Chapter; the text used in the particular Chapter will make this clear.

2 **GENERAL**

2.1 **Qualitative Assessments**

2.1.1 **General.** In the course of establishing compliance with the Handling Requirements, a general qualitative assessment of the handling qualities shall be made. If this assessment reveals any unusual features not specifically covered by the Requirements then the handling qualities in this respect shall be satisfactory to the CAA.

2.1.2 **Atmospheric Turbulence.** Although the Handling Requirements are, in general, associated with no appreciable atmospheric turbulence, a qualitative check shall be made to ensure that there is no undue deterioration in the handling characteristics in turbulent air.

2.2 **Loading.** Each requirement shall be complied with at all combinations of weight buoyancy and c.g. position within the range(s) of loading conditions for which certification is desired.

NOTE: If any reasonable distribution of disposable load can result in a c.g. position outside the c.g. limits, attention should be drawn to this possibility both in the Weight and Centre of Gravity Schedule referred to in Section A, Chapter **A5–1** and by a placard in accordance with Chapter **Q7–3**, 5.1.

2.3 **Pressure Altitude and Atmospheric Temperature.** Each requirement shall be complied with at all altitudes relevant to the particular requirement and in all temperature conditions relevant to the altitude in question, except that if the Applicant elects to select and schedule a Maximum Permissible Altitude then compliance need not be shown at altitudes in excess of the altitude selected.

NOTE: It is recommended that for Airships without pressure cabins which are not intended to be equipped with crew and passenger oxygen systems, the Applicant restricts the Airship to a flight level of less than 120. The term Flight Level is defined in the Air Navigation Order.

2.4 **Control System Characteristics.** In the course of establishing compliance with the Handling Requirements, sufficient observation shall be made of the friction (and other significant rigging characteristics) of the primary flight control systems, to enable such maintenance instructions to be formulated as will ensure that there will not be an undue variation between the handling characteristics of the prototype Airship at the time of official trials, and those of subsequent Airships, or of the same Airship during its service life.

2.5 **Structural Implications.** Where proof of compliance with Handling Requirements might involve structural loads in excess of those provided for in complying with structural requirements, these shall be reported to the CAA.

2.6 **Power Conditions.** These shall be equal (relative to the appropriate maximum power) for all engines, except as otherwise prescribed.

SUB-SECTION Q2 – FLIGHT

CHAPTER Q2–6

HANDLING – CONTROLLABILITY

1 **GENERAL** The Airship shall be safely controllable and manoeuvrable during take-off, landing, in level flight, climb and dive, over the whole speed range without excessive effort or abnormal use of the trimmers. It shall be possible to make smooth transitions from one flight condition to another; for example, turns, changes of engine power and thrust vectoring where applicable. The execution of such transitions shall not require exceptional skill and shall not introduce any danger of exceeding the Limit Load conditions, either under any normally expected operating conditions or in the event of sudden failure of any engine.

2 **ENGINE FAILURE** It shall be possible, without the attainment of a dangerous attitude and without necessitating movement of engine, propeller or trimming controls, or the application of a rudder pedal force exceeding 670 N (150 lbf) or, in the case of a wheel control, a force exceeding 135 N (30 lbf) applied at the rim of the wheel, to regain full control of the Airship in the event of failure of the Critical Engine. This requirement shall be met in the following conditions:–

(a) **Take-off.** Take-off employing the techniques established in accordance with **Q2–3**, 1, with all engines operating at Maximum Take-off Power prior to the Critical Engine becoming inoperative.

(b) **En-route**

(i) **Air Speed.** V_{MO}

(ii) **Power.** All engines operating, prior to the Critical Engine becoming inoperative, at the Maximum Continuous Power.

(iii) **Trim.** The Airship in trim for en-route flight with all engines operating, in the prescribed conditions.

3 **MAXIMUM RATES OF CLIMB AND DESCENT**

3.1 Maximum Rates of Climb and Descent shall be established and scheduled, and shall not be greater than the maximum rates of climb or descent which have been demonstrated in flight. During climbs and descents at these maximum rates it shall be possible to maintain the differential pressure between the envelope and the atmosphere substantially constant, at all altitudes up to the Maximum Operating Altitude.

3.2 For Airships in which the primary supply of air to the Ballonets is dependent upon engine power, the maximum Rate of Descent shall be established and scheduled both for the all-engines-operating condition and with the Critical Engine inoperative. The latter case may be demonstrated either with the Critical Engine inoperative or with the air supply from the Critical Engine shut-off.

3.3 Consideration shall be given to the desirability of providing information 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.

4 **RADIUS OF TURN** The radius of turn appropriate to a rudder pedal force not exceeding 670 N (150 lbf) or, in the case of a wheel control, a force applied at the rim of the wheel not exceeding 135 N (30 lbf), shall be determined and scheduled at the speeds appropriate to the following power conditions:–

(i) All engines at Maximum Continuous Power.

(ii) All engines at normal cruising power.

(iii) Engine power and propeller pitch to give maximum asymmetric thrust (Maximum Rate turn).

5 **MAXIMUM SURFACE WIND SPEED** A maximum surface wind speed in which the Airship is allowed to operate shall be established and scheduled in the Flight Manual. This speed shall not be greater than the lesser of:–

(a) 75% of the maximum still air speed of which the Airship is capable with the Critical Engine inoperative and the remaining engines operating at not more than Maximum Continuous Power, or,

(b) the maximum surface winds in which the Airship may be handled by the minimum ground handling crew established in accordance with **Q2–3**, 1.3.

6 **PRECAUTIONARY AND EMERGENCY ALIGHTING**

6.1 **Precautionary Alighting.** It shall be possible to make an alighting without assistance from ground personnel in the maximum surface wind speed established in accordance with **Q2–6**, 5. This requirement shall be met with all engines operating and with the Critical Engine inoperative. Satisfactory techniques for such an alighting, which shall include procedures for securing the Airship to the ground, shall be determined and scheduled in the Flight Manual.

6.2 **Emergency Alighting.** A technique shall be determined and scheduled in the Flight Manual for making an emergency alighting with all engines inoperative in wind speeds up to the permitted maximum for operation. The technique shall make reference to the emergency evacuation technique as established in accordance with **Q4–3**, 4.5 and shall include procedures for securing the Airship on the ground. If the use of a grapnel, or other device for bringing the Airship to rest, is prescribed, procedures for its deployment shall be given.

7 **DITCHING** The following requirements shall be met if the applicable Operating Regulations require an ability to make a forced alighting on water.

7.1 A technique shall be determined and scheduled in the Flight Manual for making an emergency alighting on water. This technique shall include the steps to be taken when such an alighting is made with an engine inoperative.

7.2 Any special equipment needed to perform a safe alighting (e.g. drogues or flotation bags) shall be specified in the Flight Manual.

7.3 The technique(s) shall be such as to give, following such an alighting, reasonable assurance that the Airship car will remain afloat for a time sufficient to enable the occupants to evacuate the Airship and the Airship will not become airborne while evacuation takes place.

7.4 The technique must be such that rotating propellers will not hazard the occupants while they are inflating and entering a life raft and while moving clear of the Airship.

SUB-SECTION Q2 – FLIGHT

CHAPTER Q2–7

HANDLING – ABILITY TO TRIM

1 It shall be possible to trim the Airship in such conditions of loading, configuration, speed and power (particularly those applicable to instrument flight) as will ensure that the pilot will not be unduly fatigued or distracted by the effort which would otherwise be required for safe handling of the Airship. This applies both in normal operation and, if applicable in the conditions associated with the failure of one engine, or with any likely single failure or malfunction of the Ballonet air supply system.

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SUB-SECTION Q2 – FLIGHT

CHAPTER Q2–8

HANDLING – STABILITY

1 **GENERAL** The Airship shall have such stability in relation to its other flight characteristics, performance, structural strength, equipment, operating limitations and most probable operating conditions, as to ensure that the demands made on the pilot's powers of concentration are not excessive, when the stage of the flight at which these demands occur, and their duration, are taken into account. The characteristics of the Airship shall not, however, be such that excessive demands are made on the pilot's strength, or that the safety of the Airship is prejudiced by lack of manoeuvrability in emergency conditions.

2 **FLUTTER, VIBRATION AND BUFFETING**

2.1 **General.** All parts of the Airship shall be free from hazardous flutter and excessive vibration, and from buffeting of such severity as to interfere with the control of the Airship or to cause structural damage or excessive fatigue of the crew.

2.2 **Associated Conditions.** The requirements of 2.1 shall be met when the Airship is flown, concurrently with normal use of the controls (including deliberate small, sharp inputs) at all speeds up to V_{DF}, (see **Q7–2**, 2.2) or V_{MO} whichever is the greater, at all power settings up to Maximum Take-off Power and in all permitted conditions of buoyancy.

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SUB-SECTION Q3 – STRUCTURES

CHAPTER Q3–1

GENERAL

1 **INTRODUCTION** Sub-section **Q3** – Structures prescribes the strength which shall be provided in the Airship as a whole and in its component parts.

2 **WEIGHT AND WEIGHT DISTRIBUTION**

2.1 Unless otherwise stated, each structural requirement shall be complied with:

(a) at all practicable weights from the Design Minimum Weight to the Design Maximum Weight;

(b) when the centre of gravity of the Airship is in the most adverse positions compatible with the weight assumed, within the centre-of-gravity range for which certification is sought;

(c) when the weight and buoyancy is distributed in the most adverse manner, within the operating limitations for which certification is sought; and

(d) when appropriate allowances are made for the effects of Virtual Inertia.

2.2 **Design Unit Weights.** The following weights shall be used to show compliance with the structural requirements:–

petrol	0·72 kg/litre (7·2 lb/Imp. Gal)
lubricating oil	0·90 kg/litre (9·0 lb/Imp. Gal)
crew and passengers	77 kg (170 lb) per person

NOTE: For weight assumption for seats, safety belts and harnesses, see **Q4–4**, 2.3 and 3.4.

3 **STATIC STRENGTH**

3.1 **Strength Factors**

3.1.1 The requirements prescribe, so far as it is possible, flight or ground manoeuvres from which the external (limit) loads can be determined. These external loads shall be placed in equilibrium with inertia loads, where appropriate, taking account of the Virtual Inertia of the Airship.

3.1.2 The Proof Factor of Safety shall be 1·0.

3.1.3 The Ultimate Factor of Safety for metallic materials shall be 1·5.

3.1.4 The Ultimate Factor of Safety for non-metallic materials shall be determined in consultation with the CAA; it shall allow for degradation in service and shall provide an adequate level of strength throughout the operational life of the Airship.

3.1.5 The corresponding Proof and Ultimate Loads shall be obtained by multiplying the Limit Loads by the factors of this paragraph 3.1.

3.1.6 Where there is uncertainty about the strength of parts of the structure, or where inspection in service is difficult, such parts shall be designed with Factors of Safety which reasonably can be expected to make them as reliable as the rest of the structure.

NOTES: (1) Main causes of uncertainty may be the absence of tests, variability of strength and possible deterioration in service.

(2) Only the highest appropriate factor, or specified combination of factors, as specified in 3.1.7 and **Q3–10**, need be considered.

(3) See also **Q4–1** App., 2.5, dealing with closed sections.

3.1.7 The Factor of Safety in bearings at bolted or pinned joints shall be increased to provide for –

(a) relative motion in operation, and

(b) joints with clearance (free fit) subject to pounding or vibration.

3.2 **Strength and Deformation**

3.2.1 The structure shall be capable of supporting the Ultimate Load. During application of loads up to and including the Proof Load, and after removal of such loads, resultant elastic and permanent deformation shall not interfere with the safe operation of the Airship, and essential moving parts shall continue to function satisfactorily.

3.2.2 Where structural flexibility would give rise to the re-distribution of externally applied loads and internal reactions, suitable allowance shall be made.

3.2.3 The CAA shall be satisfied that the loading cases of **Q3–2** to **Q3–5** inclusive are investigated and that adequate allowance has been made for dynamic loading.

3.3 **Calculations and Test Procedures.** Proof of compliance with the strength and deformation requirements of 3.2 shall be shown by structural analysis, or structural analysis and test, as decided in consultation with the CAA, for all the critical loading conditions. In the design calculations, minimum material specification properties and minimum dimensions of parts shall be used. Particular methods of calculation are not prescribed but details of the methods used shall be made available to the CAA upon request.

3.4 **Fatigue Characteristics.** The CAA 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 levels, materials of construction and, where relevant, proposed flight plans.

SUB-SECTION Q3 – STRUCTURES

CHAPTER Q3–2

DESIGN AIR SPEEDS AND MANOEUVRES

1 **INTRODUCTION** The requirements of this Chapter prescribe the strength of the Airship structure to support the loads arising when the Airship is assumed to be subjected to the prescribed manoeuvres.

NOTE: The loads corresponding to gust conditions are dealt with in **Q3–3**.

2 DESIGN AIRSPEEDS

2.1 The Design Diving Speed, V_D, shall not be less than the greater of the Design Cruising Speed, V_C, or the Demonstrated Flight Diving Speed, V_{DF}, established in accordance with **Q7–2**, 2.2.

2.2 The Design Cruising Speed, V_C, shall not be less than the maximum speed attainable in level flight with all engines operating at Maximum Continuous Power and the Airship loaded to equilibrium buoyancy or that loading which will produce minimum drag.

2.3 The Design Speed for Maximum Gust Intensity, V_B, shall be not less than the speed required to escape from the vicinity of a thunderstorm. For Airships with V_C less than the recommended speed for escape, the value of V_B need not exceed V_C.

NOTE: Meteorological information indicates that the maximum inflow velocity into the cell of a severe thunderstorm, measured around the periphery of the storm, is approximately 30 knots. On this basis the speed to enable an airship to escape from the vicinity of a storm, $V_{B\ min}$, is recommended as 40 knots EAS.

For Airships with V_C less than 40 knots EAS, appropriate operational limitations may be applied by the Authority to ensure that the Airship does not enter conditions where its performance is inadequate.

3 DESIGN MANOEUVRES

3.1 The Airship structure shall be designed to withstand the Limit Loads resulting from manoeuvring with full control deflections (except as limited by pilot effort and the maximum control rates attainable) at all speeds up to V_D and with weight and buoyancy critical for each manoeuvre. Steady state and transient effects during checked and unchecked manoeuvres shall be taken into account.

3.2 The range of manoeuvres investigated shall include consideration of the combined effects of rudder and elevator control, in addition to consideration of their separate effects.

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SUB-SECTION Q3 – STRUCTURES

CHAPTER Q3–3

GUST LOADS

1 **GENERAL** This Chapter prescribes the requirements for the gust loads on Non-rigid Airship structures for operations at altitudes up to 15 000 feet.

2 **GUST LOADS** The Airship structure shall be designed to withstand the Limit Loads resulting from encounter with the atmospheric gusts prescribed in 3 at speeds V_C and V_B with weight and buoyancy conditions critical for each speed. The dynamic response of the Airship to the design gusts shall be taken into account.

3 **DESIGN GUSTS**

3.1 **Gust Velocities and Shapes**

3.1.1 The following gusts shall be taken into account:–

(a) Step (i.e. sharp-edged) gusts with 25 ft/sec EAS gust velocity, and

(b) Gusts with 1-cosine shapes:

$U = (Uds/2) . (1\text{-}\cos(\pi.s/H)) \qquad 0<s<2H$

Where –

U = Velocity (m/sec)
Uds = the design reference gust velocity as specified below (m/sec)
s = distance penetrated into the gust (m)
H = the gust gradient distance (m) – La/2<H<4La
La = length of airship (m)

A sufficient number of gust gradient distances in the range La/2 to 4La must be investigated to find the critical response for each load quantity.

Gust velocities, both positive and negative, at the aircraft design speed V_c shall be calculated to be values proportional to the sixth root of the gust gradient distance relative to a design reference gust velocity of 17·1 m/sec (56·0 ft/sec) at a gust gradient distance of 106·7 m (350 ft) at sea level. Furthermore, the reference gust velocity may be reduced linearly from 17·1 m/sec EAS at sea level to 13·4 m/sec (44·0 ft/sec) EAS at 4573 m (15,000 ft) for a gust gradient distance of 106·7 m.

The effect of any significant airship or control system non-linearities should be accounted for when deriving limit loads from limit gust conditions.

3.1.2 The analysis of Airship response to the above family of gusts shall include variation of the gust gradient distance H in a search for critical combinations of gusts. The details of this analysis shall be agreed with CAA.

3.2 **Gust Directions.** The gusts specified in 3.1 shall be considered to act in all directions.

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SUB-SECTION Q3 – STRUCTURES

CHAPTER Q3–4

ENGINE AND PROPELLER LOADS

1 GENERAL

1.1 The engine mounting and any other structure liable to be critically affected shall have sufficient strength to withstand the loads prescribed in the structural requirements of Sub-section **Q3** together with the loads resulting from the engine and propeller at all practical ranges of engine thrust and torque.

1.2 Consideration shall be given to all forces imposed on the structure arising from the engine, in particular:–

(a) thrust (forward and reverse),

(b) engine/propeller torque,

(c) gyroscopic couples during angular motion of the airship, or vectoring of propellers,

(d) inertia forces,

(e) structural flexibility effects where significant.

2 TORQUE

2.1 For the purpose of this Chapter, 'torque' is defined as the maximum torque occurring at any instant in the given conditions, and 'mean torque' is the mean value associated with the maximum torque.

2.2 The relation 'torque' bears to the 'mean torque' will depend on the number of cylinders and other characteristics particular to the design of the engine and mounting. The torque for stressing shall, in the absence of better information, be taken as not less than:–

4 × mean torque for 2 cylinder engines	firing one cylinder at a time
2 × mean torque for 4 cylinder engines	
1.5 × mean torque for engines with more than 4 cylinders	

3 **GYROSCOPIC EFFECT** For a two-bladed propeller the maximum yawing couple shall be $2I_{w_1 w_2}$. For three or more evenly spaced blades the yawing couple shall be $I_{w_1 w_2}$, where:–

I	. .	kgm/slugs ft^2	. .	is the polar moment of inertia of a single propeller,
w_1	. .	radians/sec	. .	is the propeller rotation, and
w_2	. .	radians/sec	. .	is the rate of pitch or yaw

4 **ASYMMETRIC FLOW THROUGH PROPELLER DISC** When the airflow through the propeller is not symmetrical, e.g. when the Airship is yawing or pitching or when the propellers

are vectored in Forward Flight, the additional forces and couples associated with this condition shall be considered. The propeller designer shall be consulted on the magnitude of these forces and couples.

5 **ENGINE NODDING** Due allowance shall be made for the dynamic effects of structural flexibility on the engine loads produced during landing.

6 **CRASHWORTHINESS**

6.1 Engines and propellers which would pass through any part of the normal passenger or crew accommodation if they moved forward within a cone of 30° apex angle, the apex of the cone being at the engine c.g. and its axis parallel to the longitudinal axis of the Airship, shall have attachments sufficient to withstand an ultimate acceleration of 6 g forwards as defined by the cone.

6.2 In addition, each engine and propeller shall be secured in a manner which will ensure that it will not pass through such accommodation when subject to any combination of forward acceleration up to 6 g and downward acceleration up to 6 g.

SUB-SECTION Q3 – STRUCTURES

CHAPTER Q3–5

GROUND LOADS

1 GENERAL

1.1 **Applicability.** The requirements of this Chapter apply to Airships with landing gear that do not depart radically from conventional aircraft designs; in particular, the requirements are based on the assumption that the landing gear consists of one or two main wheel units with one wheel per unit and, possibly, one nose wheel or tail wheel unit. Supplementary or modified requirements may be necessary to provide appropriate criteria for other arrangements or unconventional designs.

1.2 **Weight and Centre of Gravity**

1.2.1 The requirements shall be met at all weights up to the Design Maximum Weight.

1.2.2 The requirements shall be met at all positions of the centre of gravity, between the foremost and aftmost limits. Impracticable combinations of weight and centre of gravity need not be considered.

1.3 **Tyre and Strut Pressures.** The range of tyre pressures, pressures in the landing gear struts, and other significant characteristics at which the requirements are met, shall be stated by the designer.

2 ENERGY ABSORPTION

2.1 The Airship shall withstand landing at the design velocity of descent, v, which shall be the maximum velocity expected to occur in service (see also 2.3) but which shall not be less than 3 ft/sec, without bottoming of any of the energy absorbing elements (including tyres), unless such bottoming can occur without detriment to the continued safe functioning of the element.

2.1.1 For energy absorption at the design velocity of descent, v, the maximum permitted (Static Heaviness) shall be assumed.

2.2 **Proof of Compliance.** The energy absorption characteristics of the landing gear shall be determined by dynamic tests, up to the vertical velocity of descent, v, except that the CAA may accept calculations for simple landing gear units, or for units similar to those for which test results are available.

2.3 **Design Velocity of Descent.** The design velocity of descent shall be substantiated by data from development flying in typical operational conditions with the Airship.

2.4 **Ultimate Velocity of Descent.** It shall be demonstrated by test that the shock absorption capacity is sufficient to withstand landing at 1·2 times the velocity of descent, v, and the corresponding reaction at 1·2 v shall be determined. The CAA may accept calculations for simple landing gear or for units similar to those for which test results are available.

3 STRENGTH

3.1 The Airship shall be designed to withstand the loads resulting from landing at the design velocity of descent, v, at the Design Maximum Weight with buoyancy equal to the maximum permitted Static Heaviness.

3.2 In addition to loads normal to the landing surface, drag loads shall be applied at the wheel hubs. The drag loads shall be determined by analysis and shall be appropriate to landing the Airship at the maximum anticipated forward landing speed. Assumed values for the coefficient of friction between the tyre(s) and the landing surface shall be agreed with the CAA.

NOTE: Engineering Sciences Data Unit Sheet No. ESDU71026 provides guidance on values of coefficients of friction.

3.3 The following landing cases shall be considered.

3.3.1 **Level Landing.** Landing on the main landing gear(s) with the nose gear, if provided, just clear of the ground when the main landing gear(s) shock strut(s) is in the fully extended position or an appropriate compressed position.

3.3.2 **Side Drift Landing.** Due consideration shall be given to the worst combination of loads which are likely to arise during a lateral drift landing.

3.3.3 **One Wheel Landing.** The Airship shall be assumed to land in a normal pitch attitude but rolled to an attitude to be agreed with the CAA.

3.3.4 **Nose or Tail Wheel Landing.** Landing on the nose (or tail) landing gear only, with the main landing gears just clear of the ground when the main landing gear shock struts are in the fully extended position. Except that the total Airship weight on the nose gear need not exceed the effective weight, W_e, as determined by $W_e = \frac{K^2}{K^2 + L^2} \times W$.

Where W_e = effective weight.

K = pitching radius of gyration of the Airship about its c.g.

L = distances from the c.g. of the Airship to the point of reaction for the nose gear.

W = Design Maximum Weight, plus the weight equivalent of the Virtual Inertia.

SUB-SECTION Q3 – STRUCTURES

CHAPTER Q3–8

CRASHWORTHINESS CONDITIONS

1 **GENERAL** The requirements of this Chapter are intended to ensure that, in the event of an accidental impact of the Airship with the ground or an obstacle during normal take-off or landing or in the event of a power-off emergency alighting, all reasonable precautions are taken to minimize the risk to the occupants.

NOTE: Hazards to occupants in crash conditions can be reduced by designing the Airship so that the following occurrences are unlikely to cause either direct physical injury to the occupants, or injury as a result of rupture of the fuel tanks –

landing gear collapse, and

engines breaking loose.

2 **ACCELERATIONS** All combinations of inertia forces in the following ranges (expressed in terms of ultimate accelerations) up to a maximum resultant of 4·5 g shall be considered, taking the direction of the forces in each case as relative to the Airship:–

4·5 g downwards to 1·5 g upwards,

4 g forwards to 4 g rearwards,

Zero to 4 g sideways.

Where a grapnel, or other device with integral shock-absorbing capability, is provided as an aid to emergency alighting, the rearwards and sideways accelerations may be reduced to 1·5 g respectively.

NOTE: See **Q3–4**, 6 for additional accelerations to be applied to engines and propellers.

3 **EQUIPMENT** Items of equipment shall, so far as is practicable, be positioned so that if they break loose they are unlikely to cause injury to the occupants or to nullify any of the escape facilities provided for use after an emergency alighting. When such positioning is not practicable the attachments and surrounding structure shall be designed to withstand inertia forces at least equal to those prescribed in 2.

NOTE: It is recommended that inertia forces corresponding to higher accelerations than those prescribed should be used for the design of seat and equipment attachments, etc, since, in the event of a crash involving such higher accelerations, it is desirable to protect occupants from injury by detached equipment and seats.

4 **CRASH LANDING** The design of the Airship shall be such that there will be every reasonable probability of the occupants escaping serious injury in the event of a crash landing.

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SUB-SECTION Q3 – STRUCTURES

CHAPTER Q3–9

STRUCTURAL DEFORMATION, FLUTTER AND VIBRATION

1 **STRUCTURAL DEFORMATION** The Airship shall be free from any dangerous effects due to structural deformation at all speeds up to the maximum airspeed, derived in accordance with **Q3–3**, attained when head-on gusts are encountered.

2 **FLUTTER** The envelope and all fixed and moveable control surfaces shall be free from hazardous flutter at all speeds up to the maximum airspeed, derived in accordance with **Q3–3**, attained when head-on gusts are encountered, or the mooring wind speed prescribed in **Q3–13**, 1, whichever is the greater.

3 **VIBRATION** The Airship shall be free from excessive vibration at all speeds up to V_{DF} (see **Q2–8**, 2).

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SUB-SECTION Q3 – STRUCTURES

CHAPTER Q3–10

CASTINGS

1 GENERAL

1.1 The requirements of this Chapter are applicable to aluminium alloy castings, magnesium alloy castings and steel castings. The variations of the requirements for castings in other materials shall be decided in consultation with the CAA.

1.2 Compliance with the requirements of this Chapter will be accepted by the CAA as ensuring the reliability of a casting (see **Q3–1**, 3.1).

NOTE: See **Q3–1**, for general fatigue strength requirements.

1.3 Castings shall be produced, tested and examined only by organisations which are fully approved for the purpose. (See Section A, Chapter **A7–6**.)

2 CLASSIFICATION OF CASTINGS

2.1 Castings shall be classified as Class 1, Class 2 or Class 3 parts, as appropriate, in accordance with 2.2. In cases where doubt exists the classification shall be decided in consultation with the CAA. The classification shall be shown on the drawing of each casting.

2.2 For the purpose of these requirements, castings are classified as follows:

2.2.1 **Class 1.** Those castings the failure of which, in flight or ground manoeuvres, would be likely to cause catastrophic structural collapse, loss of control, failure of motive power, injury to occupants, unintentional operation of or inability to operate Essential Services or Equipment.

NOTE: If the failure would lead to danger only through a second unlikely event, the casting is not deemed to be in Class 1.

2.2.2 **Class 2.** Those castings not included in Class 1 of which more than visual examination is necessary to ensure reliability.

2.2.3 **Class 3.** All other castings.

2.3 Castings shall also be classified as to their degree of complexity for radiographic examination, in accordance with (a) or (b).

(a) **Category ‘RC’ Castings.** Those castings which are comparatively simple with respect to radiography and such that the correct method of examination should be apparent to an approved radiologist.

(b) **Category ‘RA’ Castings.** Those castings which are comparatively complicated with respect to radiography.

The radiographic category shall be shown on the drawing of each casting.

3 **STRENGTH OF CASTINGS** The designer shall assess which are the important stress concentration areas in a casting which is classified as a Class 1 or Class 2 part and shall mark these areas on the drawing of each casting.

NOTE: It is recommended that, when designing a casting, the designer should consult with the casting constructor, particularly for a complex casting, regarding desirable shapes and dimensions of the casting and regarding the strength of the casting material that is to be assumed in the different parts of the casting.

4 **RADIOGRAPHIC TECHNIQUE**

4.1 The radiographic technique for examination of a casting classified as a Class 1 or Class 2 part shall be devised in consultation with the casting constructor. If radiographic examination presents great difficulty, then a break-up procedure may be adopted.

NOTES: (1) Where castings are being produced for a type of Airship which can have both civil and military applications and it is not intended that such castings should be segregated, the radiographic examination technique for 'RA' castings will have to be approved by the Aeronautical Quality Assurance Directorate (AQD) and the use of a break-up procedure rather than radiographic examination (see 4.1) will be subject to agreement by the Aeronautical Quality Assurance Directorate (AQD).

(2) It is recommended that the advice of the Aeronautical Quality Assurance Directorate (AQD) be obtained with respect to radiographic techniques for all castings.

4.2 The drawing for a casting classified as a Class 1 or Class 2 part shall indicate by suitable means the radiographic technique to be employed; approved radiographic techniques (if any) shall be called up by a definitive reference.

5 **FLAW DETECTION TESTS** The type of flaw detection test, if any, shall be indicated on the drawing of each casting. (See **Q4–1**, 3.)

6 **STRENGTH APPROVAL OF CASTINGS CLASSIFIED AS CLASS 1 PARTS**

6.1 Castings shall comply with 6.2 or 6.3 as appropriate.

6.2 **Simple Castings**

6.2.1 Simple castings shall be subjected in the finished (fully machined) condition to one of the procedures detailed in 6.4.1 to 6.4.4.

6.2.2 For the purposes of this Chapter simple castings are defined as,

(a) those castings which are not of complicated or unusual shape, nor exceptionally difficult to cast, and which in the fettled and unmachined condition weigh not more than –

(i) 8·2 kg (18 lb) for magnesium alloy,

(ii) 11·3 kg (25 lb) for aluminium alloy,

(iii) 45·2 kg (100 lb) for steel, and

(b) wheel castings of conventional design, irrespective of weight.

6.3 **Complex Castings**

6.3.1 Complex castings shall be subjected in the finished (fully machined) condition to the procedure detailed in 6.4.4.

6.3.2 For the purposes of this Chapter complex castings are defined as those castings not covered by 6.2.2.

6.4 **Means of Compliance**

6.4.1 The strength shall be proved satisfactory by comparison with tests of approved castings of similar design.

6.4.2 The designer shall prove by calculation based on the minimum specification value of the material that the casting has an Ultimate Factor of not less than –

(a) 2·0 for magnesium or aluminium alloy; and

(b) 1·5 for steel,

times the Ultimate Factor for the stressing condition for the part concerned.

6.4.3 One casting selected at random from the first twenty castings passed by the casting constructor shall be shown by test to have Proof and Ultimate Factors respectively of not less than –

(a) 0·9 and 1·5 for magnesium or aluminium alloy; and

(b) 0·9 and 1·25 for steel,

times the Ultimate Factor for the stressing condition for the part concerned.

6.4.4 Each of three castings selected at random from the first twenty castings passed by the casting constructor shall be shown by test to have Proof and Ultimate Factors respectively of not less than –

(a) 0·8 and 1·33 for magnesium or aluminium alloy; and

(b) 0·8 and 1·15 for steel,

times the Ultimate Factor for the stressing condition for the part concerned.

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SUB-SECTION Q3 – STRUCTURES

CHAPTER Q3–12

FORGINGS

1 GENERAL

1.1 The requirements of this Chapter are applicable to aluminium alloy forgings, magnesium alloy forgings and steel forgings. The variations of the requirements for forgings in other materials shall be decided in consultation with the CAA.

1.2 Compliance with the requirements of this Chapter will be accepted by the CAA as ensuring the reliability of a forging. (See **Q3–1**, 3.)

NOTE: See **Q3–1**, 3.4 for general fatigue strength requirements.

1.3 Forgings shall be produced, tested and examined only by organisations which are fully approved for the purpose. (See Section A, Chapter **A7–9**.)

2 CLASSIFICATION OF FORGINGS

2.1 Forgings shall be classified as Class 1, Class 2 or Class 3, as appropriate, in accordance with 2.2. In cases where doubt exists, the classification shall be decided in consultation with the CAA. The classification shall be shown on the drawing of each forging.

2.2 For the purpose of these requirements, forgings are classified as follows:

2.2.1 **Class 1.** Those forgings the failure of which, in flight or ground manoeuvres, would be likely to cause catastrophic structural collapse, loss of control, failure of motive power, injury to occupants, unintentional operation of or inability to operate Essential Services or Equipment.

NOTE: If the failure would lead to danger only through a second unlikely event, the forging is not deemed to be in Class 1.

2.2.2 **Class 2.** Those forgings not included in Class 1 of which more than visual examination is necessary to ensure reliability.

2.2.3 **Class 3**. All other forgings.

3 STRENGTH OF FORGINGS

3.1 The direction of grain in a forging which will best suit the directions of stress shall be agreed between the designer and the forging manufacturer. The drawing shall show both the required grain direction and the final dimensions of the forging and shall specify the appropriate standard for acceptance of the forging.

3.2 The designer shall consult with the forging manufacturer so as to determine the optimum fabrication sequence to obtain the lowest possible level of residual stress in the finished forging. Where it is considered desirable to determine residual stress levels from cut-up test specimens (e.g. for some complex forgings) the drawing of the prototype forging shall include instructions for such determination.

4 **EXAMINATION TECHNIQUE** The method of examination of the completed forging shall be agreed between the designer and the forging manufacturer. The forging drawing shall call up the inspection and testing of series forgings to an approved specification.

5 **FLAW DETECTION TESTS** The type of flaw detection test, if any, shall be indicated on the drawing of each forging. (See **Q4–1**, 3.)

6 **STRENGTH APPROVAL OF FORGINGS CLASSIFIED AS CLASS 1 AND CLASS 2 PARTS** When required by 6.1 and in other cases where the designer and the forgings manufacturer agree that control procedures necessitate the testing of test pieces cut from forgings, then the location, form, size and mechanical properties to be achieved by the test pieces, shall be agreed between the designer and the forging manufacturer and shall be stated on the relevant drawing.

6.1 **Forgings Classified as Class 1 Parts**

6.1.1 **Forgings from Magnesium or Aluminium Alloy**

(a) Except as permitted by (b) where forgings are made of magnesium or aluminium alloy and the specification for the material requires an ultimate tensile strength of 28·35 kg/mm^2 (18 $tons/in^2$) or more for magnesium alloy or 39·38 kg/mm^2 (25 $tons/in^2$) or more for aluminium alloy in an example of the forging, then at least one specimen from each source of supply which has been subject to the same forging technique shall be shown by test to withstand loads corresponding to the Ultimate Factor for the critical stressing condition for the part concerned.

(b) Where the designer and the forging manufacturer consider that a forging is sufficiently similar to forgings which have already been tested in accordance with (a) from the same source of supply, that its strength may be reliably estimated from existing test results, or where the calculated Ultimate Factor is not less than 1·5 times the Ultimate Factor for the stressing condition for the part concerned, the test of (a) may be waived.

6.1.2 **Forgings from High Tensile Strength Steel.** The CAA shall be consulted regarding the necessity for tests on forgings of high tensile strength steel.

SUB-SECTION Q3 – STRUCTURES

CHAPTER Q3–13

MOORING AND GROUND HANDLING

1 **GENERAL** The mooring and tail-to-wind loads prescribed in this Chapter **Q3–13** are based on mooring system arrangements which permit the airship to weathercock into the prevailing wind.

2 **MOORING LOADS**

2.1 The Airship structure and mooring cone shall be designed to withstand the Limit Loads resulting while the airship is moored, from:

(a) an 80 knot wind from dead ahead or from 10° either side of dead ahead and:–

(b) operating one engine at Maximum Take-off Power.

2.2 The Airship structure and mooring cones shall be designed to withstand the Limit Loads resulting from the mooring cone contacting the mooring mast at a speed of 3 knots.

2.3 If provision is made for an alternative mooring point, the structure and related attachments of the alternative point shall be designed for the maximum loads anticipated to occur in service and shall be appropriately placarded. (See Chapter **Q7–2**.)

2.4 Consideration shall be given to the loads applied to the Airship under gusting wind conditions as a result of flexibility of the mooring mast.

3 **TAIL TO WIND LOADS** The Airship structure and mooring cone shall be designed to withstand the Limit Loads resulting from a 25 knot wind from dead astern or from any angle within a cone of 20° apex angle with its axis parallel to the longitudinal axis of the Airship while the Airship is moored.

4 **GROUND HANDLING LOADS**

4.1 The stern lines and related attachments and/or other ground handling provisions shall be designed to withstand Limit Loads resulting from the most severe wind conditions in which ground handling is expected to occur.

4.2 The limiting winds assumed for this condition shall be appropriately placarded. (See Chapter **Q7–2**.)

5 **EMERGENCY ALIGHTING** The grapnel, its attachment rope and the Airship structure to which it is attached shall be designed to withstand the maximum loads resulting from the grapnel encountering a solid object when the Airship is moving without power at a speed equal to the maximum wind speed in which operation is permitted. Any trail rope and its attachments to the Airship structure shall either be designed to the same loads as the grapnel rope or the rope shall be of such strength that it will break before imposing loads greater than those for which the Airship structure is designed.

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SUB-SECTION Q4 – DESIGN AND CONSTRUCTION

CHAPTER Q4–1

GENERAL

1 INTRODUCTION

1.1 This Chapter contains general requirements which are applicable to Section Q as a whole. There may be cases where a general requirement given in this Chapter has to be overridden by a detailed requirement in a particular Chapter; the text used in the particular Chapter will make this clear.

1.2 Sub-section Q4 prescribes requirements relating to the design and construction of the Airship and its component parts other than engines and propellers. Engines, propellers and equipment shall be of types which have been approved by the CAA in accordance with the appropriate Sections of the Requirements.

1.3 The loads to which the various items are subjected and strength aspects generally are dealt with in Sub-section **Q3** – Structures, except in some cases (e.g. seats, seat harnesses and control system loads).

2 MATERIALS, FABRICATION PROCESSES AND ASSEMBLY ITEMS

2.1 All materials, fabrication processes and assembly items (e.g. bolts and rivets) shall be such as to produce:

(a) structures of consistent strength and stiffness with any scatter in these properties within the limits assumed in the design of the Airship,

(b) structures which will maintain their original strength and stiffness under reasonably expected service conditions.

2.2 Where control is necessary to achieve the properties required in the design then such materials, processes and assembly items shall conform to approved specifications. The following constitute approved specifications:

(a) Specifications approved by the CAA (see also Section A, Chapter **A6–6**.)

(b) British Standards Specifications (Aircraft Series) of the British Standards Institution.

(c) D.T.D. Specifications.

(d) Specifications accepted by an Approved Design Organisation subject to the following:–

(i) The Approved Design Organisation shall have designed the part for which the material, fabrication process or assembly item is to be used, and shall carry design responsibility for that part within the terms of their approval.

(ii) The specification shall be such as to ensure the properties assumed for design purposes.

(iii) Records shall be maintained of each specification and related details, and of any amendments thereto. Such records shall be available for inspection by the CAA.

(iv) The CAA shall not have indicated that the specification is unacceptable.

3 **FLAW DETECTION** The designer shall consider the need for a flaw detection test on a part and shall endorse the drawings of the part accordingly. The technique to be used in conducting the test shall be agreed where necessary between the designer and the manufacturer.

4 **NEGATIVE ACCELERATIONS** If there are Essential Services and Equipment the failure to function of which could, as a result of negative accelerations, have catastrophic results, these shall function satisfactorily when subjected to negative accelerations. The magnitude and associated duration of the negative accelerations shall be agreed with the CAA.

NOTE: This does not prohibit those temporary malfunctions or failure to function under negative accelerations which would not jeopardise the safety of the Airship.

5 **OPERATION OF ESSENTIAL SERVICES FOLLOWING ENGINE FAILURE** Services essential for the continued safe operation of the Airship shall be such that the functioning and performance of the services will be adequate in the conditions following irretrievable loss of power from any one engine.

6 **INSPECTION AND MAINTENANCE PROVISIONS** (see **Q4–1** App., 2) Adequate means shall be provided to permit the inspection and maintenance of such parts of the Airship as are required to be inspected and maintained in accordance with the Maintenance Manual (see Section A, Chapter **A6–2** App., 1). Regions where normal means of access cannot be provided shall be defined in the Overhaul Manual. Methods of access to, and inspection of, such regions shall be described in the Overhaul Manual (see Chapter **A6–2** App., 2).

NOTES: (1) Particular attention should be given to the design of the Airship in order to facilitate internal cleaning, inspection and re-protection.

(2) **Q4–1** App., 2.3, 2.4 and 2.5 will have to be complied with, unless otherwise agreed by the CAA for a particular case.

7 **IDENTIFICATION OF PIPE LINES**

7.1 Marking of pipe lines for the purpose of distinguishing their functions shall, when employed, be to the satisfaction of the CAA.

NOTE: It is recommended that a system of identification conforming to that contained in British Standards Specification M23 should be used.

7.2 The markings shall be such that risk of confusion by servicing or maintenance personnel will be minimized.

NOTE: Markings incorporating names or descriptions should be in the language most suitable for ensuring compliance with 7.2.

7.3 Distinction by means of colour marking alone is not acceptable. The use of alphabetical or numerical symbols may be acceptable if recognition depends upon reference to a Master Key and any relation between symbol and function is carefully avoided.

8 **PROTECTION IN SERVICE** (see **Q4–1** App.) All parts of the Airship, both inside and outside, shall be so designed, protected, drained and vented that, when the Airship is maintained

in accordance with the Maintenance Manual, there will be no unacceptable loss of airworthiness as a result of weathering, corrosion, abrasion, or unavoidable mechanical damage to protective treatment resulting from normal maintenance, or from other causes.

9 **LOCKING OF CONNECTIONS** Suitable means of locking shall be provided on all connecting elements in the Primary Structure and primary control systems, and where such locking is essential to the safe operation of the Airship, in other mechanical systems and in fluid systems. Self-locking nuts shall not be used on any bolt subject to rotation in operation.

10 **INCIDENTAL LOADS** The Airship, its equipment and systems shall be designed, installed or supported as the case may be, so as to withstand incidental loads resulting from, for example, vibration, accelerated flight, rough landing conditions, and any appropriate fluid pressures.

11 **DRAINS** Open drains shall be provided so that all car compartments, and control surfaces, are drained both in flight and on the ground.

12 **TESTS**

12.1 Additional confirmatory tests to those prescribed throughout Section Q shall be made where there is doubt as to the suitability or reliability of any detail of design or construction.

12.2 All moving parts essential to the safe operation of the Airship shall be demonstrated to function correctly, taking into account the most adverse likely operating conditions.

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APPENDIX TO CHAPTER Q4–1

PROTECTION AGAINST CORROSION AND OTHER EFFECTS OF THE PRESENCE OF FLUIDS*

1 **INTRODUCTION** This Appendix should be used for guidance purposes in meeting the requirements of **Q4–1**, 6 and 8.

2 **GENERAL** In assessing the design for inspection and maintenance provisions, and for protection, particular attention should be given to:–

(a) the effects of leaks from systems containing fluids,

(b) the effects of rain, sleet, snow, ice, hail, slush, etc.,

(c) the effects of liquids spilt in cargo compartments, galleys and toilets, and from batteries, and on areas below, where such liquids might drain,

NOTE: The liquids assumed to be spilt should be appropriate to the intended use of the Airship, e.g. carriage of special liquids, carriage of live animals.

(d) the effects of condensation, and especially where it may drip (e.g. on to the top side of the roof panels) and where it may collect in the underfloor regions and belly,

(e) the effects of gassing from batteries and condensation contaminated by such gassing.

NOTE: See also Appendix No. 4 to **Q6–12**.

(f) the effects of cleaning, or ground or airborne de-icing of, the outside of the Airship (the liquids for which could gain access to the inside of the Airship); the effects of cleaning the inside of the Airship,

(g) the effects of changes of Airship attitude in operation,

(h) those parts of the Airship in which fluids could collect –

(i) in the normal course of events,

(ii) as a result of a drain or drain hole becoming blocked,

(iii) as a result of a system leaking.

NOTE: It should be borne in mind that as time passes a liquid could bring down with it certain solids such as swarf, dirt, dust, sand, mud, flakes of paint, sealant, grease, as well as chemicals from lagging, etc.

2.1 **Fluids.** The design of the Airship should be such as to minimise the possibility that any fluid which may leak from a system or may be spilled in the accommodation (e.g. in galleys and toilets) will result in:

(a) a direct or indirect danger to the Airship or its occupants,

(b) an immediate or eventual loss of airworthiness to a serious extent.

NOTE: The effects of corrosion as a result of spilled fluids should be given particular consideration.

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*Fluids include liquids and vapours.

2.1.1 Particular attention should be given to the design of those compartments where a fluid is likely to be spilled. Sealed floors with suitable drainage, e.g. a spoil tank, should be provided for galleys and toilets.

2.1.2 Particular attention should be given to the avoidance of the possibility of fluid leaking from pipes, tanks and apparatus and freezing on or in critical electrical equipment or critical mechanical parts, where the ambient temperature, or the temperature of the equipment or parts, is below the freezing point of the fluid.

NOTES: (1) Care should be taken to avoid pockets where liquids could freeze and so jam mechanisms.

(2) It is recommended that joints and unions in pipe lines should not be located in closed portions of the structure.

2.2 **Rain.** The effects of rain on the Airship should be considered. Where sealing is not practical, precautions should be taken to ensure that any rain that does gain access to the interior of the Airship does not constitute a direct or indirect danger. Particular attention should be given to the results of the wetting of equipment, the possibility of jamming by freezing (especially if water can collect in pockets) of mechanisms (especially control systems), exits, emergency exits and latches.

NOTE: See also Section J, Chapter **J1–3**, 5 for protection of electrical equipment.

2.3 **Drainage.** All compartments in the structure, including those in control surfaces, should be adequately drained both on the ground and in flight.

2.3.1 Each drainage system should be considered separately and drains and drain holes should be so located that the blockage of any one drain or drain hole in any one drainage system will not prevent compliance with the intent of 2.3.

NOTE: Particular attention should be given to the location of internal drain holes so as to minimise the possibility of fluids being trapped in the structure and being prevented from running to a drain.

2.4 **Vents.** All compartments in the structure should be adequately vented.

2.4.1 Vents should be located, constructed, and, if necessary, drained so as to preclude the possibility of their becoming obstructed:

(a) by fluid or other foreign matter when the Airship is in the ground attitude, and when it is in any steady flight attitude,

(b) by ice, when the Airship is in any ground or flight attitude.

2.5 **Closed Sections**

2.5.1 **Structural Members**. Where closed sections are used as structural members in critical areas the design should be such that either –

(a) such structure exhibits the characteristics of a Fail-Safe Structure, or

(b) the designer should be satisfied that adequate inspection schemes have been established for checking on the presence and extent of any corrosion that may occur in these regions and that corrosion would be detected before an unacceptable loss of airworthiness has taken place.

NOTES: (1) Particular attention should be given to those closed sections which constitute tension members.

(2) Particular attention should be given to the special vulnerability of structural interfaces, e.g. bonded, spot welded, where voids in the bond, or lack of suitable protective treatment at the interface could lead to corrosion in the presence of moisture.

(3) See also **Q3–1**, 3.1.6.

2.5.2 **Other Parts.** For any part the failure of which would cause catastrophe, e.g. a control system tube, the designer should be satisfied that adequate inspection schemes have been established for checking on the presence and extent of any corrosion that may occur, and that corrosion would be detected before an unacceptable loss of airworthiness has taken place.

2.6 Corrosion

2.6.1 Contact between fluids and materials likely to result in detrimental corrosive action, should be kept to a minimum, and so far as is practical the juxtaposition of dissimilar metals should be avoided.

NOTE: With regard to electrolytic action in cases where juxtaposition is unavoidable the best available data should be used; where no such data are available then the CAA should be consulted.

2.6.2 Where contact between fluids and materials likely to result in detrimental corrosive action cannot otherwise be avoided, adequate protection should be given to parts (particularly those made up of dissimilar metals) likely to come into contact with such fluids. In particular closed sections which are employed in structural members, especially tension members and also tubes in control systems, should as far as practical be protected on assembly.

(a) The fluids to be taken into account should include –

(i) water, cleaning fluids, ground and airborne de-icing fluids, fuel, oil, fluids associated with galleys and toilets, and condensates which collect in the lower portions of the Airship, including the car,

(ii) slush (including grit, salt, and other runway de-icing chemicals) which will impinge on, and possibly get inside, parts of the Airship during taxying, take-off or landing on precipitation covered runways.

(b) Adequate protection should also be given against micro-biological attack resulting from such liquids as kerosene, water and condensates.

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SUB-SECTION Q4 – DESIGN AND CONSTRUCTION

CHAPTER Q4–2

FLIGHT-CREW ACCOMMODATION DESIGN

1 **GENERAL** This Chapter prescribes detailed requirements relating to the design and construction of the flight-crew accommodation and to the safety of the flight crew in normal and emergency conditions. The flight-crew accommodation shall also comply with all relevant requirements of **Q4–3**.

2 FLIGHT-CREW ACCOMMODATION

2.1 Suitability

2.1.1 The arrangement of the flight-crew accommodation shall be such as to ensure that each member of the flight crew will be able to perform his duties and operate the controls for which he is responsible in the correct manner without unreasonable difficulty, fatigue or concentration.

2.1.2 The arrangement of the flight-crew accommodation shall be such as to minimize the likelihood of injury to the flight crew, both in normal operation and in an emergency alighting. (See also **Q4–4**.)

2.2 **Communication with Passengers.** Where the flight crew are separated from the passengers by a partition, an opening or an openable window shall be provided to facilitate communication between the flight crew and the passengers.

2.3 **Signal Pistol and Discharger.** Where a signal pistol is carried the following apply:–

(a) It shall be demonstrated that the pistol can be used readily, discharging clear of the Airship.

(b) In the case of Airships certificated in the Transport Category, a mounting shall be provided such that the pistol can be loaded, fired and unloaded in the firing position.

(c) Provision shall be made for the stowage of the signal pistol and cartridges.

3 PILOT'S POSITION

3.1 View

3.1.1 The arrangement of the flight-crew accommodation shall be such as to afford a sufficiently extensive, clear and undistorted field of view for the safe operation of the Airship, and to prevent interference with this field of view from glare and reflections. Compliance with these requirements shall be demonstrated in flight, including night flight tests on Airships for which certification for flight by night is sought.

3.1.2 In enclosed flight-crew accommodation there shall be a readily accessible window which the pilot can open without difficulty, even in icing conditions, to enable a safe landing to be made.

3.1.3 On Airships the flight-crew compartments of which are enclosed, it shall be demonstrated that an adequate portion of pilot(s) window(s) can be maintained in a clear condition during flight in rainy conditions. The cleared portion of the window(s) shall be such as to give the pilot(s) an adequate field of view for normal flight, approach and landing, under conditions of heavy rain at all air speeds up to the normal cruising speed. On Airships intended for flight in icing conditions, this requirement shall also be met in icing conditions up to the severity in which the Airship as a whole has been shown to be satisfactory.

3.2 **Windows**

3.2.1 **Misting.** Unless such windows can be easily cleared of mist by the pilot(s), means shall be provided for preventing the pilot(s) essential view window(s) from being obscured.

3.2.2 **Transparency Heating System.** In the event of any reasonably possible single failure, a transparency heating system shall be incapable of raising the temperature of any window to a point where there would be danger of fire or structural failure.

3.2.3 **Light Transmittance Value.** The windscreen and the side windows forward of the pilot's back when he is seated in the normal flight position shall have a light transmittance value of not less than 70%.

NOTE: See also **Q4–3**, 3 for further requirements for windows.

4 **CONTROLS**

4.1 **General.** Controls in the flight-crew accommodation shall comply with the relevant requirements of **Q4–8**.

4.2 **Control Movement and Seat Position**

4.2.1 The design and arrangement of the flight-crew accommodation and in particular the relative positions of controls and seats shall be such that each member of the flight crew, with his seat and any adjustable controls suitably adjusted, can,

(a) without interference produce full and unrestricted movement of each control which is responsible for operating, both separately and with all practical combinations of movements of other controls;

(b) at all control positions exert adequate control forces for the operation to be performed.

NOTE: In showing compliance with 4.2.1, when a seat at a station from which the Airship may be piloted has been adjusted so as to suit the occupant, subsequent change of seat position to operate any controls needed for piloting is not acceptable.

4.2.2 Compliance with 4.2.1 shall be established with the flight crew having their safety belts correctly worn, except in respect of those controls which it can be shown will only be required on rare occasions dissociated from the need for safety restraint. Where safety harness is provided, compliance with 4.2.1 shall be established in respect of all controls required rapidly or constantly with the flight crew having their safety harness correctly worn.

5 **INSTRUMENTS** Instruments and their installations are specified in Sub-sections **Q5** and **Q6**.

SUB-SECTION Q4 – DESIGN AND CONSTRUCTION

CHAPTER Q4–3

COMPARTMENT DESIGN AND SAFETY PROVISIONS

1 **INTRODUCTION** This Chapter prescribes detailed requirements related to the design and construction of passenger, cargo and baggage compartments, and to the safety of occupants in normal and emergency conditions (see also **Q4–4**), for passenger cabins the seating capacity of which is not more than 20. The CAA shall be consulted for requirements when the seating capacity exceeds 20. Certain paragraphs apply also to the design and construction of the flight-crew accommodation or need to be considered in relation to the accommodation as a whole.

2 **CARGO AND BAGGAGE COMPARTMENTS** (see also 6)

2.1 **Strength.** Each cargo and baggage compartment shall have sufficient strength to withstand the maximum weight of the contents and the critical load distribution at the critical load factors corresponding to all prescribed flight and ground-load conditions, excluding the emergency alighting conditions prescribed in **Q3–8**.

2.2 **Securing of Cargo**

2.2.1 Provision shall be made to prevent shifting of the contents of the cargo or baggage compartment under the conditions of 2.1.

2.2.2 In addition, the requirements of **Q3–8**, 3 shall be complied with. If safeguarding by positioning is not practicable, strength of securing appropriate to the accelerations of **Q3–8**, 2, shall be provided.

2.3 **Cargo Interference.** Cargo and baggage compartments shall include no controls, electrical wiring, pipe lines, equipment or accessories, the damage or failure of which would affect the safe operation of the Airship, unless such items are adequately shielded, isolated or otherwise protected so that they cannot be damaged by movement of the contents of the compartments.

3 **WINDOWS**

3.1 Windows shall be of non-splintering type, and where located forward of the pilot, shall be such as not to become opaque when damaged.

3.2 **Aerodynamic Loads.** All windows and their fixings shall comply with the flight cases of the strength requirements of Sub-section **Q3** prescribed for the Airship as a whole.

4 **EXITS** (see **Q4–3** App., 1)

4.1 **General**

4.1.1 (See **Q4–3** App., 1.1.) In the case of exits for which the initial opening movement is outward, a means shall be provided to ascertain that such exits are fully locked. The inside handle of such exits shall be such that inadvertent contact with it is unlikely to cause the door to open.

4.1.2 All exits shall be marked to indicate their purpose and any necessary instruction for their use shall be clearly indicated.

4.2 Normal Exits

NOTE: A normal exit may be counted as an emergency exit provided that it complies with the requirements of 4.3 for emergency exits.

4.2.1 Each closed cabin with passenger accommodation shall be provided with at least one adequate and easily accessible external door.

4.2.2 Normal exits shall be located or protected with respect to propeller discs so as not to endanger persons using the exits.

4.3 Emergency Exits

4.3.1 **General.** There shall be sufficient suitable exits to facilitate the rapid escape of all occupants in the event of an emergency alighting.

4.3.2 **Location or Protection** (see **Q4–3** App., 1.3). Exits shall be located or protected so as not to endanger persons using the exits, by virtue of the proximity of propellers which could still be rotating following a crash landing, or during a precautionary evacuation.

4.3.3 **Number of Exits**

(a) All Airships with closed cabins shall have at least one emergency exit on the other side of the cabin to the normal exit specified in 4.2.

(b) Where the flight-crew accommodation is separated from the cabin, e.g. by a door which is likely to block the escape of the flight crew in a minor crash, an additional exit or exits shall be provided in the flight-crew accommodation.

4.3.4 **Type and Operation** (see **Q4–3** App., 1.2)

(a) Emergency exits for passenger cabins the seating capacity of which is not more than 10, shall consist of movable windows or panels, or external doors, that provide a clear and unobstructed opening large enough to admit an ellipse 483 mm × 660 mm (19 in × 26 in).

(b) Emergency exits for passenger cabins the seating capacity of which is more than 10 shall consist of unobstructed rectangular openings of not less than 483 mm (19 in) wide by 660 mm (26 in) high, with corner radii of not more than one third of the width of the opening.

(c) Each emergency exit shall:

(i) be readily accessible and usable, requiring no exceptional agility in emergencies,

(ii) have a method of opening that is simple and obvious,

(iii) be arranged and marked for easy location and operation, even in darkness (e.g. by the use of luminous paint or emergency lighting), and

(iv) have reasonable provisions against jamming by car deformation.

4.4 **Ditching.** The arrangement of the exits shall be such that:

(a) at least one of the normal or emergency exits provided in accordance with 4.2 or 4.3, or

(b) a means of escape (e.g. a hatch or window),

is likely to be usable when the Airship is floating on the water in the most critical attitude.

NOTE: In showing compliance with 4.4 calculation of the flotation characteristics is acceptable.

4.5 **Emergency Evacuation**

4.5.1 A technique shall be established and included in the Flight Manual for rapid evacuation of the Airship by all occupants in emergency:

(a) when power is available from all engines or with one engine inoperative, and

(b) with all engines inoperative.

4.5.2 The technique shall include the crew procedures for controlling passenger evacuation.

4.5.3 When following this technique, the operation of the Airship's controls, including the emergency deflation means shall be such that, during the evacuation, the Airship will not leave the ground to an extent that would prevent occupants leaving the Airship.

4.5.4 The technique shall include any special precautions to be taken in surface wind speeds between zero and the maximum in which operation is permitted.

5 **VENTILATION** (see **Q4–3** App., 2)

5.1 All passenger and flight-crew accommodation shall be suitably ventilated.

5.2 Precautions shall be taken to preclude contamination of the cabin air. In particular, compliance shall be shown with 5.2.1 to 5.2.4.

5.2.1 Carbon monoxide concentration shall not exceed one part in 20 000 parts of air in any flight or ground condition or Airship configuration which is likely to be maintained for more than 5 minutes.

5.2.2 Fuel vapour shall not be present in dangerous concentrations.

5.2.3 Harmful concentrations of fire extinguishing agent shall not be liable to occur, either as a result of intentional use of any fire extinguishing system or extinguishers provided, or as a result of any failure which might lead to unintentional discharge of the extinguishing fluid.

5.2.4 Systems employing fluids liable to give off noxious vapour (e.g. some de-icing fluids) shall be installed in such a manner as not to risk harmful contamination of the cabin air either by leakage or by use.

6 **FIRE PRECAUTIONS**

6.1 The requirements of this paragraph 6 apply to all passenger, flight-crew, cargo and baggage compartments, as appropriate, except that relaxation may be given in particular cases where there is an open cockpit or a small cabin, in which smoking is prohibited, which provides similar escape facilities.

6.1.1 Pipes, tanks or apparatus containing fuel, oil or other flammable fluids shall not be installed in such compartments unless adequately shielded, isolated or otherwise protected against damage so that any breakage or failure of such an item would not create a hazard (see also **Q5–2**, 4.3 and 5.1, and **Q5–3**, 3.3).

6.1.2 In all compartments (smoking and non-smoking alike) no material shall be used in a form in which it burns readily, and the materials of all fittings and furnishing, the covering of all upholstery, the wall, floor and ceiling linings and any lagging, shall be sufficiently flame-resistant to preclude the possibility of fire beyond the control of the occupants, following ignition by cigarettes or matches.

NOTE: Suitable methods for flame-resistance testing are available on application to the CAA.

6.1.3 Placards shall be placed in all compartments where smoking is not permitted, stating that smoking is prohibited.

6.1.4 Suitable ash containers, of adequate capacity and capable of being cleaned easily, shall be provided in all compartments where smoking is permitted.

6.1.5 In each passenger compartment in which smoking is generally permitted, and which is separate from the flight-crew compartment, an indicator shall be provided, operable by the flight crew and visible from each passenger seat, to indicate when smoking is prohibited.

APPENDIX TO CHAPTER Q4–3

COMPARTMENT DESIGN AND SAFETY PROVISIONS

1 **EXITS** (see **Q4–3**, 4)

1.1 **Outward Opening Exits** (see **Q4–3**, 4.1.1). Where outward opening exits are fitted with vertical hinges, it is recommended that the door is attached at the forward edge unless an adequate means of restraint to limit the extent of any opening in flight is provided.

1.2 **Type and Operation** (see **Q4–3**, 4.3.4)

1.2.1 **Size of Exits**. It is recommended that wherever possible, door type exits on larger Airships should be at least 508 mm × 914 mm (20 in × 36 in). If the exits are not of this size on Airships the seating capacity of which is 15 or more, an additional exit is likely to be required.

1.2.2 **Shape of Exits**. An ellipse of the minimum prescribed dimensions having the major axis vertical is considered to comply with **Q4–3**, 4.3.4 (c)(i), only if adequate stepping facilities are provided inside and outside the Airship.

1.2.3 **Access to Exits.** Where the only means of access to emergency exits is an aisle between the seats, the width of the aisle should not normally be less than the dimensions given in Table 1 (**Q4–3** App).

Table 1 (Q4–3 App)

Passenger seating capacity	*Minimum Aisle Width*	
	Up to 635 mm (25 in) from floor	*Above 635 mm (25 in) from floor*
6 to 10	305 mm (12 in)	457 mm (18 in)
11 to 20	305 mm (12 in)	508 mm (20 in)

1.3 **Location or Protection** (see **Q4–3**, 4.3.2). The location or protection of emergency exits, relative to propeller discs, will need to be considered as a factor where the exit is likely to be used when the propellers are still rotating.

2 **CONTAMINATION OF CABIN AIR** (see **Q4–3**, 5) It is recommended that, so far as is practical, equipment the failure of which might result in the production of fumes should be so installed that fumes could not find their way, or be circulated, into the cabin air.

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SUB-SECTION Q4 – DESIGN AND CONSTRUCTION

CHAPTER Q4–4

SEATS, SAFETY BELTS AND HARNESSES

1 **INTRODUCTION** This Chapter prescribes detailed requirements related to seats, safety belts and harnesses and the restraint of occupants in normal and emergency conditions.

NOTE: The CAA will supply, on request , suitable methods of testing seats to establish compliance with this Chapter.

2 **SEATS** This paragraph 2 applies to seats and, so far as its provisions are applicable, to all parts of the Airship forming the passenger accommodation adjacent to the seat.

2.1 **Approval of Seats.** Seats shall be either of a type approved by the CAA generally or shall be approved in relation to a particular installation in an Airship type. In the latter case, an Approved Design Organisation (usually the Airship constructor) shall determine that the seat and installation comply with the requirements and are suitable for the intended purpose.

2.2 **Design** (see **Q4–4** App., 1)

2.2.1 Seats shall be of a form such as to fulfil the duty for which they are installed, and to provide, as far as possible, the maximum safety in emergency conditions for the occupants and other persons thrown against the seats. In particular, there shall be no hard edges or excrescences in positions likely to cause injuries to the occupants of the Airship in emergency conditions.

2.2.2 Any cushions, etc, designed for use with seats occupied by members of the flight-crew on duty, shall be suitably secured in position so that it is impossible for the cushions, etc, to move and in any way interfere with the use of the controls or with the normal free movement of the flight-crew. The pilot’s seat together with its upholstery shall be such as to react the loads applied to it by the pilot without deflecting to an extent that would prejudice his use of the controls.

2.3 **Strength**

2.3.1 The weight of each occupant shall be assumed to be 170 lb for design purposes, except that for seats designed to be used with a parachute, the weight of the occupant shall be assumed to be 190 lb; in addition, allowance shall be made for the weight of the seat including any equipment which will be carried on it.

2.3.2 Seats shall comply with the strength requirements for the Airship as a whole as prescribed in **Q3–2**, **Q3–3**, **Q3–5** and **Q3–8**.

2.3.3 Due allowance shall be made for the loads taken by safety belts or harnesses as prescribed in 3.

2.3.4 If the emergency alighting restraint is taken through the seat, the seat attachments shall have an Ultimate Factor of Safety of 1·33 times the loads corresponding to the emergency alighting accelerations of **Q3–8**.

2.4 **Installation.** The installation of the seats shall not obstruct access to, or use of exits or any essential or emergency equipment.

3 SAFETY BELTS AND HARNESSES

3.1 **Applicability.** The requirements of this paragraph 3 apply to safety belts and harnesses provided in accordance with **Q6–1**.

3.2 **Approval.** Safety belts and harnesses shall be of approved types.

NOTE: An 'approved type' of safety belt or harness is one complying with a specification accepted by the CAA.

3.3 Strength

3.3.1 The safety belt or harness and its attachment to the Primary Structure shall have a factor of at least 1·0 based on the certified strength when, in conjunction with the seat, it is restraining the wearer against forces resulting from the acceleration prescribed for emergency alighting conditions in **Q3–8**.

NOTES: (1) The minimum strengths acceptable for safety belts and harnesses are prescribed in 3.3.1. However, considerably greater crash protection can be provided by stronger restraint in well-designed accommodation (see **Q4–2**, 2.1.2 and **Q4–4** App., 1). The strength of stronger installations may be certified in terms of the 'g' against which they provide restraint.

(2) The 4·5 g downwards acceleration prescribed in **Q3–8** is the largest downward acceleration which need be considered together with the forward accelerations prescribed. A seat, however, is also required to withstand the appropriate flight, landing and take-off accelerations prescribed throughout Sub-section **Q3**.

3.3.2 Local attachments in the load path between the safety belt or harness and the main Airship structure, restraining the occupant in the emergency alighting conditions, shall be not less strong than the strength necessary for 1·33 times the loads corresponding to the emergency alighting accelerations of **Q3–8**.

3.4 Strength Assumptions

3.4.1 The wearer of the safety belt or harness shall be assumed to weigh 170 lb.

3.4.2 The designer shall make reasonable conservative assumptions regarding the load distribution on, and the geometry of, the safety belt or harness. No relief shall be assumed from muscular forces.

3.5 Installation

3.5.1 **General.** The certified strength which is required for each member of a safety belt or harness shall be stated on the drawings relating to its installation.

NOTE: A safety belt or harness is regarded as being divisible into various members (e.g. left thigh strap, right thigh strap, release mechanism, etc) which are liable to be detached from one another for purposes of stowage or replacement.

3.5.2 It is acceptable, in certain cases, to make provision for relaxing the upper restraints of a safety harness to enable the wearer to increase his reach or field of view, but if this is done, it shall be possible for the wearer to re-secure them without difficulty (see also **Q4–2**, 4).

3.5.3 Where there is otherwise a risk that a safety belt or harness might, when not in use, foul the controls or impede the flight-crew, suitable stowage shall be provided.

3.5.4 **Safety Belts.** Safety belts shall be installed in accordance with the approved Specification; in the case of belts conforming to the Specification obtainable from the CAA, the belt, when worn, shall lie across the groins of the wearer. The belt when so worn shall lie in a plane which is approximately at 45° to the plane of the longitudinal and lateral axes of the Airship.

NOTE: When designing accommodation incorporating a safety belt it is important to ensure as far as possible that the occupant, if pivoting forward about the belt under the conditions of 3.3.1, will not be liable to come into contact with potentially dangerous objects.

3.5.5 **Safety Harnesses.** The harness shall be installed in accordance with the approved Specification, and when correctly adjusted to the wearer:–

(a) the straps or belts shall remain in position regardless of any variation of load,

(b) the upper part of the torso shall be restrained sufficiently to ensure that the wearer's head and trunk are safeguarded, under the conditions of 3.3.1 from contact with potentially dangerous objects.

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APPENDIX TO CHAPTER Q4–4

SEATS, SAFETY BELTS AND HARNESSES

1 **DESIGN OF SEATS** (see **Q4–4**, 2.2)

1.1 **Energy Absorption.** It is recommended that seats should be designed with a view to absorbing as much energy as possible before total failure in a crash.

NOTE: Compliance with this recommendation and provision of increased restraint in both forward and downward directions will provide additional protection to occupants in emergency conditions.

1.2 **Protection of Occupants**

1.2.1 In emergency conditions sources of potential injury to occupants are solid objects, sharp edges or excrescences within the areas through which the body, head and limbs of the occupant will move in the prescribed emergency alighting conditions. Attention should therefore be paid to the passenger accommodation including the occupant's own seat and the seat(s) in front of him to avoid, where possible, the presence of such sources of potential injury. Where the presence of solid objects cannot be avoided, they should be smooth and either flat or of large radius; padding may also be desirable.

1.2.2 It is recommended that consideration be given to designing seat backs so that they pivot forward under forward acting emergency alighting loads and thus assist in avoiding the presence of solid objects within the arc of travel of the occupant.

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SUB-SECTION Q4 – DESIGN AND CONSTRUCTION

CHAPTER Q4–5

LANDING GEAR DESIGN

1 WHEELS AND TYRES

1.1 **Wheels.** Wheels shall be designed to have adequate strength and fatigue life under the loads prescribed in **Q3–5**.

1.2 **Tyres.** Tyres shall be such that, when fitted to the Airship wheels and inflated to the recommended pressures, they will be capable of withstanding the permitted operation of the Airship.

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SUB-SECTION Q4 – DESIGN AND CONSTRUCTION

CHAPTER Q4–6

ELECTRICAL BONDING AND LIGHTNING DISCHARGE PROTECTION

1 **INTRODUCTION** This Chapter prescribes requirements and its Appendix gives recommended practices relating to the following subjects:–

1.1 The protection of the Airship against lightning discharges.

1.2 The electrical bonding of the Airship structure, components and equipment in order:–

(a) to prevent dangerous accumulation of electrostatic charges,

(b) to minimize the possibility of electric shock from the electricity supply and distribution system,

(c) to provide an adequate electrical return path on Airships having earthed electrical systems,

(d) to prevent interference with the functioning of Essential Services (e.g. radio communications and navigational aids).

NOTE: **Q6–13**, 6.3 also prescribes requirements for the earthing of electrical systems.

2 **PRIMARY AND SECONDARY CONDUCTORS** (see **Q4–6** App., 1) For the purposes of this Chapter, Primary Conductors shall be those conductors which are required to carry lightning discharge currents, and Secondary Conductors shall be those conductors provided for other forms of bonding.

2.1 The cross-sectional area of Primary Conductors made from copper shall be not less than 3 mm^2 (0·0045 in^2) e.g. 0·25 in by 26 S.W.G., except that, where a single conductor is likely to carry the whole discharge from an isolated section, the cross-sectional area shall be not less than 6 mm^2 (0·009 in^2) e.g. 0·5 in by 26 S.W.G. Aluminium Primary Conductors shall have a cross-sectional area giving an equivalent surge carrying capacity.

2.2 Primary Conductors shall be used for:–

(a) Connecting together the main earths of separable major components which may carry lightning discharges.

(b) Connecting engines to the main earth (see 4).

(c) Connecting to the main earth all metal parts presenting a surface on or outside of the external surface of the Airship.

2.3 The electrical impedance of Primary Conductors to a lightning discharge shall be as low as practicable.

2.4 The cross-sectional area of Secondary Conductors made from copper shall be not less than 1 mm^2 (0·0015 in^2). Where a single wire is used its size shall be not less than 1·2 mm (18 S.W.G.).

3 PROTECTION AGAINST LIGHTNING DISCHARGES

3.1 The Airship shall be effectively provided with means to conduct lightning strikes, so that the Airship or its occupants will not be endangered. The means provided shall be such as to:–

(a) Minimise damage to the Airship structure or components.

(b) Prevent the passage of such electrical currents as will cause dangerous malfunctioning of the Airship or its equipment.

(c) Prevent the occurrence of high potential differences within the Airship.

3.2 **Control Surfaces**

3.2.1 Control surface hinges shall:–

(a) have bearings of a type which are capable of withstanding a lightning discharge without dangerous seizure, or

(b) be provided with at least one bonding conductor across each end hinge.

3.2.2 Where bonding conductors are provided in accordance with 3.2.1 (b), they shall be as flexible and as short and straight as possible and shall not be tinned. Great care shall be taken to avoid any possibility of their jamming the controls.

3.3 **Fuel System.** The fuel storage system of the Airship shall either be situated so that it is most unlikely to be struck by lightning or shall be so protected that in the event of it being struck by lightning a catastrophe is not likely to occur. The outlets of venting and jettisoning systems shall be so located and designed that they are unable to be struck by lightning.

4 **ENGINES AND ENGINE MOUNTINGS** Where the engine is not in direct electrical contact with its mounting the engine shall be electrically connected to the main earth system by at least two removable Primary Conductors, one on each side of the engine.

5 PROTECTION AGAINST THE ACCUMULATION OF STATIC CHARGES

5.1 **General.** All items, which by the accumulation and discharge of static charges may cause a danger of electric shock, ignition of Flammable vapours, or interference with Essential Equipment, e.g. radio communications and navigational aids, shall be adequately bonded to the main earth systems.

NOTE: See 7.1 for resistance values appropriate to various forms of bonding.

5.2 **Envelope.** Provision shall be made for the safe discharge, when the Airship, or at least one ground handling line (see **Q4–9**, 4), makes contact with the ground, of any electrostatic charge which may have accumulated on the envelope.

5.3 **Intermittent Contact.** The design shall be such as to ensure that no fortuitous intermittent contact can occur between metallic and/or metallized parts.

5.4 **Grounding of Main Earth System.** The main earth system shall be connected to ground automatically when the Airship is on the ground. The resistance between the main earth system and the ground, when the Airship is at rest, shall not exceed 10 megohms.

NOTE: The resistance should be measured between the main earth system and a metal plate on which the earthing means, e.g. tyre, is resting.

5.5 **Filling Points.** It shall readily be possible to bond refuelling equipment, including the refuelling nozzle, to the Airship, and to make the bonding connection before the filler cap is removed. The efficiency of the connection shall be independent of the particular type of refuelling equipment being used.

5.6 **High-Pressure Refuelling.** High-pressure refuelling systems shall, unless otherwise agreed by the CAA, comply with the requirements of Section D, Chapter **D4–6**.

6 **MANDATORY RADIO EQUIPMENT** The requirements of this paragraph 6 are applicable to the installation of mandatory radio equipment in Airships.

NOTES: (1) In the case of Airships fitted with mandatory radio receiving or transmitting apparatus an additional reason for bonding is to provide an earth system of low resistance and maximum self capacity for the efficient operation of the radio equipment.

(2) See also Section R 'Radio'.

6.1 The metal frame and mounting structure carrying each radio unit shall be bonded to the main earth by at least one Primary Conductor or its equivalent.

6.2 Within a radius of 2·5 m (8 ft) of any unscreened radio and radio transmitting equipment or its aerial lead, any long electrically conducting parts (including metallic pipe lines and metal braiding and conduit) which are not insulated from earth, shall be electrically bonded to the main earth system.

6.3 Provision shall be made for the bonding of all radio transmitting and receiving apparatus to the main earth by means of one or more Primary Conductors, or their equivalent. In the case of Airships of non-metallic or composite construction, the main bonding strips shall be connected together near these points with Primary Conductors.

7 RESISTANCE AND CONTINUITY

7.1 Resistance Between Bonded Components and Earth

7.1.1 **General.** Where bonding is provided for the purpose of lightning protection or for the efficient operation of radio equipment, the resistance between any bonded component and the portion of the main earth to which it is connected shall not exceed 0·05 ohm.

7.1.2 **Secondary Bonding**

(a) *For the Dissipation of Electrostatic Charges*

(i) Metallic parts normally in contact with Flammable fluids shall be bonded together and to the main earth system. The resistance between each bonded part and earth and between the parts themselves shall be not greater than 1 ohm.*

(ii) All isolated conducting parts not covered by (i), inside and outside the Airship, having an area greater than 19·3 cm^2 (3 in^2) and a linear dimension greater than 7·6 cm (3 in) which may be subjected to appreciable electrostatic charging

*The value of 1 ohm has been chosen to allow for the inclusion of the resistance of any cable that may be employed for this bonding case, but no one contact resistance should exceed 0·05 ohm.

because of precipitation or of fluid or air in motion shall be so electrically bonded that the leakage resistance to the main earth system will not exceed 0·5 megohm or 100 000 ohms/sq ft of surface area whichever is the less.

(b) *For the Avoidance of Electrical Shock from the Airship Electrical Systems.* Where an unearthed electrical system is used or the voltage used in any part of the system exceeds 50 volts (RMS), the Requirements of Section D, Chapter **D4–6**, 8.2.2(b) shall be complied with.

(c) *Bonding Carrying the Main Electrical Supply.* The cross-sectional area of the main earth system and of any connections to it shall be such that it will, without overheating or causing excessive voltage drop, carry any electrical currents which may pass through it, normally, or under fault conditions.

APPENDIX TO CHAPTER Q4–6

1 **PRIMARY CONDUCTORS** (see **Q4–6**, 2) The joints detailed in this paragraph 1 are acceptable as parts of Primary Conductors.

1.1 Provided that all insulating finishes are removed from the contact area before assembly, metal-to-metal joints held together by threaded devices, riveted joints, structural wires under appreciable tension, and bolted and clamped fittings.

NOTE: A surface anodised in accordance with Specification DEF.151 is an almost perfect insulator for a potential difference of less than 130 volts, but the surface is readily broken by the rotation of a bolt head or the forming of a rivet. In these latter cases it is unnecessary to remove the anodic finish. However, when two anodised parts are clamped together without any relative motion being involved, the anodised surface should be removed over an area strictly limited to that necessary to ensure efficient electrical contact, and the assembly coated with a suitable protective material such as a jointing compound containing barium chromate.

1.2 Most cowl fasteners and locking and latching mechanisms.

1.3 Metal-to-metal hinges for doors and panels and metal-to-metal bearings (including ball bearings).

NOTE: For control surface hinges see **Q4–6**, 3.2.

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SUB-SECTION Q4 – DESIGN AND CONSTRUCTION

CHAPTER Q4–7

FLIGHT IN PRECIPITATION CONDITIONS

1 **GENERAL** The design of all Airships shall be such that the stability and control of the Airship is unlikely to be critically affected by such ice accretion as may occur during Flight in Anticipated Operating Conditions.

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SUB-SECTION Q4 – DESIGN AND CONSTRUCTION

CHAPTER Q4–8

CONTROL SYSTEM LOADS AND DESIGN

1 CONTROL SYSTEM LOADS

1.1 Primary Flight Controls

1.1.1 The flight control system and supporting structure shall have Proof and Ultimate Factors of not less than 1·0 and 1·5 respectively under whichever is the greater of (a) or (b):–

(a) either

(i) the loads corresponding to 'maximum pilot effort' in Table 1 (**Q4–8**), or

(ii) if a reliable estimate can be made of the hinge moments of the control surfaces, the loads corresponding with 1·25 times the maximum hinge moments, except that such loads shall be not less than those resulting from the 'minimum pilot effort' given in Table 1 (**Q4–8**).

(b) the automatic-pilot effort if it alone can produce higher control surface loads than the human pilot.

1.1.2 The loads assumed shall, in any case, be sufficient to ensure that the system is robust so that it will adequately cater for:–

(a) excess loading arising as a result of ground handling, handling during maintenance operations, and jarring (such as might occur as a result of gusts) taking into account control inertia and friction,

(b) lower loads which occur with high frequency.

1.1.3 The loads resulting from pilot effort shall be assumed to act at the appropriate control grips or pads in a manner simulating operating conditions and to be placed in equilibrium by an appropriate force at the attachment of the control system to the control surface.

1.1.4 **Rudder Loading Case.** When the rudder operating control is a wheel mounted on a column in front of the pilot, the loads shall be applied tangentially to the rim of the wheel. In the rudder wheel torque case, the torque shall be produced by equal and opposite forces, applied tangentially to opposite sides of the wheel.

1.1.5 **Elevator Loading Cases**

(a) When the operating control is a capstan wheel mounted beside the pilot, the fore-and-aft force shall be applied to the highest point on the rim of the wheel.

(b) When the operating control is a wheel or grip, mounted on a column in front of the pilot, the fore-and-aft force shall be equally divided between two points on opposite sides of the wheel on a horizontal diameter.

(c) As a separate case to (b), a single load of half the magnitude of the fore-and-aft force used in (b) shall be applied at all points on the rim of the wheel.

1.1.6 In cases where the simultaneous application of the loads in more than one system (e.g. elevator and rudder systems) is liable to cause critical loads, the system shall have Proof and Ultimate Factors of not less than 1·0 and 1·5 respectively under combinations of load of 50% of the magnitude of the loads prescribed for the separate systems.

1.1.7 In determining the distribution of loading in the elements of the control system, the angular setting of the control surfaces most appropriate to the prescribed loading conditions shall be assumed.

1.1.8 **Dual Controls.** Dual control systems shall have Proof and Ultimate Factors of not less than 1·0 and 1·5 respectively under the following conditions:–

(a) *Pilots Acting Together.* Each pilot exerting an effort equal to 75% of that corresponding to the loads employed in 1.1.1.

(b) *Pilots Acting in Opposition.* Each pilot exerting an effort equal to 75% of that corresponding to the loads employed in 1.1.1, but not less than those prescribed in Table 1 (**Q4–8**) for minimum pilot effort.

TABLE 1 (Q4–8)

Control	Maximum Pilot Effort	Minimum Pilot Effort
ELEVATOR:–		
(i) Capstan wheel (see 1.1.5(a)	805 N (180 lbf)	445 N (100 lbf)
(ii) Wheel mounted on a column (see 1.1.5(b))	980 N (220 lbf)	445 N (100 lbf)
(i) Rudder bars:–		
On one side of rudder bar.	1055 N (237 lbf)	580 N (130 lbf)
Simultaneously on each side of rudder bar.	805 N (180 lbf)	805 N (180 lbf)
(ii) Wheel control (see 1.1.4)		
wheel lateral	325 N (72 lbf)	180 N (40 lbf)
wheel up and down	360 N (80 lbf)	225 N (50 lbf)
wheel torque	280D + Nm (63D ‡ lbf in)	180D + Nm (40D ‡ lbf in)

+ D . . . m . . . is control wheel diameter ‡ D . . in . . . is control wheel diameter

1.2 **Other Control Systems.** Each system shall have Proof and Ultimate Factors of at least 1·0 and 1·5 respectively, under the maximum loads likely to be experienced.

1.3 **Control Chains and Cables**

1.3.1 Irrespective of the factors prescribed elsewhere in this Chapter, control chains and cables shall achieve the following when subjected to the maximum (unfactored) design loads:–

(a) control chains – an Ultimate Factor of 3·0,

(b) control cables – nominal strength giving a factor of 2·0.

1.3.2 Cables in primary flight control systems shall be not less than 3 mm (0·12 in) diameter.

1.4 **Joints**

1.4.1 Control system joints subject to angular motion in push-pull systems, except ball and roller bearings, shall incorporate a special factor of not less than 3·33 with respect to the ultimate bearing strength of the softest material used as a bearing; this factor may be reduced to 2·0 for such joints in cable control systems.

1.4.2 The loading limitations of ball and roller bearings shall not be exceeded.

2 **CONTROL SYSTEM DESIGN**

2.1 **General***

2.1.1 Operating controls shall be capable of operation with sufficient ease, smoothness and positiveness to permit the proper performance of their function and,

(a) shall be so arranged and identified,

(i) to provide satisfactory convenience in operation,

(ii) to prevent the possibility of confusion and inadvertent operation;

(b) for controls other than primary flight controls, shall give clear and unambiguous indication, visually and where necessary, by feel, of their settings.

NOTE: Some controls may need to be further marked or identified in accordance with **Q7–3**.

2.1.2 The design and location of the operating controls shall be such as to minimise the risk of inadvertent operation either by personnel entering or leaving the Airship or by the flight crew during normal movement in the crew accommodation.

2.1.3 Where practicable, the sense of motion involved in the operation of all controls shall correspond with the sense of the response either of the Airship or, if the Airship response is relatively unimportant, of the part operated.

NOTE: Specific directional movement for particular controls is prescribed elsewhere in the Requirements, e.g. 2.2.2(b) for primary flight controls, **Q5–7** for Powerplant controls.

2.1.4 Operating controls, other than those which are under constant supervision (e.g. primary flight controls) shall maintain any chosen setting without subsequent attention by the flight crew and shall not tend to creep under control loads or vibration.

2.1.5 Operating controls, in addition to compliance with 1, where applicable, shall possess adequate rigidity to withstand operating loads without excessive deflection.

2.1.6 Essential Services and their control systems shall be so designed that when a movement to one position has been selected, a different position can be selected without having to wait for completion of the initially selected movement. It shall not be necessary for the pilot to follow other than a normal control sequence in selecting the new position. Following this selection, the service being operated shall arrive at the finally selected

*For control systems in Designated Fire Zones, see **Q5–8**, 9.

position without further crew action. The movement(s) which follow and the time taken shall not be such as to adversely affect the airworthiness of the Airship.

2.1.7 All control systems and operating controls shall be designed and installed so as to prevent:–

(a) Jamming; chafing; interference by passengers, cargo or loose objects.

(b) Slapping of chains, cables or tubes against parts of the Airship.

(c) The jamming of controls by the accumulation of frost; or by the freezing of water in any part where it is likely to freeze.

2.1.8 Means shall be provided in the flight-crew accommodation to prevent the entry of foreign objects where they could jam the control system.

2.1.9 Sprockets shall be guarded so as to prevent chains jamming or coming off when slack.

2.1.10 All control systems shall be provided with stops which positively limit the range of movement of the pilot's controls. These stops shall be capable of withstanding the loads corresponding to the design conditions for the control system (see also 1.1.2) and shall be so located in the control system that the range of travel of the control surface is not appreciably affected by wear, slackness or tensioning adjustments.

2.1.11 Provision shall be made for inspecting visually all fairleads, pulleys, terminal fittings and turnbuckles.

2.1.12 **Cable Systems**

(a) Cable systems shall be designed such that there will be no hazardous change in cable tension throughout the range of travel under all operating conditions and temperature variations for which the Airship is certificated.

(b) Each pulley shall be provided with closely fitted guards to prevent cables becoming displaced or fouled, even when slack. The alignment of pulleys shall be such that cables will not rub against pulley flanges.

(c) Fairleads shall be installed such that they do not cause a change in cable direction of more than 3°.

(d) Shackle pins subject to load or motion and retained only by split pins shall not be used in the control system.

2.1.13 **Location of Controls in Flight-crew Accommodation.** The engine controls shall be located so as to prevent any misleading impression as to the engines to which they relate.

2.2 **Flight Controls**

2.2.1 **General**

(a) Flight controls include the following control systems:–

(i) Primary Flight controls.

(ii) Trimming controls.

(iii) Gas and Ballonet air system controls.

(b) All elements of the flight control systems shall be so designed as to minimize the possibility of the controls being assembled in such a way as to impair the continued safe operation of the Airship. In particular, the design shall be such as to minimize the possibility of:–

(i) assembling the controls disastrously out of phase,

(ii) assembling the controls so that they operate in the reverse sense,

(iii) interconnecting the controls of different systems where this is not intended,

(iv) assembling items of the controls in such a way as to result in interference with or jamming of the controls by other parts of the control system or Airship.

(c) The reliability of any spring device shall be established by tests unless it can be shown that failure of the spring will not cause flutter or unsafe flight characteristics.

(d) Where a device is carried in the Airship for locking a control surface while the Airship is on the ground, the locking device shall be such that while it is engaged it will provide to the pilot unmistakable warning which it is impossible for him to ignore. Means shall be provided to preclude the possibility of the lock becoming engaged in flight.

2.2.2 **Primary Flight Controls**

(a) Primary flight controls are defined as those used by the pilot for the immediate control of the pitching and yawing of the Airship.

(b) **Control Sense**

(i) When the elevator control consists of a capstan wheel mounted beside the pilot, or a wheel mounted on a column in front of the pilot, a rearward displacement of the top of the wheel shall cause the Airship to pitch nose up.

(ii) When the rudder control consists of a pair of foot pedals, a forward displacement of the right-hand rudder pedal shall cause the Airship to turn to the right.

(iii) When the rudder control consists of a wheel mounted on a column in front of the pilot, a right-hand rotational displacement of the wheel shall cause the Airship to turn to the right.

(c) The design of the primary flight control system shall ensure that the static friction in the systems has no material adverse effect on those stability and control characteristics necessary to comply with **Q2**.

(d) The primary flight controls shall be so located with respect to the propellers that no portion of the flight crew or the controls, excluding cables and control rods, lies in the region between the plane of rotation of any inboard propeller and the surfaces generated by a line passing through the centre of the propeller hub and making an angle of 5° forward and aft of the plane of rotation of the propeller.

(e) Moveable surfaces on the fin and tailplane shall be such that there is no interference between any surfaces or their bracings when one surface is held in its extreme position(s) and the others are operated throughout their full angular movement.

(f) If an adjustable tailplane is fitted, it shall be provided with stops to limit its range of travel to that allowing safe flight and landing.

(g) *Limit Load Static Test*

(i) A static test at the Limit Load shall be conducted on the control system. The direction of the test loads shall be such as will produce the most severe loading in the control system.

NOTE: The test should include each fitting, pulley and bracket used in attaching the system to the main structure.

(ii) Compliance with 1.4.1 shall be demonstrated by individual tests at the Limit Load or by analysis.

2.2.3 **Trimming System**

(a) Where trimming devices are provided to reduce the aerodynamic control forces the design shall be such that should any one connecting or transmitting element in the primary control system fail, it will be possible to continue the flight safely.

(b) Trimming controls, and the means provided for indicating the position of trimming devices, shall be conveniently grouped and shall be so arranged that they will not give the pilot a misleading impression of the Airship motion which will result from a particular movement of the control (for example, each trimming control may be arranged to operate in the plane, and with the sense of motion of the Airship, which its operation is intended to produce). Suitable precautions shall be taken to minimize the possibility of inadvertent or abrupt operation of trimming devices.

(c) Means shall be provided adjacent to the control to indicate to the pilot both the direction of movement necessary to produce the desired direction of motion of the Airship and the position of the trimming device.

2.2.4 **Functioning Tests.** Functioning tests shall be conducted on each complete flight control system from the flight crew position, with each system loaded as prescribed in (a) or (b), as appropriate. During the test there shall be no evidence of jamming, excessive friction or excessive deflection over the complete range of movement.

(a) *Primary Flight Controls.* Each system loaded so as to correspond to the limit air load on the appropriate control surface.

(b) *Other Control Systems.* A load not less than the maximum force that a member of the flight crew is likely to apply to the particular control system.

2.3 **Emergency Deflation Controls**

2.3.1 The controls provided in compliance with **Q4–9**, 3 to permit emergency deflation of the envelope on the ground shall be guarded against inadvertent operation, and shall be fitted with a restraining device such that a force of 67 N (15 lb) must be exerted before the control can be actuated.

2.3.2 The control shall be placarded in compliance with **Q7–3**, 3.3.

SUB-SECTION Q4 – DESIGN AND CONSTRUCTION

CHAPTER Q4–9

ENVELOPE DESIGN

1 GENERAL

1.1 The envelope shall be designed to operate with sufficient pressure to ensure that the envelope remains in tension whilst supporting the maximum Limit Loads which arise from the loading cases prescribed in Sub-section **Q3**. The minimum and maximum operating pressures shall be established.

1.2 Account shall be taken of the effect of local aerodynamic pressures on the stresses developed in the envelope.

1.3 The properties of the Airship envelope shall be such that hazardous propagation of tears or local damage will not occur while the envelope is supporting limit loads. The damage to be considered for evaluation must be at least that which will result in a catastrophic loss of airworthiness by deflation or other causes.

With this magnitude of damage no significant rate of propagation may occur at maximum permissible overpressure in normal operation.

These properties must be substantiated by representative testing.

1.4 The envelope material shall have properties such that, in the event of a source of ignition being applied accidentally to the envelope, combustion will not propagate beyond the immediate area of the ignition source when the Airship is inflated with the prescribed gas up to maximum permissible overpressure.

NOTE: Proposed methods of compliance with paragraphs 1.3 and 1.4 should be agreed with CAA.

2 **BALLONETS** Ballonets shall be designed and installed such that the centre of gravity of their combined volume will coincide longitudinally, within approved limits, with the centre of buoyancy of the envelope.

3 EMERGENCY DEFLATION ON THE GROUND

3.1 Means shall be provided to permit emergency deflation of the Airship on the ground. Requirements for operating controls are given in **Q4–8**, 2.3.

3.2 When the envelope is deflated by operation of the emergency deflation means, the Airship shall lose lift at a rate consistent with compliance with **Q4–3**, 4.5. In the absence of information to the contrary it shall be assumed that the occupants will leave the Airship in not more than 60 seconds.

3.3 Design precautions shall be taken to render it extremely unlikely that the envelope will deflate at a dangerous rate either by reason of a fault in the system or by inadvertent operation of the device by the crew or other occupants.

NOTE: If operation of the emergency deflation means is irreversible, it is recommended that inadvertent opening of any single means of gas release will not result in ground contact at a dangerous rate of descent, allowance being made where appropriate for aerodynamic lift, vectored thrust and release of ballast.

3.4 If the Airship is to be moored to a mast and left unattended, provision shall be made for automatic deflation of the envelope should the Airship break away from the mast. Design measures shall be taken to ensure that the Airship cannot be deliberately flown from the mast in a condition where automatic deflation will take place.

4 **GROUND HANDLING** Provisions for ground handling shall be provided and be capable of withstanding the ground loads specified in **Q3–13**. At least one ground handling line shall incorporate provisions for electrostatic discharge in accordance with **Q4–6**, 5.2, and shall be appropriately identified. The ground handling procedures shall state that the electrostatic discharge line must make contact with the ground before the ground handling crew touch the handling lines.

5 **PROTECTION FROM DEBRIS** The envelope in the plane of the propellers shall be so designed or protected as to minimize the probability of losing gas to an extent that would hazard the Airship due to penetration by debris thrown up by the propellers or by ice shed by the propellers.

6 **CAR ATTACHMENTS** If a catenary or a similar system is used, means shall be incorporated to permit measurement and equalisation of the tension loads as necessary. The installation of such systems shall be such as to prevent chafing of the envelope or the Ballonets.

APPENDIX TO CHAPTER Q4–9

ENVELOPE DESIGN

1 The physical size of damage to be considered is dependent on the design of the Airship and the consequence of failures in various locations.

2 The size of damage to be considered in the helium envelope is at least that which would cause a catastrophic deflation during a descent from normal operational height to ground level. In the absence of a more rational analysis, 'catastrophic deflation' may be taken to mean that which assuming no crew response would result in a final uncontrolled descent rate of 1800 ft/min or greater. Similarly, normal operational height may be assumed to be 2500 ft.

3 The size of damage to be considered in the ballonets is that which achieves equilibrium at 90% of the maximum permissible over-pressure.

4 Significant propagation may be taken to be equivalent to a rate of 0·5% of basic tear length per minute.

NOTE: Discrete tear containment features are in principle a method of preventing a catastrophic deflation due to structural collapse. However, their use in design must be subject to agreement with the CAA.

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SUB-SECTION Q5 – POWERPLANT INSTALLATIONS

CHAPTER Q5–1

GENERAL

1 **INTRODUCTION** This chapter contains general requirements applicable to Sub-section **Q5** as a whole. There may be cases where a general requirement given in this Chapter has to be overridden by a detailed requirement in a particular Chapter; the text used in the particular Chapter will make this clear.

2 **FUNCTIONING**

2.1 **General.** The Powerplant installation shall be constructed and arranged in a manner which will ensure safe functioning under all Anticipated Operating Conditions.

2.2 **Negative Accelerations.** If there are parts of the Powerplant the failure to function of which could have catastrophic results, these shall function satisfactorily when subjected to negative accelerations. The magnitude and associated duration of the negative accelerations to be covered shall be agreed with the CAA.

NOTE: This does not prohibit those temporary malfunctions or failure to function under negative accelerations which would not jeopardise the safety of the Airship.

2.3 **Isolation of Engines**

2.3.1 The engines and the Powerplant installation as a whole shall be such that:–

(a) each engine is or will be isolated from the other(s) such that should any engine, or any component of the Powerplant installation serving any engine, fail or malfunction, the remaining engine(s) will continue to operate satisfactorily without requiring any immediate action by the flight crew,

(b) consequent on the failure or malfunctioning of any engine or of any component of the Powerplant installation serving any engine, isolation of the engines is possible such that permanent loss of power of more than one engine is prevented.

2.3.2 **Fire.** Destruction by fire of all installations (including the fusing of electrical installations) in the Designated Fire Zones of any engine shall not interfere with the functioning of the other engine(s).

NOTE: See also Chapter **Q5–8**.

2.4 **Stopping and Re-starting**

2.4.1 **General.** The design of the installation shall be such that risk of fire or mechanical damage to the engine or Airship as a result of starting the engine in any conditions in which starting is to be permitted, is reduced to a minimum. Any techniques and associated limitations shall be established and included in the Flight Manual.

2.4.2 Means shall be provided for preventing hazardous rotation of an engine in flight after engine failure if overspeeding might be caused by windmilling of the propeller.

2.4.3 Where means are provided for stopping an engine in flight, it shall be possible to restart the engine and to unfeather any feathered propeller. Any altitude limit on restarting in flight shall be declared.

3 **BONDING AND LIGHTNING DISCHARGE PROTECTION** Requirements and Appendix material covering the electrical bonding and lightning discharge protection of Powerplant installations are contained in **Q4–6**.

4 **PROPELLER CLEARANCE** Adequate propeller blade clearances shall be provided under the most critical operating conditions.

4.1 In determining the propeller blade clearances, the most adverse logical combination of weight, centre of gravity position, propeller pitch and envelope deflection shall be assumed. In addition the particular conditions of 4.2 shall be considered.

4.2 The following minimum clearances shall be provided:–

(a) **Ground Clearance**

(i) With the landing gear statically deflected and the car in the most critical ground attitude, 229 mm (9 in) clearance between the propeller and the ground.

(ii) With the car in the most critical ground attitude and the tyre(s) on the critical landing gear unit completely deflated and the corresponding landing gear strut completely bottomed, positive clearance between the propeller and the ground.

(iii) With the car in the most critical ground attitude positive clearance with critical unit(s) and tyre(s) deflated corresponding to the design limit load conditions of **Q3–5**.

(b) **Structural clearance.** Adequate clearance shall be provided between the structure of the Airship and the blade tips and other rotating parts of the propeller.

5 **INSTRUMENTS AND EQUIPMENT**

5.1 **Instruments.** Requirements for instruments and their installation are contained in **Q5–2**, **Q5–3** and **Q6–1**.

5.2 **Equipment.** Each Group 2 equipment (see Section A, Chapter **A3–1**, 3.2) shall be satisfactory for mounting on the engine concerned.

6 **PIPE LINES AND DUCTS**

6.1 Inverted U-bends shall be avoided in all systems where vapour or air locks might cause malfunctioning of the system.

6.2 Pipelines shall be installed and supported so as to prevent excessive vibration and so as to withstand loads resulting from accelerated flight conditions and fluid pressure.

6.3 Pipes and ducts connected to components of the Airship between which relative motion may occur shall incorporate provisions for flexibility. Flexible pipe lines and their couplings shall be approved for the particular installation.

6.4 In pipelines that are under pressure, flexible hose assemblies shall be used at each flexible connection subject to axial loading.

6.5 Pipe lines and their connections shall be designed so as to minimize the risk of incorrect assembly of pipe lines by connecting the pipe lines of one system to those of another Powerplant system or to those of another system in the Airship.

7 DRAINS

7.1 Service draining points shall be provided for each system and shall be designed and positioned so as to enable the system to be completely drained when the Airship is in the normal ground attitude, without introducing a fire hazard.

NOTE: See also **Q5–2**, 4.4 and **Q5–8**, 2.2.

7.2 Service draining points shall be readily accessible and shall be provided with means for positive, or automatic, locking in the closed position. The drains shall discharge clear of the Airship.

7.3 Open drains shall be provided so that all sections of the engine cowling and neighbouring airframe compartments are drained to discharge clear of the airship, both in flight and on the ground.

8 VALVES CONTROLLING FLUID

8.1 Means shall be provided to enable the pilot rapidly to shut off, or otherwise prevent, hazardous quantities of fuel, oil and other Flammable fluids from flowing into, within or through Designated Fire Zones, except in lines forming an integral part of the engine.

8.2 The shut-off means shall be located outside Designated Fire Zones, unless equivalent safety can be provided (e.g. the means is Fireproof). It shall be shown that not more than 1·0 litre (1 qt) of Flammable fluid (or any greater amount shown to be safe) will drain into the Designated Fire Zones after operation of the shut-off means.

8.3 Operation of the shut-off means shall not prevent the functioning of emergency equipment (e.g. propeller feathering system).

8.4 All valves controlling fluid shall be provided with positive stops at, or locating provisions in, the ‘on’ and ‘off’ positions. The valves shall be so supported that loads resulting from their operation, or from accelerated flight conditions, are not transmitted to the lines connected to them.

8.4.1 Means shall be provided to guard against the inadvertent operation of the valves and to make it possible for the appropriate member of the flight crew rapidly to re-open the valves after they have been closed.

8.4.2 Mechanically-operated valves shall be installed so that they will be positive and easy to operate and will not change their setting under vibration. Power-operated valves shall give a positive indication of their setting and shall not change their setting under vibration.

8.5 **Non-return Valves.** Where practicable, it shall be mechanically impossible for non-return valves to be assembled and/or connected so that they operate in a reverse sense.

8.6 **Valve Operating Controls**

8.6.1 Where a valve is operated by a lever or switch, the lever or switch shall be designed and installed so as to give clear and unambiguous indication, both visually and by feel, of the valve setting.

8.6.2 Valve operating control handles and their connections to the valve mechanisms shall be such as to minimize the possibility of incorrect installation.

NOTE: See also **Q5–2**, 5.2 and **Q5–3**, 4.3.

9 **MARKINGS** Requirements relating to the markings associated with Powerplant instruments and operating controls and with filler caps are prescribed in **Q7–3**.

10 **TESTS**

10.1 **General.** In addition to 10.2, the Powerplant shall be subjected to such tests as are decided in consultation with the CAA. The tests shall include functioning checks and flight tests, up to the maximum operating altitude and range and in the climatic conditions appropriate to the particular test. These tests will be used as the basis for those limitations and procedures which are scheduled in the Flight Manual.

10.2 **Starting Tests.** Tests shall be made to determine safe starting techniques.

11 **FIRE PRECAUTIONS** The requirements of **Q5–8** shall be complied with and the designer shall give every possible consideration to the reduction of fire hazard.

SUB-SECTION Q5 – POWERPLANT INSTALLATIONS

CHAPTER Q5–2

FUEL SYSTEMS

1 **GENERAL** The fuel system shall be constructed and arranged so as to ensure an adequate supply of fuel to each engine at the prescribed flow rate and design pressure under all conditions of operation for which certification is desired.

NOTES: (1) See **Q5–1**, 2.2, negative accelerations.

(2) **Q5–8** prescribes requirements affecting the construction and location of various items in the fuel system; it is recommended that the designer pays particular attention to the relationship between these two Chapters.

2 **INDEPENDENCE OF SYSTEMS**

2.1 The fuel system shall be such that compliance can be shown with **Q5–1**, 2.4. The fuel system shall be so arranged as to permit the supply of fuel to each individual engine through a system (excluding fuel tanks) which is independent (but see 2.2) of the system(s) supplying fuel to the other engine(s).

2.2 Where a single tank is provided, there shall be:

(a) at least two independent vents,

(b) a separate outlet to each engine, and

(c) a shut-off valve at each outlet.

NOTE: This valve may be taken into account when showing compliance with **Q5–1**, 8.1.

3 **FUEL SUPPLY**

3.1 **General**

3.1.1 The fuel system shall be so arranged that no one fuel pump can draw fuel from more than one tank at a time unless means are provided to prevent the introduction of air into the fuel lines.

3.1.2 The fuel system (including the tanks) shall incorporate means to prevent the collection of water or foreign matter, or the deposition of ice or other substances from the fuel, from interfering with the satisfactory functioning of the system. Where fuel filters, strainers and other components susceptible to blockage by ice are incorporated in a fuel system in which icing might occur, means shall be provided that will maintain a fuel flow to the engine in the event of icing conditions occurring. For systems not equipped with fuel heating, this means shall be automatic.

3.1.3 The design of the system shall be such that there is no malfunctioning as a result of vapour or air locks, or from any other cause, when the Airship is operated under critical operating conditions, with the approved fuel at a temperature of not less than 45°C.

3.1.4 The closing of the shut-off means required by **Q5–1**, 8 for any engine shall not make any fuel unavailable to the remaining engines that would be available to those engines with that shut-off means open.

3.2 **Fuel Flow Rate**

3.2.1 **General**

(a) The ability of the fuel system to provide the required flow rate and pressure shall be demonstrated with the Airship in the most adverse likely attitudes, including those prescribed in **Q5–2** App., 1.1. During this test, fuel shall be delivered to the engine at the applicable flow rate (see 3.2.2 to 3.2.4) at not less than the minimum approved pressure.

(b) The quantity of fuel in the tank supplying fuel to the system under test shall not exceed the amount established as the unusable fuel quantity (see 8) for that tank, together with the minimum required for conducting the flow test.

(c) If significant restriction of the fuel flow rate can result from the malfunctioning of a flowmeter (including the metering unit) a suitable by-pass shall be incorporated. During the test the flowmeter shall be blocked and the fuel shall flow through the by-pass.

3.2.2 **Fuel Flow Rate for Gravity Systems.** The fuel flow rate for gravity systems (main and reserve supply) shall be not less than 150% of the Maximum Take-off Power fuel consumption rate of the engine.

3.2.3 **Fuel Flow Rate for Pump Systems.** The fuel flow rate for pump systems (main and reserve supply) shall be not less than 125% of the Maximum Take-off Power fuel consumption rate of the engine or the consumption rate plus 45·5 litres (10 gal) per hour, whichever is the greater. This flow rate shall be applicable both to the primary engine-driven pump and to the emergency pump and shall be available at the pump speed normally applicable during take-off. In the case of hand-operated emergency pumps, this speed shall be considered to be not more than 60 complete cycles (120 single strokes) per minute.

3.2.4 **Fuel Flow Rate for Auxiliary and Transfer Fuel Systems.** The provisions of 3.2.2 or 3.2.3 whichever is applicable, shall apply also to auxiliary and transfer systems, except that the required fuel flow rate shall be based on the Maximum Continuous Power conditions instead of Maximum Take-off Power conditions.

NOTE: In the case of a small auxiliary tank feeding into a large main tank, a lesser flow rate will be acceptable, provided a suitable placard is installed prescribing a satisfactory operating procedure for the use of the auxiliary tank.

3.3 **Flow Between Interconnected Tanks.** In the case of systems with tanks the outlets of which are interconnected, it shall not be possible in any of the attitudes prescribed in **Q5–2** App., 1, for fuel to flow between such tanks in quantities sufficient to cause an overflow of the fuel from a tank vent when the tanks contain the maximum permissible quantities of fuel.

3.4 **Fuel Supply Pumps**

3.4.1 The supply system shall be so arranged that in the event of a failure of any main fuel supply pump, the requirements of 3.2.3 and 3.2.4, as appropriate, are met. (See **Q6–12**, 2.)

3.4.2 Where a main pump is a positive displacement pump, a means of by-passing the pump shall be provided.*

3.4.3 Emergency pumps shall be immediately available for use.*

3.4.4 If main and emergency pumps operate continuously, means shall be provided to indicate to the flight crew when any pump is malfunctioning.*

3.4.5 At least one pump for each engine shall be driven by that engine.

3.4.6 Where a hand pump is incorporated to facilitate starting the engine, a relief valve shall be provided if excessive pressures could be attained which would cause damage to the fuel system or flooding of the carburettor.

4 FUEL TANKS

4.1 General

4.1.1 Fuel tanks shall have sufficient strength to:

(a) withstand without leakage or detrimental deformation all combinations of vibration, inertia, fluid and structural loads to which they may be subjected within Limit Load conditions, and

(b) withstand without structural failure all combinations of vibration, inertia, fluid and structural loads to which they may be subjected within Ultimate Load conditions.

4.1.2 Fuel tanks shall be provided with an expansion space of not less than 2% of the tank capacity. It shall not be possible to inadvertently fill the expansion space when the Airship is in the normal ground attitude.

4.1.3 Integral tanks shall be provided with adequate access to enable inspection and repair of the interior of the tanks to be carried out.

4.1.4 **Sumps.** Each tank shall be provided with a drainable sump having a capacity of not less than 0·25% of the tank capacity or 0·28 litres (0·5 pt), whichever is the greater. The sump shall be effective in both normal ground and flight attitudes. As an alternative to a sump, a sediment bowl the capacity of which is not less than 0·04% of fuel tank capacity may be installed, provided that the safe functioning of the system is not thereby impaired. The sediment bowl shall be so located that, when the Airship is in the normal ground attitude, water will drain into it from all portions of the tanks. Easy access to the bowl for drainage purposes shall be provided.

4.1.5 **Outlets.** Each tank outlet shall be provided with a strainer of from 3 to 6 meshes per cm (8 to 16 meshes per in) and the diameter of which is not less than the diameter of the outlet. Where a 'finger' strainer is provided, its length shall be not less than 4 times the diameter of the outlet. Strainers shall be accessible for inspection and cleaning.

4.1.6 **Filler Caps**

(a) Each tank filler cap shall be such as to maintain a fuel-tight seal.

NOTE: Small openings in the filler cap for venting purposes or to permit the passage of a fuel gauge are permissible.

*These requirements do not apply if the engine-driven pump is a fuel injection pump approved as part of the engine.

(b) Filler caps shall be designed to minimize the possibility of incorrect assembly and shall be such that they will not shake loose in flight. The caps shall be permanently attached by a chain or equivalent means.

NOTE: See **Q7–3** for filler cap markings.

(c) Incorrect fitting or loss of the fuel tank filler cap shall not result in siphoning of fuel (other than minor spillage) or collapse of flexible tank liners.

4.2 **Tests**

4.2.1 **Prototype Tanks – Pressure Tests.** Fuel tanks shall be capable of withstanding the pressure tests prescribed in (a), (b) or (c), as applicable, without failure or leakage.

NOTE: The prescribed pressures may be applied in a manner simulating the actual pressure distribution in service.

(a) *Conventional Metal Tanks and Non-metallic Tanks the Walls of which are not Supported by the Airship Structure.* A pressure condition of 24 kN/m^2 (3·5 lbf/in^2) or the pressure developed with a full tank during the maximum accelerations corresponding with the Ultimate Load factors of the Airship, whichever is the greater.

(b) *Integral Tanks.* The application of the critical combination of structural loads and internal pressures developed with a full tank during the maximum accelerations corresponding with the maximum Load Factors of the Airship.

(c) *Non-metallic Tanks the Walls of which are Supported by the Airship Structure.* The prototype tank of a specific design shall, with actual or simulated support conditions, be tested at a pressure of 14 kN/m^2 (2 lbf/in^2) or the pressure corresponding to the ultimate design condition for the tank, whichever is the greater. The supporting structure shall be capable of withstanding the critical loads occurring in the flight or landing strength conditions combined with the fuel pressure loads resulting from the corresponding accelerations.

4.2.2 **Prototype Tanks – Vibration and Surging Tests**

(a) Each metallic tank with large unsupported or unstiffened flat surfaces shall be subjected to vibratory and rocking tests to a schedule agreed with the CAA. Each tank shall withstand the tests without leakage or excessive deformation.

(b) Each non-metallic tank shall be subjected to rocking tests to a schedule agreed with the CAA, unless there is satisfactory operating experience with a similar tank in a similar installation.

4.2.3. **Series Tanks.** The drawings shall contain a note specifying the test pressure and procedure to be adopted for testing series tanks.

4.3 **Tank Installation**

4.3.1 **Location**

(a) Fuel tanks shall, so far as is practical, be designed, located and installed so as to render the liberation of fuel in or near the car or near the engines unlikely in otherwise survivable crash conditions. In particular fuel tank installations shall be such that it is unlikely that the tanks will be ruptured by a collapsed landing gear or by any engine mounting tearing away.

(b) Fuel tanks shall not be located in personnel compartments unless isolated by vapour- and fuel-proof compartments.

(c) Fuel tanks shall not be located on the engine side of a firewall. Not less than 12·7 mm (0·5 in) of clear air space shall be provided between any tank and a firewall.

(d) No portion of the engine nacelle skin which lies immediately behind a major air exit from the engine compartment shall be part of the wall of an integral tank.

4.3.2 **Support**

(a) Tank supporting structures shall have sufficient strength to withstand without failure any vibration, inertia and structural loads to which they may be subjected in normal conditions of operation.

(b) There shall be no chafing between the tank and supporting structure, and any padding used for this purpose shall be non-absorbent.

(c) Flexible tank liners shall be so supported that they are not required to withstand fluid loads. Either the interior surfaces of compartments for such tanks shall be smooth and free of projections which could cause wear of the tank, or provision shall be made for the protection of the tank.

4.4 **Structure Containing Tanks – Venting and Drainage.** Structure containing tanks shall be vented and drained to prevent the accumulation of Flammable vapours or fluids. Structure adjacent to flexible tank compartments and integral tanks shall also be vented and drained overboard.

NOTE: See also **Q5–1**, 7 and **Q5–8**, 2.2.

4.5 **Tank Vents**

4.5.1 Each fuel tank shall be vented from that part of the expansion space which will permit adequate venting under all normal ground and flight conditions.

NOTE: See also 2.2(a).

4.5.2 Each fuel tank vent shall be designed and constructed so as to preclude the possibility of fuel siphoning. Compliance shall be established with the fuel occupying a volume equal to the nominal capacity of the tank plus the expansion space.

NOTE: This margin is to cover the possible increase which may occur as a result of thermal expansion.

4.5.3 The venting capacity shall be such as to prevent excessive differences of pressure between the interior and exterior of the tank.

4.5.4 For flexible tank installations, the design shall be such as to maintain positive pressure differential within each flexible tank relative to the tank bay in all operating conditions, including change of altitude at the maximum rate.

4.5.5 Vents shall be located, constructed and drained so as to reduce to a minimum the possibility of their becoming obstructed by fluids, foreign matter or ice.

4.5.6 Vents from tanks shall not terminate at points where the discharge of fuel would constitute a fire hazard or result in fumes entering personnel compartments.

4.5.7 The air spaces of tanks the outlets of which are interconnected, shall be interconnected.

4.6 **Carburettor Vapour Vents.** Carburettor vapour vents shall terminate in a fuel tank. Where fuel tanks are used in a definite sequence, the termination of the vent shall be decided after taking account of the sequence and the relative capacities of the tanks.

5 LINES AND FITTINGS

5.1 **Pressurised Fuel Lines.** Pressurised fuel lines passing through personnel or cargo compartments shall:–

(a) be enclosed in a fuel- and vapour-proof enclosure ventilated and drained to the exterior of the Airship, or

(b) consist of a pipe line suitably routed or protected against accidental damage and without fittings on or within the personnel or cargo compartments.

5.2 **Valves Controlling Fuel**

5.2.1 The shut-off means required by **Q5–1**, 8, shall be installed in a protected location.

5.2.2 Where excessive pressure could otherwise occur in the system, e.g. from thermal expansion of the fuel, a means for the relief of such pressure shall be provided.

5.3 **Filters**

5.3.1 A filter shall be provided between the tank outlet and inlet to an engine-driven pump or engine fuel-metering device.

NOTE: A filter fitted to the bare engine in accordance with Section **C** is acceptable.

5.3.2 The filter shall provide the necessary degree of protection for the fuel pumps and metering system against sediment and other foreign matter which might be present in the fuel.

5.3.3 The fuel filter shall be easily accessible for draining and cleaning and the filter element shall be removable.

6 **FILLING POINTS** Filling points shall be so arranged that spilled fuel drains overboard and cannot gain access to the interior of the structure.

NOTE: The requirements relating to the markings associated with filling points are prescribed in **Q7–3**.

7 FUEL QUANTITY INDICATORS

7.1 **General.** Means shall be provided to indicate to the pilot during flight the quantity of usable fuel in each tank.

NOTES: (1) Tanks, the outlets and airspaces of which are interconnected, may be considered as one tank and need not be provided with separate indicators.

(2) Indicators need not be provided for small auxiliary tanks, the contents of which can only be transferred to another tank, provided that the relative size of the tanks, the rate of fuel transfer and the instructions pertaining to the use of the tanks are adequate to guard against overflow and to give the pilot prompt warning if transfer is not being achieved as intended.

7.2 **Sight Gauges.** Sight gauges that form a trap in which water can collect shall be provided with a means to permit drainage overboard.

7.3 **Transmitter Units.** The installation of tank transmitter units shall be such as to reduce to a minimum the false readings arising from changes of Airship attitude.

7.4 **Calibration**

7.4.1 Indicators shall be calibrated for the Airship attitude corresponding to level flight at cruising speed. In addition, when calibration is seriously affected by ground attitude, a second calibration with the Airship in the ground refuelling attitude shall be made.

7.4.2 The contents of the tank shall be indicated in standard units (i.e. not fractions of tank capacity) and shall be clearly and immediately apparent to the pilot. The 'Zero' marks on each indicator shall correspond to the condition of the tank when the quantity of fuel remaining is equivalent to the unusable fuel quantity.

7.4.3 The accuracy of indicators shall be demonstrated by tests on the prototype Airship. The drawings shall contain a note requiring the accuracy to be checked on a proportion of the series Airships.

8 DETERMINATION OF UNUSABLE FUEL QUANTITY (see **Q5–2** App., 1)

8.1 The unusable fuel quantity of each tank shall be established and shall be not less than that quantity of fuel at which the first evidence of malfunctioning of the engine occurs under the most adverse fuel feed condition. Account shall be taken of intended types of operation and the associated manoeuvres during which the tank is in use.

8.2 The effect on the unusable fuel quantity as a result of a failure of any booster pump shall be determined and included in the Flight Manual.

9 DETERMINATION OF USABLE FUEL QUANTITY

9.1 The usable fuel quantity, i.e. the total capacity of the tank less the expansion space (see 4.1.2) and less the unusable fuel quantity, shall be determined for each tank.

9.2 The total usable fuel quantity shall not be less than that required for 30 minutes operation at Maximum Continuous Power.

9.3 Where the unusable fuel quantity is determined in accordance with **Q5–2** App 1.2 a statement shall be made in the Flight Manual and a placard shall be provided to indicate to the pilot the conditions under which the full usable fuel quantity can be safely used.

10 **FUEL EXHAUSTION** When malfunctioning of the engine occurs through depletion of the supply from one tank, it shall be possible, on switching to an alternative supply, to regain the required fuel pressure and full engine power within 20 seconds.

11 **FUEL JETTISONING AND PRESSURE REFUELLING SYSTEMS** Fuel jettisoning and pressure refuelling systems shall, unless otherwise agreed by the CAA, comply with the requirements of Section D, Chapter **D5–2**, 7 and 9.

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APPENDIX TO CHAPTER Q5–2

FUEL SYSTEMS

1 **DETERMINATION OF UNUSABLE FUEL QUANTITY** (see **Q5–2**, 8)

1.1 The most adverse conditions of flight should be investigated and should, except in the circumstances described in 1.2 include the conditions of 1.1.1 to 1.1.4.

1.1.1 Level flight at Maximum Continuous Power.

1.1.2 Climb at Maximum Continuous Power at the maximum permitted angle of climb.

1.1.3 Descent at power for descent at maximum permitted angle for descent.

1.1.4 Turning flight to port or starboard at maximum turn rate.

1.2 When more than one tank is fitted, any tank which is required to supply fuel under limited conditions (e.g. level flight) need be investigated only for those conditions in which it will be used. The unusable fuel quantity determined for a particular tank should be based on the most critical of these limited conditions (see also **Q5–2**, 9.3).

1.3 There should be no evidence of engine malfunctioning during take-off and one minute of climb at:

(a) the maximum permitted angle of climb, and

(b) Maximum Take-off Power,

Where the take-off is commenced with an amount of fuel in each tank equal to the unusable fuel quantity for that tank, plus 0·15 litre/kw (0·025 UK gal/h.p.) at Maximum Continuous Power per applicable maximum continuous kilowatt.

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SUB-SECTION Q5 – POWERPLANT INSTALLATIONS

CHAPTER Q5–3

OIL SYSTEMS

1 GENERAL

1.1 Each engine shall be provided with a completely independent oil system capable of supplying an adequate quantity of oil to the engine at temperatures over the range established for its safe functioning under all conditions of operation for which certification is desired.

NOTES: (1) See **Q5–1**, 2.2, negative accelerations.

(2) **Q5–8** prescribes requirements affecting the location and construction of various items of the oil system; it is recommended that the designer pays particular attention to the relationship between these two Chapters.

1.2 The capacity of each oil system shall be such that the amount of usable oil is not less than the product of the maximum endurance of the Airship with the engines operating continuously in critical operating conditions (see **Q5–3** App., 1) and the corresponding maximum approved oil consumption rate of the engine, plus an agreed quantity to allow for adequate system circulation and cooling.

2 OIL TANKS

2.1 **Tank Strength.** Oil tanks shall have sufficient strength to:

(a) withstand without leakage or detrimental deformation all combinations of vibration, inertia, fluid and structural loads to which they may be subjected within Limit Load conditions, and

(b) withstand without structural failure all combinations of vibration, inertia, fluid and structural loads to which they may be subjected within Ultimate Load conditions.

2.2 **Expansion Space and Vents**

2.2.1 Oil tanks shall be provided with an expansion space, to allow for foaming and expansion of the oil and for the oil displaced from the system during operation, which shall be not less than 10% of the tank capacity or 2·27 litres (0·5 gal), whichever is the greater. It shall not be possible inadvertently to fill this expansion space when the Airship is in the normal ground attitude.

2.2.2 The expansion space shall be adequately vented under all normal conditions of operation. The vents shall comply with **Q5–2,** 4.5.

2.3 **Filler Caps**

2.3.1 Filler caps shall be such as to maintain fluid tightness at the maximum test pressure prescribed for the appropriate tank (see 2.5).

2.3.2 Filler caps shall be designed to minimize the possibility of incorrect installation and shall be such that they will not shake loose in flight. The caps shall be permanently attached by a chain or equivalent means.

NOTE: See **Q7–3**, for filler cap markings.

2.4 **Oil Flow Obstruction.** Provision shall be made to prevent entry into the tank itself or into the tank outlet of any foreign matter that may obstruct the flow of oil through the system. Any screen or guard enclosing the oil tank outlet shall not reduce the flow of oil below a safe value at any operating temperature condition.

2.5 **Tests.** Oil tanks shall comply with the relevant requirements of **Q5–2**, 4.2, except as prescribed in 2.5.1 and 2.5.2.

2.5.1 The test pressure shall be 35·0 kN/m^2 (5 lbf/in^2) or the pressure developed with a full tank during the maximum accelerations corresponding with the Ultimate Load factors of the Airship, whichever is the greater, instead of the pressure prescribed in **Q5–2**, 4.2.1.

2.5.2 In the case of flexible tanks, the surging test prescribed in **Q5–2**, 4.2.4 shall be conducted using oil which, in recirculating oil systems, shall be at a temperature of 120°C.

3 **TANK INSTALLATION** The oil tank installation shall comply with the relevant requirements of **Q5–2**, 4.3, except that an oil tank may be located on the engine side of a firewall (see **Q5–8**, 2.1).

4 **LINES, FITTINGS AND ACCESSORIES**

4.1 **General.** The inside diameter of the engine oil pump inlet and outlet lines shall be not less than the diameter of the corresponding engine oil pump inlet and outlet.

4.2 **Oil Breather Pipe Lines**

4.2.1 Oil breather pipe lines shall be so arranged that oil or condensed water vapour cannot collect at any point and either freeze or obstruct the line. The breather outlet shall be protected against blockage by ice or foreign matter.

4.2.2 Oil breather lines shall discharge in a location which will not constitute a fire hazard. Oil discharged from the lines shall not enter or impinge upon any portion of the Airship where it is likely to constitute a fire risk or have detrimental effects.

NOTE: See also **Q5–8**, 2.2.

4.3 **Valves Controlling Oil.** Where a shut-off means is required in accordance with **Q5–1**, 8.1 the controls shall be so arranged and installed, or shall incorporate such provisions, as to minimize the possibility of the engine being started with the shut-off valve closed. When the flow of oil to the engine has been shut off by means of the shut-off valve, it shall still be possible to feather the propeller.

4.4 **Filters.** Oil filters shall be so constructed and installed that complete blockage of the flow through the filter element will not prevent the safe operation of the engine and propeller governing and feathering system.

4.5 **Oil Radiators**

4.5.1 Oil radiators and their supporting structure shall have sufficient strength to withstand without failure any temperature changes and any vibration, inertia and oil pressure loads to which they may be subjected in all conditions of operation for which certification is desired.

4.5.2 Oil radiator air ducts shall be so constructed and located that, in the event of fire, flames issuing from the normal openings of the engine nacelle will not impinge directly upon the radiator.

5 PROPELLER FEATHERING

5.1 If a propeller feathering system making use of the engine oil supply is installed, provision shall be made to trap and maintain a quantity of oil in the tank if the supply becomes depleted due to failure of any part of the lubricating system other than the tank itself. The amount of trapped oil shall be sufficient to enable the propeller to be feathered and shall be available only to the feathering pump. The ability to feather the propeller when the supply of oil has been reduced to the feathering reserve shall be demonstrated either in flight or on the ground.

5.2 Adequate provision shall be made to prevent sludge or other foreign matter affecting the safe operation of the propeller feathering system.

6 **FILLING POINTS** Filling points shall be so arranged that spilled oil drains overboard and cannot subsequently gain access to the interior of the structure.

NOTE: The requirements relating to the markings associated with filling points are prescribed in **Q7–3**.

7 **OIL QUANTITY INDICATORS** Means shall be provided for measuring the quantity of oil in each tank when the Airship is on the ground. If an oil transfer system or a reserve oil supply system is installed, means shall be provided to indicate to the pilot during flight the quantity of oil in each tank.

8 **OIL COOLING TESTS** The test for establishing compliance with the requirements of 1 shall be made under the conditions governing the Powerplant cooling tests of **Q5-4**.

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APPENDIX TO CHAPTER Q5–3

OIL SYSTEMS

1 **OIL SYSTEM CAPACITY** (see **Q5–3**, 1.2). Critical operating conditions are considered as flight for one half of the maximum range of the Airship with all engines operating, followed by flight with one engine inoperative until that distance is reached where the fuel supply would have been exhausted had all engines been operating.

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SUB-SECTION Q5 – POWERPLANT INSTALLATIONS

CHAPTER Q5–4

COOLING SYSTEMS

1 **GENERAL**

1.1 The design of the Powerplant shall be such that it is capable of maintaining the temperatures of the engines, components and accessories, engine fluids and nearby structural components within safe values. These temperatures shall be maintained for all conditions of ground and flight operations liable to occur within the Standard Climatic Conditions for which the designer declares compliance.

1.2 The designer shall declare for which of the Standard Climates of **Q1–2**, 1.9, compliance will be established and these shall not be less severe than the ICAO Intercontinental Maximum Standard Climate. The maximum and minimum temperatures for which compliance has been established shall be stated in the Flight Manual.

2 **LIQUID-COOLANT SYSTEMS** Requirements for liquid-coolant systems shall be decided in consultation with the CAA. The CAA shall be consulted at an early stage in the design.

3 **AIR-COOLED SYSTEMS** A cylinder head temperature indicator shall be provided for each engine equipped with adjustable cooling gills.

4 **TESTS** Compliance with 1 shall be demonstrated in the flight tests prescribed in 4.2 and in any other critical ground and flight operating conditions. The data to be recorded shall be agreed with the CAA.

4.1 **General.** The requirements of this paragraph 4.1 are applicable to all tests.

4.1.1 **Atmospheric Conditions**

(a) The atmospheric temperature conditions in which the tests are made shall be within reasonable limits of the temperatures for which compliance with cooling requirements is to be shown. When the tests are conducted in atmospheric temperatures below the appropriate Standard Climatic Condition declared in accordance with 1, the recorded temperatures (e.g. cylinder head, oil inlet, carburettor air, liquid coolant) shall be corrected by adding the difference between the air temperature for the Standard Climatic Condition declared in accordance with 1 and the temperature of the ambient air recorded during the tests.

(b) Ground tests shall not be made in conditions of rain and flight tests shall not be made in conditions of rain or cloud.

4.1.2 **Fuel.** The fuel used during the cooling tests shall be the minimum grade permitted by the Flight Manual. The engine operating conditions and the fuel delivery control settings shall be those normally employed for the power specified. If adjustments affecting the fuel consumption are made during the tests, those parts of the tests already completed shall be reassessed and, if necessary, repeated.

4.2 **Flight Tests**

4.2.1 **Cooling Devices.** Flight tests shall be made n the configuration (including cowling gill and radiator/oil-cooler flap position, air intake setting, etc), at the airspeed and using the technique for which the performance of the Airship is to be established. Automatically-functioning gills, radiator flaps and oil cooler shutters shall not operate automatically for these tests but shall, if practicable, be fully open. Such controls shall be checked after the tests to ensure that the range of automatic operation is adequate.

4.2.2 **Buoyancy.** The Static Heaviness of the Airship during the flight tests shall be near the maximum for which approval is desired.

4.2.3 **Engine Conditions**

(a) Take-off shall be commenced with the corrected values of engine oil and cylinder head temperatures as close as possible to the maximum permitted at the beginning of a take-off run.

(b) En-route climb shall be commenced at the highest practical engine temperatures at which an en-route climb is likely to be commenced in operation.

4.2.4 **All Engines Operating**

(a) *Take-off and Initial Climb.* Take-off and climb for a total period of 5 minutes with the controls set to the Maximum Take-off Power position, using an established take-off technique, including, if applicable, the use of vectored thrust.

(b) *Hover.* Where a vectored thrust facility is provided, hover at the appropriate power setting until temperatures stabilize.

(c) *Level Flight at Maximum Weak-mixture Power Conditions*

(i) With the engine controls set at the Maximum Weak-mixture Power position, level flight at a height between the full-throttle height and 152 m (500 ft) below full-throttle height for this power until temperatures stabilize. If the full-throttle height is at or near sea-level, the test shall be made at a height as near sea-level as is reasonably possible.

(ii) If the full-throttle height of the engine for the test of (i) is 1219 m (4000 ft) or above, repeat the test of that paragraph at a height as near sea-level as is reasonably possible.

4.2.5 **Critical Engine Inoperative**

(a) *Take-off and Initial Climb.* Climb from as near sea-level as practicable for a total period of 5 minutes with the Critical Engine inoperative and with the controls of the operating engine(s) set to the Maximum Take-off position, using an established take-off technique, including, if applicable, the use of vectored thrust.

(b) *En-route Climb.* Climb from 152 m (500 ft) with the controls of the operating engine(s) set at the Maximum Continuous Power position until temperatures stabilize.

SUB-SECTION Q5 – POWERPLANT INSTALLATIONS

CHAPTER Q5–5

ENGINE AIR INTAKE AND ICE PROTECTION SYSTEMS

1 GENERAL

1.1 It shall be demonstrated (by tunnel or flight tests, or both) that air intake systems will permit the supply and maintenance of an adequate supply of air to each engine under all conditions of operation for which the Airship is to be certificated in a manner that will permit the continued safe functioning of the engines, components and accessories.

1.2 Each engine shall be provided with at least two separate air intake sources. Alternative air intakes shall be located in a sheltered position and shall be so designed that snow or ice cannot prevent their coming into operation. The use of sheltered air intakes shall not result in excessive power loss in addition to the power loss resulting from the rise in air temperature.

1.3 Air intake and induction system ducts shall be provided with drains which, in all normal ground and flight attitudes, will prevent hazardous accumulations of fuel or moisture. Drains shall be arranged to preclude the possibility of fire hazard.

1.4 The risk of engine failure resulting from ice shed from forward parts of the Airship shall be acceptably remote.

2 DE-ICING AND ANTI-ICING PRECAUTIONS (see **Q5–5** App., 1)

2.1 Means of protection against the accumulation of ice in the induction system shall be provided such that compliance can be shown with the appropriate requirements of 2.2 to 2.6 when associated with the operation of the Airship in air at a temperature of –1°C and free from moisture.

2.2 On Airships with unsupercharged engines employing conventional venturi carburettors – a temperature rise of 50°C shall be obtained when the engines are operating at 75% Maximum Continuous Power.

2.3 On Airships with unsupercharged engines employing carburettors which embody features tending to reduce the possibility of ice formation – a temperature rise of 50°C shall be obtained when the engines are operating at 75% Maximum Continuous Power.

2.4 On Airships with unsupercharged engines employing conventional venturi carburettors located ahead of the supercharger – a temperature rise of 67°C shall be obtained when the engines are operating at 60% Maximum Continuous Power.

2.5 On Airships with supercharged engines employing, ahead of the supercharger, carburettors which embody features tending to reduce the possibility of ice formation – a temperature rise of 55°C shall be obtained when the engines are operating at 60% Maximum Continuous Power.

NOTE: The pre-heater need not provide a heat rise in excess of 22°C if an Approved fluid de-icing system is used (see **Q5–5** App., 1).

2.6 Other means of protection against the accumulation of ice shall be provided, as necessary, to enable the complete engine installation in the Airship, including the propeller, to function satisfactorily without unacceptable loss of power when operated in the conditions for which certification is required.

NOTE: Normally no protection against ice is required for wooden propellers. The amount of protection, if any, required by the CAA on other types of propellers will depend upon the icing conditions for which approval for operation is sought, vibratory conditions and the risk of injury to occupants or degree of damage to the Airship which might be caused by the shedding of ice from the propeller blades.

3 DETAIL DESIGN

3.1 **Fire Precautions** (see **Q5–8**, 6)

3.2 **Air Intake System Screens.** Where air intake system screens (other than protective screens which are part of the bare engine and protected by local heat) are employed, they shall be located ahead of the carburettor and it shall not be possible for fuel to impinge upon them. Except where the screens can be de-iced, they shall not be located in portions of the air intake system which constitute the only passage for air to the engine. Screens shall not be de-iced by means of alcohol alone.

APPENDIX TO CHAPTER Q5–5

ICE PROTECTION SYSTEMS

1 **CARBURETTOR FLUID DE-ICING SYSTEM** (see **Q5–5**, 2.1) This paragraph 1 provides information on an acceptable carburettor fluid de-icing system.

1.1 **Flow Rate.** The system should be capable of providing each engine with a rate of fluid flow in kg/hr of not less than 1·312 times the square root of the Maximum Continuous Power* of the engine in kilowatts. Flow at this rate should be available to all engines simultaneously. The fluid should be introduced into the air intake system at a point close to, and upstream of, the carburettor in such a manner as to ensure equal distribution over the entire cross-section of the air intake system air passages.

1.2 **System Capacity.** The fluid de-icing system capacity should be not less than that required to provide fluid at the rate specified in 1.1, for a time equal to 3% of the maximum endurance of the Airship, with the engine(s) operating continuously, or 20 minutes, whichever is the greater.

*In lb/hr, not less than 2·5 times the square root of the Maximum Continuous Power of the engine in horsepower.

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SUB-SECTION Q5 – POWERPLANT INSTALLATIONS

CHAPTER Q5–6

EXHAUST SYSTEMS

1 GENERAL

1.1 Exhaust systems shall be so constructed and arranged as to ensure the safe discharge of exhaust gases without hazard of fire or contamination of air in personnel compartments.

1.2 Exhaust systems shall be constructed of heat-resistant and corrosion-resistant materials and shall incorporate provision to prevent failure resulting from expansion when heated to operating temperatures.

1.3 Exhaust systems shall be so designed and supported as to withstand without failure all vibration and inertia loads to which they may be subjected in normal conditions of operation.

1.4 The temperature of exposed surfaces of the exhaust system shall be such that they will not constitute a fire hazard, and the mechanical reliability of the exhaust system and the safety of adjacent structure will not be affected. To this end components of the exhaust system shall be ventilated, shrouded or insulated where necessary so that remaining exposed surfaces will not constitute a hazard.

1.5 Exhaust system components shall be separated by means of Fireproof shields from adjacent Flammable portions of the Airship which are outside the engine compartment.

NOTE: See also **Q5–8**, 5.

1.6 Portions of exhaust systems connected to components between which relative motion may occur shall incorporate provisions for flexibility.

1.7 Unless suitable precautions are taken, exhaust system components shall not be located in close proximity to portions of any systems containing Flammable fluids or vapours, nor shall they be located under those portions of such systems which may be subjected to leakage.

1.8 The exhaust system shall be provided with drains to prevent hazardous accumulations of fuel or moisture in all normal ground and flight attitudes.

1.9 On all Airships for which certification for flight by night is sought, there shall be no danger of the pilot's vision being seriously affected by glare from the exhaust.

2 PISTON ENGINES

2.1 Exhaust Heat-Exchangers

2.1.1 Exhaust heat-exchangers shall be so constructed and installed as to withstand without failure all vibration, inertia and other loads to which they may be subjected in normal conditions of operation. They shall be constructed of materials which are both suitable for continued operation at high temperature and resistant to the corrosive effects of the products of combustion.

2.1.2 Provision shall be made to permit the inspection of all welded joints and critical portions of the heat-exchanger and the exhaust manifold parts which the heat-exchanger surrounds.

2.1.3 Exhaust heat-exchangers used in ventilating-air systems shall be so constructed as to preclude the possibility of exhaust gases entering the ventilating air.

2.1.4 It shall not be possible, unless adequate provision has been made to protect the heat-exchanger form damage at the higher operating temperatures that would be attained, for the heat-exchanger to be brought into use without the air supply which is to be heated flowing through it.

SUB-SECTION Q5 – POWERPLANT INSTALLATIONS

CHAPTER Q5–7

CONTROLS

1 **GENERAL** (see also **Q5–8**, 9)

1.1 The requirements of this Chapter are applicable to the particular controls of the Powerplant installation. General requirements applicable to operating controls are contained in **Q4–2**, 4.2 and **Q4–8**, 2.1.

1.2 A fault analysis of the engine control system shall be made to establish that no single fault, or double fault if one of the faults may be present and undetected during pre-flight checks, could lead to unsafe engine conditions beyond the normal control of the flight crew.

NOTES: (1) The fault analysis would normally include investigation of all manual and automatic controls, such as engine and fuel system speed governors, propeller control systems, etc.

(2) This fault analysis is a re-assessment of an analysis which will have been made on the bare engine in accordance with Section C, Chapter **C2–2**, so as to take account of the characteristics of the engine control system used in the actual Airship installation as compared with the typical installation assumed by the engine manufacturer.

2 **IGNITION CONTROLS**

2.1 Ignition switches shall be provided for each ignition circuit on each engine and, when mounted on a vertical surface, shall be such that ignition is 'off' when the switch is down and 'on' when the switch is up.

2.2 Means shall be provided for shutting off all ignition quickly, either by the grouping of switches or by providing a master ignition control. If a master control is provided, a suitable guard shall be incorporated to prevent inadvertent operation.

3 **ENGINE POWER CONTROLS**

3.1 A separate engine power control system shall be provided for each engine. The operating controls shall be so grouped and arranged as to permit separate control of each engine and simultaneous control of all engines.

3.2 Engine power control systems shall operate so that a forward movement of the operating control is necessary to increase forward thrust. The systems shall afford an adequately sensitive, immediate and progressive means of controlling the engines over their whole operating range.

4 **MIXTURE CONTROLS**

4.1 Mixture control systems shall be separate for each engine. The operating controls shall be so grouped and arranged as to permit separate control of each engine and simultaneous control of all engines.

4.2 Each mixture control shall be provided with a guard or shall be so shaped or arranged as to prevent by feel confusion with other controls.

5 **CARBURETTOR-AIR PREHEAT CONTROLS** Carburettor-air preheat control systems shall be separate for each engine.

6 PROPELLER CONTROLS

6.1 Propeller Speed and Pitch

6.1.1 A separate control system shall be provided for each propeller and shall be such that ready synchronisation of the propellers may be carried out by the flight crew. The control systems shall be designed so as to prevent:–

(a) The assumption of dangerous propeller pitch positions as a result of a malfunction of the control system in flight or during take-off.

(b) The inadvertent operation of propeller feathering systems.

6.1.2 The controls shall be so grouped and arranged as to permit separate control of each propeller and simultaneous control of all propellers.

7 VECTORED THRUST CONTROLS

7.1 Where provision is made for thrust vectoring, the vectoring control system shall be designed to prevent inadvertent operation and shall be such that the pilot can readily and positively select each appropriate vectored thrust position.

7.2 Unless the Airship is demonstrated to have safe flight characteristics when the vectored thrust units are in the normal flight position on one side and in the fully vectored position on the other, with engines operating at Maximum Take-off Power, the vectoring motion of the thrust units shall be synchronised by mechanical or equally reliable means.

SUB-SECTION Q5 – POWERPLANT INSTALLATIONS

CHAPTER Q5–8

FIRE PRECAUTIONS

1 GENERAL

1.1 In addition to compliance with the requirements of this Chapter, all practical measures shall be taken to minimize both the risk of fire and the extent of damage which could result from a fire, under all conditions of operation.

1.2 **Designated Fire Zone.** For the purposes of this Chapter, a Designated Fire Zone is a compartment containing a main engine, an auxiliary power-unit, a combustion heater or other combustion equipment intended for operation in flight.

2 LAYOUT OF INSTALLATIONS

2.1 Flammable Fluids and Gases

2.1.1 Tanks containing Flammable fluid or gas which are located in Designated Fire Zones shall be such that the danger of the occurrence and the results of fire will not thereby be increased. To this end, the design of the system and its supporting structure, the materials used in the tank and all connections, lines and controls shall be such as to ensure compliance with this requirement.

NOTE: Fuel tanks cannot be located in Designated Fire Zones (see **Q5–2**, 4.3)

2.1.2 Absorbent materials shall not be located in proximity to those components (e.g. joints, couplings) which might be subject to leakage.

2.1.3 Components which may be subject to leakage, filling points, vents and drains shall be arranged to minimize the possibility of fluids or vapours finding their way to a possible source of ignition or accumulating inside the Airship. Systems containing Flammable fluids shall, as far as is practicable, be isolated from electrical equipment and wiring.

NOTE: Requirements for valves controlling Flammable fluids are given in **Q5–1**, 8.

2.2 Drainage and Venting of Designated Fire Zones (see **Q5–8** App., 1)

2.2.1 Adequate drainage of all portions of Designated Fire Zones, cowling and nacelle regions shall be provided, with the Airship in all normal ground and flight attitudes, to minimize the hazards resulting from failure or malfunctioning of components containing Flammable fluids.

2.2.2 Fluid discharged from drains and fluid that may, as a result of leakage, be discharged from points other than drains, shall not re-enter the Airship at any point where a fire hazard could result.

2.2.3 All Designated Fire Zones, cowling and nacelle regions shall be vented to prevent the accumulation of Flammable vapours.

NOTE: Zone pressures should be maintained above external local skin pressure to assist drainage and prevent re-entry of fluids.

2.2.4 Vents and other openings in Designated Fire Zones shall be so located that flames that may issue from them in the case of a fire will not enter into or impinge upon other portions of the Airship so as to constitute a hazard.

2.3 **Crash Conditions.** Precautions shall be taken to reduce, as far as is practicable, the hazard of fire in conditions following a crash of moderate severity. To this end the electrical system and all systems containing Flammable fluid or gas shall be designed so as to reduce to a minimum the risk of their being damaged.

NOTE: Reference should be made to **Q6–13**, 6.9, for more detailed requirements regarding electrical systems.

3 **ENGINE COWLING** Engine cowling shall be constructed of material at least equivalent in fire resistance to aluminium alloy. If the engine cowling is subjected to excessive temperatures by the exhaust system or efflux, it shall be constructed of, or shielded with, Fireproof material (see 9).

4 **NACELLE SKIN AND OTHER AIRSHIP SURFACES AND ITEMS** All items and Airship surfaces over which flames might reasonably be expected to play in the event of an engine fire in flight shall be constructed of or protected by material at least equivalent in fire resistance to aluminium alloy.

5 **AIR INTAKES**

5.1 When an air intake is located within a cowling, it shall be confined to such portions as are isolated from the engine accessory section by means of a fire-resistant diaphragm or shoulder cowl unless provision is made to prevent the emergence of backfire flames.

5.2 Sufficient strength shall be incorporated in air intake ducts to prevent failures resulting from backfire conditions of moderate severity. Where the ducts are subject to the full severity of backfire conditions, the strength shall be such as to withstand a test pressure of 103 kN/m^2 (15 lbf/in^2).

NOTE: Devices which reduce the severity of backfire conditions may be employed.

6 **FIREWALLS**

6.1 Designated Fire Zones shall be isolated from the remainder of the Airship and from each other by means of Fireproof and corrosion-resistant firewalls in the form of bulkheads, shrouds, etc.

NOTE: Stainless steel sheet 0·38 mm (0·015 in) thick, or mild steel sheet, 0·46 mm (0·018 in) thick and suitably protected against corrosion, is acceptable.

6.2 Firewalls shall be so constructed that no hazardous quantities of fluid or gas and no flames can pass from the Designated Fire Zone to another portion of the Airship, e.g. by sealing all openings in the firewall with suitable close-fitting Fireproof grommets, bushings or fittings, and by adequately sealing the firewall periphery.

7 **PROTECTION OF ITEMS OUTSIDE A DESIGNATED FIRE ZONE** Items on the safe side of a firewall shall be of such materials and at such distances that they will not suffer damage sufficient to endanger the Airship if the inner surface of the firewall is subjected to a flame temperature of 1100°C for 15 minutes.

8 **PROTECTION OF ITEMS INSIDE A DESIGNATED FIRE ZONE** When the items below are located in a Designated Fire Zone they shall be:–

8.1 **Fire Resistant**

(a) Systems carrying Flammable fluid, gas or air. Compliance shall be shown under the most critical conditions of pressure and flow.

(b) All Powerplant controls that are required to be operated in the event of fire (see also **Q5–1**, 8.2).

8.2 **Fireproof**

(a) All parts of the flying control system.

(b) Class 1 parts and structural members while carrying the loads appropriate to gentle manoeuvres and any superimposed loads resulting from vibration.

9 **FIRE PROTECTION STANDARD**

9.1 The testing of items for Fire-resistance and Fireproofness shall be by submission to the Standard Flame.

9.2 Sufficient sources of heat shall be used to ensure that the appropriate portions of the items under test are adequately enveloped by the test flame(s).

10 **FIRE DETECTOR AND EXTINGUISHER SYSTEMS** The necessity for, and the requirements applicable to, fire detector and extinguisher systems shall be decided in consultation with the CAA.

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APPENDIX TO CHAPTER Q5–8

FIRE PRECAUTIONS

1 **DRAINAGE AND VENTING OF DESIGNATED FIRE ZONES** (see **Q5–8**, 2.2)

As far as is practicable, compartments adjacent to Designated Fire Zones should be isolated from the other parts of the Airship to minimize the spread of leaking Flammable vapours or fluids and of fire.

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SUB-SECTION Q5 – POWERPLANT INSTALLATIONS

CHAPTER Q5–9

ENGINES, TRANSMISSIONS AND PROPELLERS

1 **APPLICABILITY** The requirements of this Chapter apply to:–

(a) piston engines of orthodox design and construction for use in Airships for the purpose of providing propulsive thrust or directional control (by vectoring or differential thrust) by means of propeller(s) driven either directly or remotely.

(b) the propellers themselves, and

(c) items forming the mechanical transmission from engine to propeller.

2 **GENERAL** The design of the engine, transmission and propeller shall be such as to enable the powerplant installation, and other relevant requirements of this Section Q to be met.

3 **SAFETY ANALYSIS** A safety analysis of the Airship shall be carried out in order to assess the effect on the Airship of any engine, propeller or transmission failure. The airworthiness requirements to be applied for the approval of the transmission, the engine (in the case of 4.1(b)) and the propeller will be determined by the degree of hazard to the Airship as identified by applying the results of the safety analysis to Figure 1 (**Q5–9**).

4 **ENGINE APPROVAL**

4.1 Engines will be approved by the CAA either:–

(a) for use on any Airship, in which case the requirements of BCAR Section C shall apply, or

(b) in relation to a particular Airship type as part of the acceptance of that type, in which case the appropriate requirements will be identified in relation to the safety analysis of para. 3 (See Figure 1 (**Q5–9**)).

5 **PROPELLER APPROVAL**

5.1 Propellers will be approved only in association with a defined Airship/engine/ transmission application.

5.2 It will normally be assumed that propeller hub or blade failures are potentially hazardous in which case the requirements of Section C, Sub-section C5 shall apply, but if it can be shown that such failures will not be hazardous then the appropriate requirement shall be identified in relation to the safety analysis of para. 3 (see Figure 1 (**Q5–9**)).

6 **TRANSMISSION**

6.1 When the safety analysis of 3 indicates a hazard to the Airship as a result of transmission failure, the requirements of 6.1.1, 6.1.2 and 6.1.3 shall be applied as appropriate (see Figure 1 (**Q5–9**)).

NOTE: When the propeller is not mounted directly on the engine, the drive system from the engine to the propeller will be treated as transmission.

6.1.1 A vibration survey of the transmission system shall be carried out in the Airship when running with the appropriate engine(s) and propeller(s) over the full range of flight and engine power conditions. To be acceptable the results of the survey shall show that no dangerous torsional or flexural vibration or whirling of shafting can occur at any possible torque/speed combinations up to 105% of the maximum permitted shaft operating speed.

6.1.2 For those components whose failure would result in a hazard to the Airship:–

(a) adequate fatigue strength, and where necessary a safe fatigue life, shall be established, and

(b) the quality control procedure applicable to such parts shall be to the satisfaction of the CAA.

6.1.3 An endurance test of the engine/transmission/propeller system, shall be carried out in the Airship or on a representative rig during which all the operating limitations of the system shall be substantiated. The duration of the test (normally 150 hours) and a detailed schedule specifying ranges of power running and control functioning shall be agreed by the CAA.

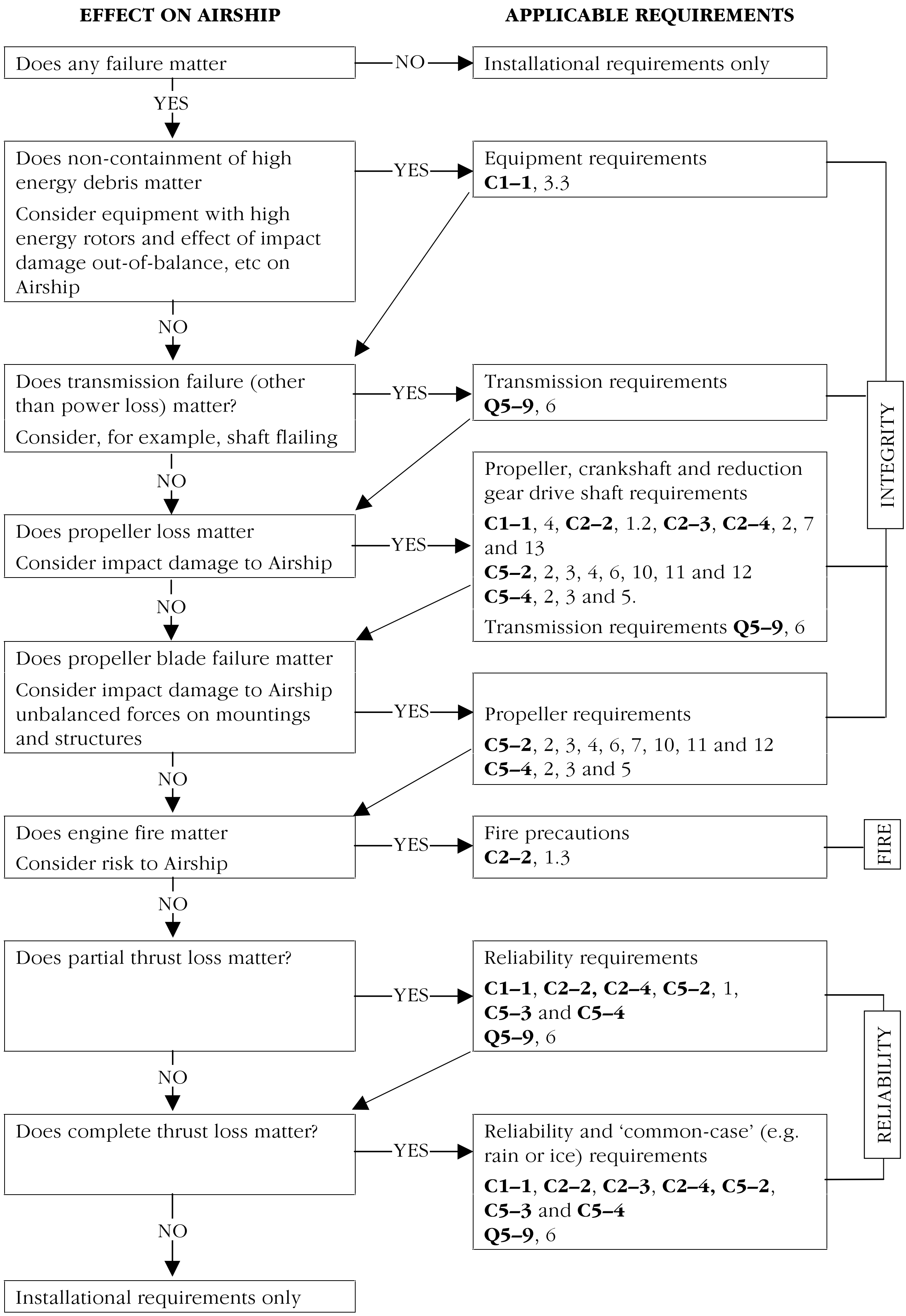
EFFECT ON AIRSHIP
APPLICABLE REQUIREMENTS
Does any failure matter
NO
Installational requirements only
YES
Does non-containment of high energy debris matter
Consider equipment with high energy rotors and effect of impact damage out-of-balance, etc on Airship
YES
Equipment requirements
C1–1, 3.3
NO
Does transmission failure (other than power loss) matter?
Consider, for example, shaft flailing
YES
Transmission requirements
Q5–9, 6
NO
Does propeller loss matter
Consider impact damage to Airship
YES
Propeller, crankshaft and reduction gear drive shaft requirements
C1–1, 4, C2–2, 1.2, C2–3, C2–4, 2, 7 and 13
C5–2, 2, 3, 4, 6, 10, 11 and 12
C5–4, 2, 3 and 5.
Transmission requirements Q5–9, 6
NO
Does propeller blade failure matter
Consider impact damage to Airship unbalanced forces on mountings and structures
YES
Propeller requirements
C5–2, 2, 3, 4, 6, 7, 10, 11 and 12
C5–4, 2, 3 and 5
INTEGRITY
NO
Does engine fire matter
Consider risk to Airship
YES
Fire precautions
C2–2, 1.3
FIRE
NO
Does partial thrust loss matter?
YES
Reliability requirements
C1–1, C2–2, C2–4, C5–2, 1, C5–3 and C5–4
Q5–9, 6
NO
Does complete thrust loss matter?
YES
Reliability and 'common-case' (e.g. rain or ice) requirements
C1–1, C2–2, C2–3, C2–4, C5–2, C5–3 and C5–4
Q5–9, 6
RELIABILITY
NO
Installational requirements only

FIG 1 (Q5–9)

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SUB-SECTION Q6 – EQUIPMENT INSTALLATIONS

CHAPTER Q6–1

GENERAL

1 INTRODUCTION

1.1 The requirements of this Chapter are applicable to all Airships unless otherwise stated. They cover the general requirements applicable to Equipment Installations and list mandatory equipment. Certain detailed installational requirements are associated with individual items for ease of reference.

NOTE: The requirements for electrical systems are given in **Q6–12** and **Q6–13**; the requirements for radio and radio installations are given in Section R.

1.2 The requirements of **Q4–1** are applicable to this Sub-section Q6; see **Q4–1**, 1.1

2 GENERAL*

2.1 Equipment, systems and installations shall be such that they do not hazard the safe operation of the Airship or the proper functioning of any Essential Service, even in the event of their malfunctioning or failure (e.g. by introducing a risk of fire or explosion; prejudicing the safe operation of Essential Systems; causing unacceptable radio or compass interference).

2.2 Mandatory equipment, systems and installations, i.e. those installed for compliance with the Requirements or the Air Navigation Order, or those on the proper functioning of which the airworthiness of the Airship may depend, shall be such as to ensure that the intended function will be performed reliably even under the most adverse likely operating conditions. To this end, all such equipment, except that specifically exempted by the Air Navigation Order, shall comply with (a), (b) or (c):–

(a) be Approved by the CAA generally for use on Airships, or

(b) be Approved by the CAA in relation to the particular Airship type, or

(c) be Approved in relation to the particular type of Airship as part of the acceptance by the CAA of the Airship type including the equipment.

NOTE: Where duplicate instruments are provided, or where to some extent one instrument is a standby for another, it is recommended that the systems shall be such that no one fault, which might impair the operation of one, is likely to impair the operation of both.

2.3 In the case of approval in accordance with 2.2(c), the Approved Design and Inspection Organisations (usually the Airship constructor) shall establish that the equipment is suitable for the purpose for which it is installed. The suitability of such equipment (including commercial equipment) shall be established by the employment of one or more of the following procedures –

(a) A detailed examination of the equipment and its design.

(b) Suitable testing.

(c) Consideration of previous use.

*See also Section A/B, Chapter **A4–8/B4–8** for approval procedures.

2.3.1 The Approved Organisation accepting responsibility for equipment approved in accordance with 2.2(c) shall establish a procedure to ensure that the quality of series items is consistent.

2.4 Equipment to which the requirements of this paragraph 2 apply shall be subject to such pre-installational inspection and, where applicable, functional testing as will ensure that any loss of accuracy, damage or deterioration resulting from transit or storage is revealed.

2.5 **Instrument Location.** Instruments shall be located so that they can be read easily by the pilot(s).

2.5.1 Such of the flight, navigational and Powerplant instruments as are used by each pilot shall be so arranged as to be convenient for their purpose.

2.5.2 Flight instruments shall be conveniently grouped and, as far as possible, symmetrically disposed about the vertical plane of the pilot's forward vision along the flight path.

2.5.3 Powerplant instruments shall be conveniently grouped on instrument panels in such a manner that the appropriate pilot(s) may see them readily. Powerplant instruments for each engine shall be so located that the engine to which they relate is indicated with certainty.

2.5.4 Due regard shall be given to possible errors in reading the instruments arising from location and size of instruments, fineness of scale of the operating range, parallax, etc.

2.6 **Instrument Installation.** The means of illuminating the instrument shall be such that the pilot's eyes are shielded from direct rays of light. There shall be no reflections which significantly impede the pilot's view.

NOTE: The design of night shields for emergency lights should be such that the lights will not be obscured inadvertently.

2.7 **Instrument Panel Vibration Characteristics.** The vibration characteristics of instrument panels shall be such that the accuracy of the instruments will not be impaired.

2.8 **Flight Instruments Requiring a Power Supply**

2.8.1 All mandatory flight instruments requiring a power supply (e.g. gyroscopic instruments) shall be provided with at least two independent sources of supply.

2.8.2 Means shall be provided to indicate the adequacy of each power source.

2.8.3 Power supply systems shall be such that the failure of one instrument will not interfere with the proper supply of power to any remaining instrument the information from which is essential to the continued safe flight of the Airship.

2.9 **Engine Instruments**

2.9.1 All mandatory engine instruments shall have independent operating systems except where it can be shown that the failure of any system which serves more than one instrument will not jeopardise the continued safe flight of the Airship.

2.9.2 All mandatory engine instruments requiring a power supply shall have at least two independent sources of supply, except where it can be shown that the loss of information resulting from the failure of a single source of supply will not jeopardise the continued safe flight of the Airship.

2.9.3 Means shall be provided to indicate the adequacy of each power source.

2.9.4 Power supply systems shall be such that the failure of one instrument will not interfere with the proper supply of power to any remaining instrument the information from which is essential to the continued safe flight of the Airship.

2.10 **Air Speed Indicating Systems.** The air speed indicating system shall be calibrated to establish the difference between IAS and EAS, i.e. the total error of the system, and the calibration shall be made available to the pilot by means of a placard.

2.11 **Pitot-static Systems**

2.11.1 The installation of all instruments having air pressure connections shall be such that their accuracy cannot be seriously affected by:–

(a) the Airship speed, attitude or configuration,

(b) moisture or other foreign matter.

NOTE: It is recommended that consideration should be given to heating the pitot-static head so as to ensure its suitability for short periods of flight in ice-forming conditions.

2.11.2 Where static vents are used, to obviate yawing errors they shall be situated on opposite sides of the car, and connected together to form one static system.

2.11.3 Lag and the possibility of moisture blockage in pitot-static lines shall be kept to an acceptable minimum. The lines shall be installed so as to avoid chafing and restrictions, e.g. resulting from distortion or excessively tight bends.

NOTE: In this connection tubing having an inside diameter less than 6·35 mm (0·25 in) will not normally be acceptable.

2.11.4 Sufficient moisture traps shall be installed to ensure positive drainage throughout the whole of the system.

2.11.5 A separate pitot-static system shall be provided for additional instruments and equipment which –

(a) have not been Approved or shown to achieve the reliability of those instruments and equipment installed in accordance with 2.1 and 2.2, or

(b) would introduce an increased lag of an unacceptable order.

2.12 **Instrument Pipe Lines.** Instrument pipe lines shall comply with the relevant requirements of **Q5–1** and **Q6–2** as appropriate. In addition, lines carrying Flammable fluids or gases under pressure shall be provided with restricted orifices or equivalent safety devices at the source of the pressure, to prevent escape of excessive amounts of fluid or gas in the event of line failure.

2.13 **Exposed Sight Gauges.** Exposed sight gauges shall be installed or guarded so as to minimize the risk of breakage or damage.

2.14 **Safety Equipment.** Safety equipment which the flight crew or passengers are expected to operate at the time of an emergency shall be readily accessible and plainly marked as to its method of operation. Where safety equipment is carried in compartments or containers, such compartments or containers shall be marked to identify the contents.

3 **MINIMUM EQUIPMENT** Items of equipment included in this paragraph 3 shall be installed on all Airships.

3.1 **Flight and Navigation Instruments**

3.1.1 Air-speed indicator.

3.1.2 Altimeter (see also 4.3).

3.1.3 Magnetic compass or its equivalent (see also 6).

3.1.4 Pitch attitude indicator, when the Airship is capable of exceeding any specified pitch attitude limitation.

3.1.5 Vertical speed indicator.

3.1.6 Yaw indicating device.

3.1.7 Means to enable the flight crew to check the pressures in the envelope and Ballonet.

3.1.8 Means to enable the flight crew to check the extent of inflation of Ballonets.

3.1.9 Means for measuring the temperature differential between the lifting gas and the outside air.

3.2 **Powerplant Instruments and Equipment.** The following instruments and equipment shall be provided.

(a) Oil pressure indicator for each engine.

(b) Oil temperature indicator for each engine.

NOTE: Where Flight Tests show that there are adequate margins, this instrument may be omitted after consultation with the CAA.

(c) Fuel quantity indicator (see **Q5–2**, 7).

(d) Means for measuring the quantity of oil in each tank (see **Q5–3**, 7).

(e) Fuel pressure indicator for each engine supplied by a pressure fuel system.

(f) Tachometer to indicate the rotational speed of each engine.

(g) Cylinder head temperature indicator for each engine.

(h) Induction system air temperature indicator for each engine equipped with a pre-heater, unless the nature of the engine is such that the instrument is unnecessary.

(j) Induction manifold pressure indicator for:

(i) an engine fitted with a variable pitch propeller,

(ii) a supercharged engine.

(k) Such instruments, additional to those prescribed, as are necessary to enable compliance in operation with the limitations to which the engine is approved.

3.3 **Miscellaneous Equipment**

3.3.1 Spare fuses for all electrical circuits, the fuses of which can be replaced in flight, consisting of 10% of the number of each rating, or 3 of each rating, whichever is the greater.

3.3.2 Means to enable the flight crew to check the functioning of the engine and air intake ice protection systems.

3.3.3 Safety belts for all occupants.

3.3.4 Such other equipment as the CAA may prescribe.

4 **MINIMUM EQUIPMENT FOR TRANSPORT CATEGORY AIRSHIPS (PASSENGER AND CARGO)**

In addition to the items of equipment prescribed in 3, the items included in this paragraph 4 shall be installed.*

4.1 A gyroscopic direction indicator.

4.2 Means of indicating that the power supply to the gyroscopic instruments is working satisfactorily.

4.3 Sensitive altimeter adjustable for changes in barometric pressure, unless the altimeter installed in compliance with 3.1.2 meets these conditions.

4.4 For Airships equipped with three or more piston engines, a means of indicating to the pilot immediately any significant change in the power output of an engine and also which engine is at fault.

4.5 A timepiece with a sweep second hand.

NOTE: This item does not have to be approved but is required by the Air Navigation Order to be suitable for its purpose and may be installed or carried in any manner which will ensure that it can be used effectively as and when required.

4.6 One portable fire extinguisher for each enclosed passenger and crew compartment, one of which shall be convenient to a member of the flight crew.

4.7 A means, additional to that provided in compliance with 3.1.7, to enable the flight crew to check the gas pressure in the envelope.

5 **MINIMUM EQUIPMENT – PARTICULAR CONDITIONS** In addition to the items prescribed in 3 or 4, as appropriate, on all Airships for which extension of the Certificate of Airworthiness to include flight in one or more particular conditions is sought, the items of equipment prescribed in this paragraph 5* as relevant to the certification and condition shall be installed, except that the equipment already installed in accordance with 3 and 4 need not be duplicated.

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*Whilst at the time of printing this list is intended to cover the requirements of the Air Navigation Order in respect of instruments, it does not list all items required by the Order (for example, minimum radio equipment is not listed). Reference should be made to the Order both during design and at the time of certification.

5.1 **Flights by Night – All Airships**

5.1.1 Navigation lights (see **Q6–7**).

5.1.2 Adequate electrical illumination, supplied from the main source of supply, for the instruments and equipment (including maps) the carriage of which is prescribed and the illumination of which is necessary to enable use to be made of them during flight (see also 2.6).

5.1.3 A gyroscopic direction indicator.

5.1.4 A rate-of-turn indicator.

5.1.5 A pitch attitude indicator.

5.1.6 Means of indicating that the power supply to the gyroscopic instruments is working satisfactorily.

5.2 **Flights by Night – Transport Category Airships (Passenger and Cargo)**

5.2.1 **Passenger and Cargo**

(a) **Landing Lights.** Two lamps or one double-filament lamp with separately energised filaments.

5.2.2 **Passenger Only**

(a) Illumination in all passenger compartments.

(b) Where the number of occupants permitted by the Flight Manual in accordance with **Q7–5**, 4 (j)(vii) is greater than 20, an emergency lighting system to facilitate evacuation of the Airship in the event of failure of the lights provided in accordance with (a).

5.3 **Flights under Instrument Flight Rules in Control Zones and Control Areas**

NOTE: For certain limited conditions of flight under Instrument Flight Rules a lower standard is prescribed by the Air Navigation Order and is acceptable.

5.3.1 Gyroscopic direction indicator.

5.3.2 Rate-of-turn indicator.

5.3.3 A pitch attitude indicator.

5.3.4 Means of indicating that the power supply to gyroscopic instruments is working satisfactorily.

5.3.5 Two sensitive altimeters adjustable for changes in barometric pressure, one of which may be the altimeter installed in compliance with 3.1.2 if this complies with these conditions.

5.3.6 Timepiece, with a sweep second hand.

5.4 **Flights for which the Air Navigation Order Requires Oxygen.** Oxygen equipment to the satisfaction of the CAA.

6 COMPASS

6.1 The compass prescribed in 3.1.3 shall be installed so that after compensation the residual deviation does not exceed 5°. In addition, the change in deviation as a result of the movement of or interaction between other components (e.g. control movement) or the worst likely combination of electrical interference shall not exceed 5°.

6.2 A card shall be installed on or adjacent to the magnetic compass and shall –

(a) give the deviations (errors) of the installation in level cruising flight with all engines operating. The deviations shall be stated unambiguously and shall be related to standard headings at intervals not exceeding 30°, and

(b) state whether the deviations were measured with the radio installation switched ON or OFF.

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SUB-SECTION Q6 – EQUIPMENT INSTALLATIONS

CHAPTER Q6–2

GAS AND AIR SUPPLY SYSTEMS

1 **GENERAL**

1.1 The gas and air supply systems, including all valves, controls, lines, fittings and other related components, shall be designed and installed such that the failure or malfunction of any single component, or reasonably probable combination of failures, will not result in a dangerous measure of control of the Airship being applied or lost, or in pressure being attained which could cause rupture of the envelope.

1.2 The capacities of the Ballonet and gas vent valves and of the Ballonet air supply system shall be adequate to ensure safe operation of the Airship under all Anticipated Operating Conditions.

NOTE: Guidance on values for the velocities and extent of atmospheric up and down draughts is given in **Q1–2**, App., 2.

2 **GAS** The lifting gas shall be non-Flammable. If helium is selected as the lifting gas, its density, at 100% purity, shall be assumed to be 0·169 kg/m^3 (0·01055 lb/ft^3) at ISA sea level, conditions.

NOTE: The unit lift of helium (air density minus helium density) may be assumed to be proportional to the gas purity.

3 **GAS VALVES** Gas valves, controllable by the pilot, and automatic, shall be designed and installed in accordance with 3.1 to 3.3.

3.1 The valves shall:–

(a) prevent the operating pressure differential between the gas and the external atmosphere form exceeding specified limits, and

(b) remain operable at all Airship speeds and under all anticipated operating conditions, including accumulation of frost or ice.

3.2 Permissible limits of leakage under maximum operating pressure shall be prescribed in the Maintenance Manual.

4 **AIR VALVES** Air valves, controllable by the pilot and automatic, shall be provided for the purpose of discharging air from the Ballonets in order to stabilize the envelope pressure and preclude over-pressurisation of Ballonets. The valves shall be operable at all Airship speeds and under all Anticipated Operating Conditions, including accumulation of frost or ice. Means shall be provided in the envelope for the automatic release of air to preclude over-pressurization of the Ballonets.

5 BALLONET AIR SUPPLY

5.1 **Air Supply Source.** A reliable means of supplying air to the Ballonets, shall be provided, and shall have adequate capacity to enable the pressure in the envelope to be maintained during flight at low engine powers and forward speeds, and, if appropriate, when thrust vectoring reduces the effectiveness of the engines in supplying air. The means shall also permit the envelope pressure to be maintained following the failure of all engines for a sufficient time to permit a landing to be made.

5.2 **Air Supply Ducts.** The air supply system shall be so designed and installed as to prevent a partially deflated Ballonet from closing an air supply duct and trapping air within the Ballonet.

5.3 **Envelope Emergency Air Supply.** Provision shall be made for the blowers or external air inlets to supply air directly into the gas space of the envelope for the purposes of emergency inflation.

6 TESTS

6.1 **General.** The operation and reliability of the gas and air supply system, including all valves, blowers, controls and other components, shall be substantiated by tests, unless the systems and components incorporated are shown to be identical to those the reliability of which has been proven to be satisfactory in service.

6.2 **Flight Tests.** Any limitation imposed on the rate of climb or rate of descent by the flow capacities of the gas and air supply systems shall be established.

SUB-SECTION Q6 – EQUIPMENT INSTALLATIONS

CHAPTER Q6–3

BALLAST SYSTEMS

1 **GENERAL** The ballast system, including all controls and related components, shall be designed and installed so as to enable the pilot to release the ballast in a controlled manner in Anticipated Operating Conditions, including maximum pitch attitudes and moderate ice accretion.

2 **CAPACITY** The minimum quantity of ballast to be carried shall be specified in the Flight Manual and shall be sufficient for the safe operation of the Airship in Anticipated Operating Conditions. The quantity of ballast shall in any case not be less than the quantity required to be dropped to achieve the necessary buoyancy to enable the Airship to descend at a practical rate from its cruising altitude with all propulsion engines inoperative and thereafter achieve a safe alighting.

3 **BALLAST MATERIAL** The type of ballast shall be fine sand, fine shot or liquid. Where a liquid is used it shall be non-toxic and non-Flammable and a means shall be provided to preclude its freezing prior to release under all Anticipated Operating Conditions.

4 **LOCATION OF BALLAST PORTS** The ballast disposal ports or vents shall be located so as to discharge ballast clear of the engines, air intakes and Airship structure, unless impingement can be shown to have no adverse effect on the engines and structure or on the operation of the Airship.

5 **CONTROLS AND INSTRUMENTS** Controls and instruments necessary for release of the ballast by the pilot shall be provided. Such controls and instruments shall be located and arranged so that they may be operated by the pilot in the correct manner without undue concentration or fatigue.

6 **TESTS** The operation and reliability of the ballast system, including all valves, instruments and controls, shall be substantiated by tests, unless the system is shown to be identical to a system the reliability of which has been proven satisfactory in service. The strength of the ballast storage provisions, including attachments, shall be substantiated by tests or analysis to be capable of supporting the ground and flight loads of **Q3**.

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SUB-SECTION Q6 – EQUIPMENT INSTALLATIONS

CHAPTER Q6–4

AUTOMATIC-PILOTS

1 **APPLICABILITY** When an automatic-pilot is installed it shall be of an Approved type.

2 **GENERAL**

2.1 The automatic-pilot system shall be designed so that it cannot produce excessive loads on the Airship or hazardous deviations in the flight path under any conditions of flight appropriate to its use either during normal operation or, assuming that corrective action is initiated within a reasonable period of time, in the event of malfunctioning.

2.2 Compliance with the requirement of 2.1 shall be established by showing compliance with the requirements of Section D, Chapter D6–4 or such other requirements as are considered acceptable by the CAA for application to a particular installation and Airship.

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SUB-SECTION Q6 – EQUIPMENT INSTALLATIONS

CHAPTER Q6–5

COMBUSTION HEATER SYSTEMS

1 The CAA shall be consulted at an early stage in the design for all requirements relating to combustion heaters, their installation and the functioning of the system.

NOTE: The requirements of Section D, Chapter D6–5 will normally be applied.

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SUB-SECTION Q6 – EQUIPMENT INSTALLATIONS

CHAPTER Q6–6

LIFE RAFTS

1 When the carriage of life rafts is mandatory, the equipment, its installation and functioning shall comply with requirements prescribed by the CAA. All life rafts shall be Approved by the CAA.

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SUB-SECTION Q6 – EQUIPMENT INSTALLATIONS

CHAPTER Q6–7

EXTERNAL LIGHTS

1 **APPLICABILITY** The requirements of this Chapter are applicable to the external lights which are provided in order to comply with the Rules of the Air and Air Traffic Control Regulations, 1976.

2 **DEFINITIONS** For the purposes of this Chapter the following definitions apply.

2.1 **Longitudinal Axis.** The longitudinal axis of the Airship is the longitudinal axis of symmetry of the envelope.

2.2 **Horizontal Plane.** The horizontal plane is the plane containing the longitudinal axis and perpendicular to the plane of symmetry of the Airship.

2.3 **Vertical Planes.** Vertical planes are planes perpendicular to the horizontal plane defined in 2.2.

2.4 **Dihedral Angles.** The four dihedral angles referred to as Dihedral Angle L, Dihedral Angle R, Dihedral Angle A and Dihedral Angle F are formed by pairs of intersecting vertical planes, the intersections of which with the horizontal plane are as shown in plan in Fig. 1 (**Q6–7**).

2.5 **Effective Flash Frequency.** The frequency at which the anti-collision light or lights are observed from a distance. The frequency applies to all sectors of light including the overlaps which might exist when the system consists of more than one light source.

2.6 **Candela.** The unit of luminous intensity, as defined in BS 233 'Glossary of Terms used in Illumination and Photometry'.

3 **GENERAL**

3.1 **Determination of Intensity.** The intensities of light prescribed shall be those to be provided by new equipment with all filters and covers in place. Intensities shall be determined with the light source operating at a steady value equal to the average luminous output of the light source at the normal operating voltage of the Airship.

3.2 **Location of Light Sources**

3.2.1 Light sources shall be located so that they will not cause glare objectionable to the pilot.

3.2.2 The white astern light shall be as far aft as practicable, and the red port and green starboard lights shall be spaced as far apart as practicable, and the white forward light shall be as far forward as possible.

3.3 **Light Filters and Covers**

3.3.1 The prescribed colours shall be within the limits for Class A Red, Class A Green and Class A White as specified in BS 1376 'Colours of Light Signals'.

3.3.2 The determination of the colour of a light shall be made with the light source operating at the average efficiency corresponding to the normal operating voltage of the Airship.

3.3.3 Covers and filters shall be of material which is not Flammable, shall be constructed so that they will not change colour or shape, and shall be such that there is no appreciable loss of light transmission during normal use.

4 NAVIGATION LIGHTS

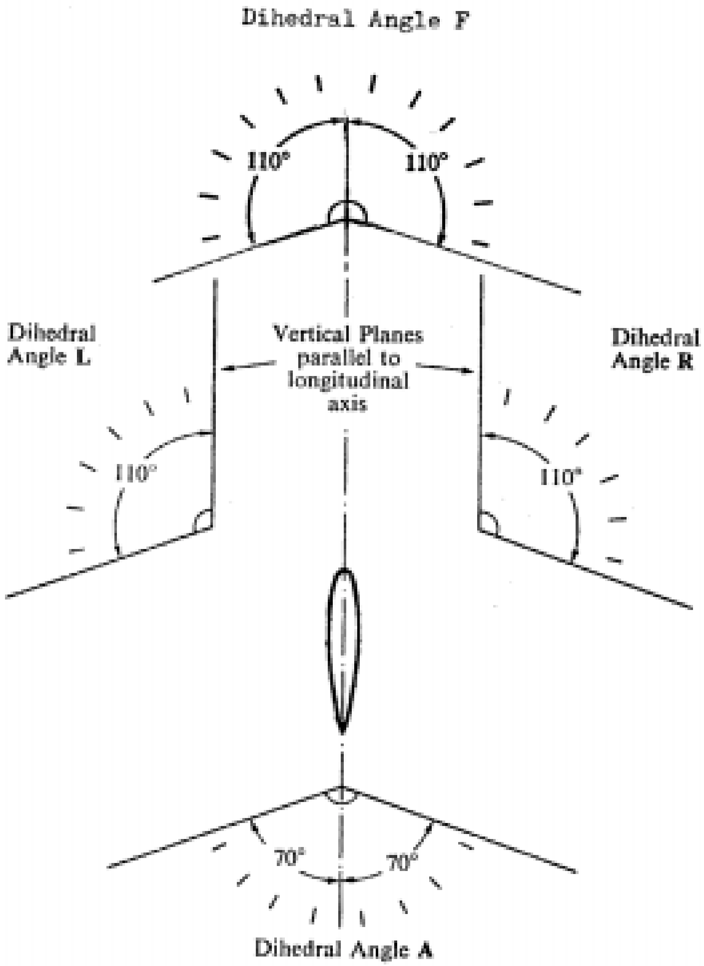
4.1 The following lights shall be emitted within the Dihedral Angles of Fig. 1 (**Q6–7**) –

(a) Starboard Signal. A steady green light within Dihedral Angle R.

(b) Port Signal. A steady red light within Dihedral Angle L.

(c) Astern Signal. A steady white light within Dihedral Angle A.

(d) Forward Signal. A steady white light within Dihedral Angle F.



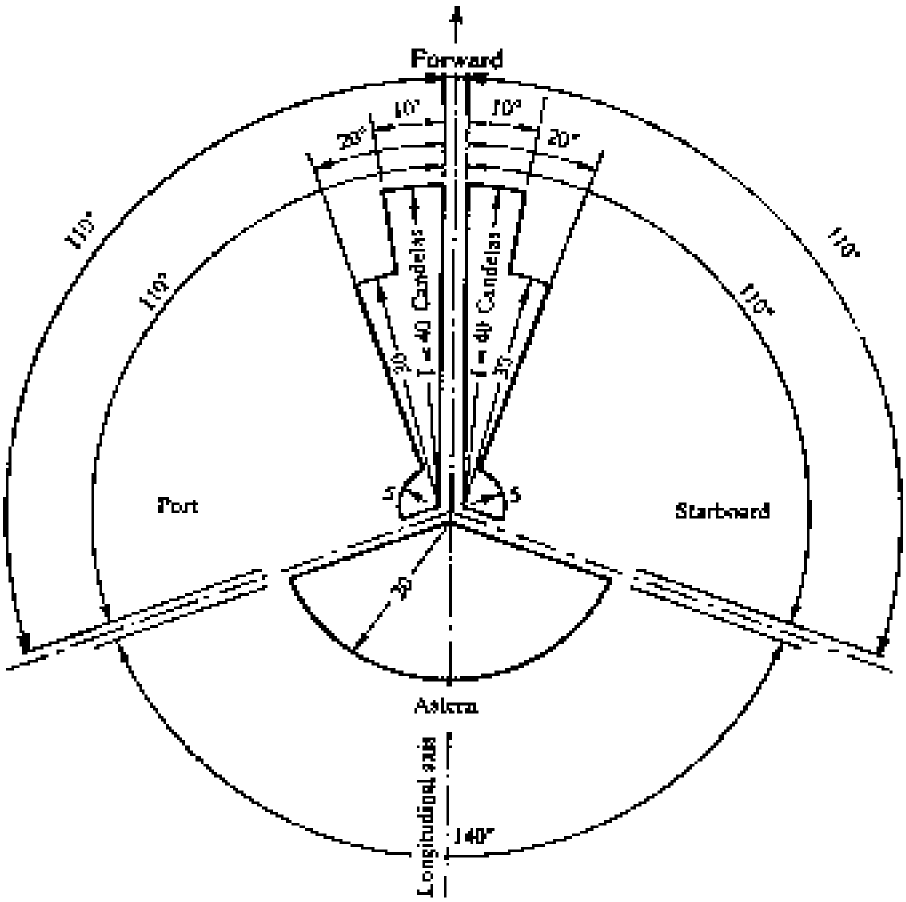
NAVIGATION LIGHTS – DIHEDRAL ANGLES

Fig 1. (Q6–7)

4.2 The intensity in any direction in the horizontal plane shall be not less than the values given in Table 1 (**Q6–7**) (see also Fig. 2 (**Q6–7**)).

TABLE 1 (Q6–7)
MINIMUM INTENSITIES IN THE HORIZONTAL PLANE

Dihedral Angle	Angle from Right or Left of Longitudinal Axis measured from Dead Ahead (degrees)	Intensity (candelas)
L & R	0 to 10 10 to 20 20 to 110	40 30 5
A	110 to 180	20
F	0 to 110	20



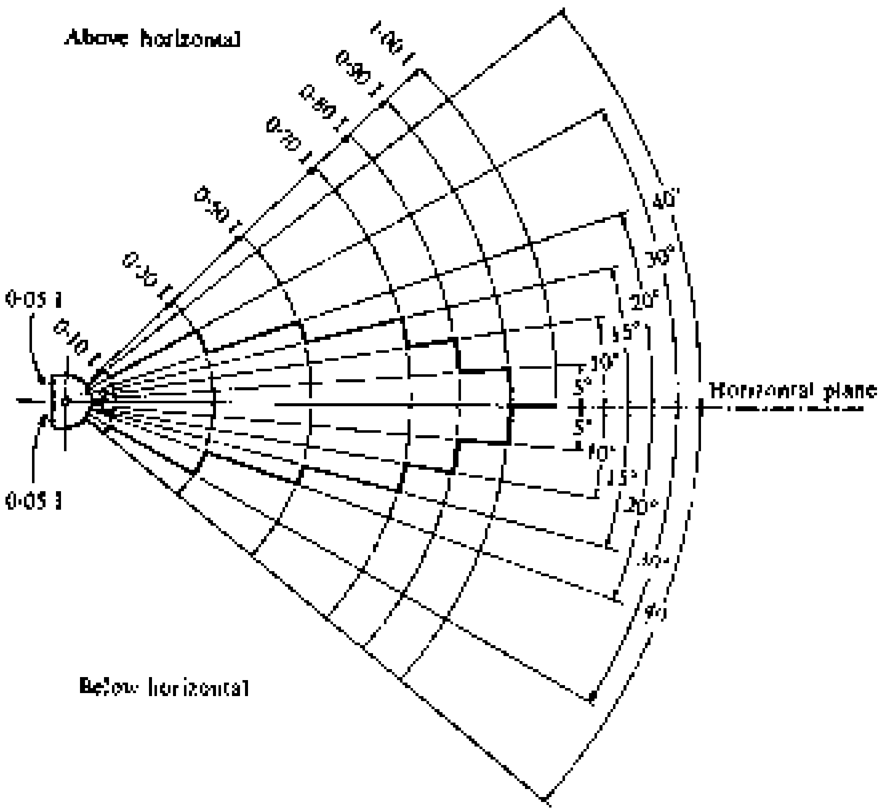
NAVIGATION LIGHTS – MINIMUM INTENSITIES IN HORIZONTAL PLANE

Fig. 2 (Q6–7)

4.3 The intensity in any direction in any vertical plane shall be not less than the appropriate value given in Table 2 (**Q6–7**) (see also Fig. 3 (**Q6–7**)).

TABLE 2 (Q6–7)
MINIMUM INTENSITIES IN ANY VERTICAL PLANE

Angle Above or Below Horizontal (degrees)	Intensity (candelas)	
0	1·00	
0 to 5	0·90	
5 to 10	0·80	
10 to 15	0·70	× I
15 to 20	0·50	
20 to 30	0·30	
30 to 40	0·10	
40 to 90	0·05	
I . . is the minimum intensity, prescribed in Table 1 (**Q6–7**).		



NAVIGATION LIGHTS – MINIMUM INTENSITIES IN VERTICAL PLANE

Fig. 3 (Q6–7)

5 ANTI-COLLISION LIGHTS

5.1 Anti-collision lights shall be installed on the upper and lower parts of the Airship in order to provide the maximum practical coverage in all directions within 30° above and 30° below the horizontal plane.

5.2 The lights shall be installed at such a location as not to impair the vision of members of the flight crew or detract from the conspicuousness of the navigation lights.

5.3 The signals emitted by the anti-collision lights shall consist of flashing red lights.

5.4 The effective flash frequency of the signals emitted by the anti-collision lights shall be not less than 40 and not more than 100 flashes per minute. In an overlap, flash frequencies of up to 180 flashes per minute will be permitted.

5.5 The minimum effective light intensity in all vertical planes shall be in accordance with Table 4 (**Q6–7**). In the determination of minimum effective intensity the following relationship shall be assumed.

$$Ie = \frac{\int_{t_1}^{t_2} It\,dt}{0 \cdot 2 + (t_2 - t_1)}$$

Where, Ie . . . . candelas . . effective intensity;

It . . . . is instantaneous intensity as a function of time;

$(t_2 - t_1)$ . . . . secs. . . . . is flash time interval.

TABLE 4 (Q6–7)
MINIMUM EFFECTIVE INTENSITIES FOR ANTI-COLLISION LIGHTS

Angle Above or Below Horizontal Plane (degrees)	Effective Intensity (candelas)
0 to 5	100
5 to 10	60
10 to 20	20
20 to 30	10

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SUB-SECTION Q6 – EQUIPMENT INSTALLATIONS

CHAPTER Q6–12

ELECTRICAL GENERATION SUPPLY AND DISTRIBUTION

1 INTRODUCTION

1.1 This Chapter states the requirements governing:–

(a) The reliability and the capability of the electrical supply system under normal and emergency conditions.

NOTE: The failures required to be taken into account in this Chapter are those in the electrical generation, supply and distribution systems. However, where relevant, requirements relating to failures in the airship will also need to be taken into account in the electrical system (e.g. debris from high energy rotating parts, bird strikes).

(b) The provision and installation of generators and batteries, together with their control and indicating equipment.

(c) Electricity distribution systems.

1.2 Where the airship uses a number of separate or interrelated electrical systems, the provisions of this Chapter shall apply to each system and to the systems as a whole.

2 **SYSTEMS RELIABILITY** (see **Q6–12**, App. No. 1) A review will be required to show that the reliability achieved for the electrical supply and distribution system is compatible with the interrelationship with other critical systems in the airship and critical characteristics of the airship.

3 SYSTEM CHARACTERISTICS

3.1 The electrical equipment in the airship shall be afforded an electrical supply having the characteristics required for the normal functioning of the equipment and to suit its role and performance.

3.2 The voltage and frequency of each system shall be so regulated as to ensure the reliable and continued safe operation of all necessary equipment while operating under the normal and emergency conditions detailed in 4.

3.3 The system characteristics in regard to voltage and frequency under steady state and transient conditions shall be defined for each electrical supply system on the airship. This definition shall be used as a basis for the specification of generating and consuming systems and equipment.

NOTE: Wherever practical, the characteristics of the system should provide a power supply to utilisation equipment which conforms to the latest issue of British Standard 3G.100: Part 3.

4 SYSTEM CAPABILITY (see Q6–12, App. No. 1)

4.1 General

4.1.1 The primary electrical power supply or systems shall consist of a sufficient number of generator channels and primary busbars and have characteristics of nominal voltage and, where appropriate, frequency, suitable for the type and role of the airship having regard to the extent of dependence on electrical power, the nature of the loads, appropriate failure cases of Power-units or other mechanical drives, failures in other systems and failures within the electrical power supply defined in 4.3.

4.1.2 Secondary electrical power supply systems shall consist of a sufficient number of conversion units, or independent power sources, and have electrical characteristics and system arrangement to achieve the objectives of 4.1.1 or the objectives appropriate to the sub-system(s) supplied.

4.1.3 The performance predicted for mechanically driven electrical generation equipment shall be compatible with the capability and reliability of the mechanical drive system.

4.2 The continuous and overload capacity of each generator channel, each conversion unit, and each section of each electrical supply system, as well as of the system as a whole, shall be adequate to ensure the satisfactory functioning of all normal likely combinations of equipment powered from the system, having due regard to failure cases and to any unserviceability likely to be authorised in the minimum equipment list for operation of the airship.

4.3 Under each of the following failure or emergency conditions, and having regard to their possible duration and to the most onerous combinations of equipment likely to be used in the particular condition, such an electrical supply shall be afforded to equipment required to operate under each condition as will enable that equipment to function satisfactorily for the duration required (see 4.4, 4.5 and 4.6).

(a) Failure of any single source of electrical power (or conversion unit in the case of secondary systems).

(b) Failure of any two sources of electrical power (or conversion units) on airships having two or more Power-units.

(c) The failure of any group of electrical power sources (or conversion units) connected to the same busbar.

(d) The total failure or temporary interruption of power from a group of sources constituting one supply system, but not necessarily connected to the same busbar, for reasons of single or multiple failures within the electrical supply system itself, including the possibility of incorrect diagnosis and mismanagement of the system by the flight crew.

(e) The inadvertent paralleling of generation sources (or conversion units) not intended by design to be paralleled, as a result of switchgear or other faults.

(f) The loss of any one busbar.

(g) Under conditions applicable during, or after, drills for the dispersal of smoke.

(h) Under any of the above conditions, taking into account any unserviceability likely to be authorised in the minimum equipment list for operation of the airship.

4.4 In considering the failure and emergency conditions of 4.3 due regard shall be given to the following:–

(a) The provision of an adequate electrical supply to equipment required for the restarting of Power-unit(s).

(b) The provision of an adequate electrical supply to the equipment and services which may be required to make a controlled descent and landing in the event of failure of all power units and the inability to restart them.

(c) Delays in flight crew recognition of failures and completion of drill, where flight crew action is necessary may be assumed to be:–

(i) Normally 10 minutes, for multiple and single source failures, where such a delay is acceptable and in order to allow the crew's primary attention to be given to other vital actions.

(ii) 5 minutes, for multiple and single source failures provided that the failure indication system has clear and unambiguous attention-getting characteristics and where such delay is acceptable and compatible with the crew's primary attention being given to other vital actions.

(d) The role of the airship and the possible duration time of the flight to make a safe landing. The emergency power supply shall:–

(i) Be of sufficient endurance, and of such capacity and independence from the main electrical system as to allow the flight to be completed and a safe landing made. (See also **Q6–12** App. No. 1, 2); or

(ii) Have an endurance of not less than 30 minutes, having due regard to and including the delay times defined in 4.4(c).

NOTE: The endurance time must be compatible with the role of the airship, for example those which are utilised for extended operation over water or unfriendly terrain and which may be dependent on battery power to complete a flight and make a landing in the event of interruption of all normal generated electrical power.

The endurance time, determined by calculation or actual measurement, should be declared in the appropriate section of the Flight Manual (see also **Q6–12** App. No. 3, 3.6).

4.5 It shall be shown by analysis, test, or both, that the airship is capable of operating safely under VFR conditions, initially at its maximum altitude, and with the critical type of fuel (from the standpoint of engine flame-out and restart capability) for 5 minutes with the normal electrical power system inoperative (i.e. electrical power sources excluding the main battery) prior to any flight crew action which may be required to provide the emergency supplies required to complete the flight in safety. If the main battery supply is used as the source of emergency power during the failure of the normal electrical power, then it shall be shown that no single malfunction, electrical or mechanical, will simultaneously affect the normal electrical power and power from the battery supply. (See **Q6–12** App. No. 1, 2.5.)

4.6 Whilst at the mast, prior to departure, the electrical supply system shall ensure the satisfactory functioning of the most onerous combination of apparatus likely to be supplied under this condition. Where a battery supplies part of the power, the system shall maintain the battery in a state of charge that will ensure satisfactory operation of all equipment and provide adequate power to enable the airship to re-land in the event of a failure of generated electrical power shortly after take-off.

4.7 The electrical power supply system shall be capable of affording an adequate supply to those items of equipment required to operate during or following an emergency alighting on land or water. The circuits to these services shall be so designed and protected that the risk of causing a fire is minimised.

5 **LOAD ANALYSIS** (see **Q6–12** App. No. 3)

5.1 Load analyses shall be prepared giving details of the maximum continuous electrical power and the maximum demand needed to ensure compliance with 4. Account shall be taken in the analyses, of the equipment required to operate under normal and emergency conditions.

5.2 When any additions, either temporary or permanent, are made, reference shall be made to these load analyses to ensure that, under the new loading conditions, the requirements of 4 are still met.

6 **EARTHING OF SUPPLY SYSTEM**

6.1 Earthing arrangements shall comply with the requirements of **Q6–13**, 6.3.

6.2 The failure of a single earth connection shall not cause the loss or malfunctioning of more than one source of electrical supply or more than one busbar.

6.3 Electrical supplies of different characteristics (e.g. voltage and frequency) shall be connected to separate earth points unless it can be established that the joining of the circuits with the earth disconnected will not produce a dangerous condition.

7 **GENERATORS**

7.1 **Rating.** Generators shall be so designed and installed as to meet the requirements of 4 at all the appropriate generator speeds corresponding to airship operating conditions.

7.2 **Excitation.** Generators shall, when used in conjunction with their appropriate control equipment be capable of building up their output voltage and connection to their busbar, without the need of a supply separate form the machine unless a supply of adequate integrity can be provided.

7.3 **Cooling**

7.3.1 The cooling installation for the generator system shall be effective for all conditions for which the airship is certificated including any overload operation under emergency conditions and any ground manoeuvres. (See also **Q5–4**.)

7.3.2 Effluent cooling air shall be so discharged that it does not constitute a fire risk even under generator fault conditions (e.g. bearing failure).

7.3.3 The cooling installation shall not be liable to inadvertent damage and the intake shall be so situated that it does not, even under fault conditions, collect such Flammable fluids as will endanger the airship. Precautions shall be taken to prevent the accumulation of water, snow and ice in the cooling system.

NOTE: **Q5–5** gives requirements for de-icing and anti-icing precautions for air intake systems.

8 **SUPPLY AND DISTRIBUTION SYSTEMS – EQUIPMENT AND CIRCUITS** (see **Q6–12** App. Nos. 1, 3 and 4)

8.1 The electrical supply system shall be so designed that each of the sources of electrical supply functions properly, both when connected in combination and independently.

8.2 To ensure compliance with the system characteristics of 3, means shall be provided to maintain the voltage and frequency within the required limits.

8.3 The electrical and mechanical arrangements for each source of electrical supply, its associated wiring and control equipment and circuits, and the arrangement and sub-division of busbars shall be such that no failure will:–

(a) cause any hazardous malfunction or the loss of more than the particular source of electrical supply or major busbar which the failure affects, and/or

(b) cause any dangerous effects in circuits other than that in which the failure occurs.

8.4 The protective and controlling devices shall be such as to de-energise and disconnect faulty sources of electrical supply from their associated system with sufficient rapidity to prevent dangerous malfunctioning of the system, but shall not cause nuisance disconnects due to transients caused by normal system operation. (See also 8.5.)

8.5 **Isolation.** Means shall be provided for such individual isolation of sources of electrical supply from the main busbar(s) as are necessary for the tracing and isolation of major faults. These means and all other protective and controlling devices which are under the control of the flight crew shall be available to the appropriate flight crew members in their normal seated positions, and so located that they can be operated with sufficient rapidity in the case of an emergency.

(a) A switch, directly or remotely operated, shall be provided to isolate the battery from the electrical system irrespective of whether the system is wholly or partly dependent on the battery. This switch shall be so located, or guarded, as to render its inadvertent operation unlikely. Any load circuits which are required to remain connected to the battery after its isolation from the main electrical system (e.g. those required by **Q6–13**, 6.9.2) shall be limited in number and protected by suitable circuit protective devices located adjacent to the battery.

(b) Means shall be provided to ensure that the battery cannot be damaged inadvertently by an external source of supply (see **Q6–12** App. No. 4, 2.3.6).

8.6 **Resetting**

(a) It shall be possible in flight to make at least one restoration or resetting of any protective device in the electrical supply system.

(b) It shall not be possible to override the operation of the protective device when an overload or circuit fault exists.

8.7 **Warning Devices**

(a) Clear visual and unmistakable indication shall be provided within the pilot's normal line of sight, to give notice of either:–

(i) loss of the output of each engine driven generator at the main distribution point or busbars;

(ii) reduction of the generating system voltage to a level where the battery commences to support any part of the main electrical load of the airship;

(iii) isolation of the battery or batteries.

8.8 **Indicating Equipment.** Such instruments shall be provided as are necessary to enable the appropriate flight crew members to determine those generating system quantities which are essential for the safe operation of the system, to assist the flight crew in the correct operation of the facilities provided for 8.5 and to take such action as is required to meet 4.4.

9 BATTERIES (see **Q6–12**, App. No. 4, 4)

9.1 Batteries shall have such characteristics and be so installed that for all the operating conditions and manoeuvres for which the airship is certificated:–

(a) they are capable of supplying the electrical power required for the normal and emergency conditions described in 4,

(b) they do not constitute a danger to the airship or to the occupants,

(c) they, and their compartments are adequately ventilated, and sealed to prevent escape of electrolyte and gases to the interior of the airship gondola, and

(d) unless it can be shown not to be necessary, the battery case or the battery compartment(s) is located, and constructed of suitable materials, such as to contain safely any fire or explosion which may occur within it.

9.2 Account shall be taken of any normal deterioration of the battery which may take place during service or operational life, and of the physical environment in which the batteries are located.

9.3 Means shall be provided to minimise the risk of overcharging or overheating of batteries.

9.4 For nickel-cadmium batteries used for engine or APU starting, and/or as part of the main power supply system, an overheat warning at the flight deck shall be provided unless an automatic charge control system provided to meet 9.3 affords an equivalent level of safety.

9.5 Metal-cased batteries shall be electrically insulated from the gondola structure or earth return system. Where bonding to earth of the case is necessary for other reasons, the connection shall be made through a fusible element compatible with the current rating of the bonded lead.

10 DISTRIBUTION

10.1 The arrangement, protection and control of the feeders from the busbar(s) to the distribution points, and the division of loads among the feeders, shall be such that no single failure or combination of failures occurring in any feeder, group of feeders or associated control circuit can result in a dangerous condition.

10.2 Where electrical services are multiplicated in order to comply with the requirements, their loads shall be distributed between different busbars and/or different feeders and shall be routed separately to the maximum extent practical. (See also **Q6–13**, 6.2.1.)

10.3 Where duplicate electrical power supplies for particular items of equipment are prescribed in the Requirements, these shall be derived from different busbars and shall be routed separately as far as practical.

11 **MECHANICAL PROTECTION OF LIVE PARTS OF THE SUPPLY AND DISTRIBUTION SYSTEM** (see also **Q6–13**, 7.1)

Live parts shall be mechanically protected to reduce the possibility of short circuits and earth faults.

12 **FLUID AND VAPOUR CONTAMINATION** (see **Q6–13**, 6.5)

13 **ELECTRICAL & MAGNETIC INTERFERENCE** The effect of any conducted or radiated interference, caused by the operation of any equipment, upon the systems required by this or other chapters shall be kept to a minimum. (See also **Q6–13**, 6.8.)

All practical steps shall be taken to minimise the hazardous effects of a lightning discharge through, or static discharges from the airship. (See also **Q4–6**.)

14 **GENERAL INSTALLATION REQUIREMENTS** The requirements of **Q6–13**, 6.5 Precautions against Deterioration, 6.6 Precautions against Fire and Explosion, 6.7 Precautions against Injury and 6.9 Crash Fire Precautions shall apply in so far as they are appropriate to the electrical supply and distribution system.

15 **TESTS** (see **Q6–12** App. No. 2 and **Q6–13**, 6.10)

15.1 **Ground Tests.** Tests shall be made to establish, as far as is practicable the satisfactory collective performance of equipment comprising a functional system, in order to confirm that the individual components of the system are correctly related to each other and to the duty which the system is required to perform. Such tests shall be made with an equivalent standard of equipment as used in the airship under conditions which simulate the various flight and ground conditions of the airship.

15.2 **Flight Tests.** To confirm the system performance in flight and to test those parts of the system where the conditions of flight have not been adequately simulated during the ground tests of 15.1, tests under prescribed conditions of flight shall be made using a suitably instrumented test airship.

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APPENDIX NO. 1 TO CHAPTER Q6–12

SYSTEMS RELIABILITY

1 **INTRODUCTION** (see **Q6–12**, 2 and 4)

1.1 This Appendix describes acceptable methods of compliance with **Q6–12**, 2 and 4, and the general system requirements of **Q6–1**, with particular reference to electrical supply and distribution systems. Other methods are acceptable, as long as an equivalent level of safety is achieved. In addition, examples are given of faults which have led to electrical system failures.

1.2 For the purpose of this Appendix only, airships are classified as in (a) to (c):–

(a) Class P – Airships in which loss of electrical supply could result in a Catastrophe (e.g. those airships which are entirely dependent on electrically powered ballonet fans).

(b) Class Q – Airships in which a continued loss of electrical supply may result in a dangerous situation (e.g. where substantially uninterrupted power supplies are required for flight instruments, such as attitude and altitude indicators, powerplant or flight control systems and communication and navigation systems).

(c) Class S – Airships in which the loss of the electrical supply does not affect the safety of continued flight.

2 **ALL AIRSHIPS**

2.1 The duration of power available from emergency sources should, in addition to meeting the requirements of **Q6–12**, 4.3 to 4.7, take into account the operational requirements for the particular airship (e.g. single engine endurance on a twin-engined airship and any time required for necessary flight crew action to be taken).

2.2 Due account should be taken, when considering the requirements for the provision of emergency electrical supplies, of any unserviceability in the normal electrical supply system which may be authorised in the minimum equipment list for the operation of the airship.

2.3 Means independent of the main generating system should be provided for the restarting in sequence of all main Power-units and of any driven sources of emergency power.

2.4 In considering those loads which, under emergency conditions, require electrical power to enable the flight to be completed and a safe landing made, the following should be included:–

(a) Attitude information.

(b) Essential radio communication.

(c) Essential heading navigation or direction finding equipment.

(d) Ballonet fan operation.

(e) Powerplant controls.

(f) Flight controls.

(g) Essential cockpit lighting.

(h) Pitot head heating, where air speed or altitude information are essential.

(j) Secondary surveillance radar equipment.

(k) Any other services essential for continued safe flight or landing.

NOTE: See also **Q6–12** App. 3, 3.

2.5 In meeting the requirements of **Q6–12**, 4.5 it is recognised that, under certain critical conditions, an engine or engines may flame out. This is acceptable if:–

(a) The relight capability of the engine(s) is guaranteed.

(b) No hazard will ensue during the period prior to relight, and

(c) All services necessary for such a relight are available under the specified conditions.

3 CLASS P AND Q AIRSHIPS

3.1 Arrangements should be made so that in the event of a major fault in the main electrical system sufficient services can still be supplied to enable the flight to be completed in safety.

(a) **Regaining of Main Generators.** In the event of a loss of electrical power, provision may be made to regain the output from one or more main generators using separate control and switching arrangements on the generator side of the main busbars. It should be shown that no probable failure will lose both the main system and the alternative means of control and distribution.

(b) **Provision of Emergency Systems.** In the event of a loss of electrical power, the emergency electrical system used to supply those services necessary to complete the fight in safety should not be dependent on equipment or circuits which may have been damaged or made inoperative by the failure of the main system.

4 CLASS S AIRSHIPS No separate emergency supply would normally be required.

5 MALFUNCTIONS AND FAILURES

5.1 **Definition.** For the purpose of this Chapter a Probable Malfunction is defined as any single electrical or mechanical malfunction or failure within an airship electrical system which is considered probable on the basis of past service experience with similar components in airship applications. The definition should be extended to multiple malfunctions when:–

(a) the first malfunction would not be detected during normal operation, including periodic checks which are carried out, the intervals between which are consistent with the degree of hazard involved, or

(b) the first malfunction would inevitably lead to other malfunctioning.

NOTE: See also **Q6–1**.

5.2 The following are examples of failures and malfunctions (some of which have occurred a number of times) which have led to a complete loss of electrical supply on aircraft. These at least, should be included in investigations into probable malfunctions:–

(a) Consecutive failures of generators, on two-generator aircraft, including cases of reversed polarity, of consecutive failures of shear or quill shafts, and the problem that automotive alternators do not normally accept overloads.

(b) Sticking of unprotected starter relays.

(c) Over-voltage causing damage to the whole of the system.

(d) Busbar faults (short circuit, open circuit and the effects of loose connections of heavy duty cables and switchgear on the busbar).

(e) Consecutive operations of protection devices (e.g. fuses and thermal circuit breakers).

(f) Instability of system with battery disconnected. (This is particularly relevant to aircraft with automotive type alternators).

(g) Single fault affecting the control system of more than one generator (e.g. fault between adjacent terminals, fault to equalising system).

(h) Failure of the two Power-units driving the two generators on aircraft with four Power-units.

(j) Faulty protection equipment.

(k) Flight crew error in switching off the wrong generator, or the battery.

(l) The use of unsuitable insulation materials not capable of withstanding the temperature of fault as well as normal operating conditions. In a number of cases, the use of insulating materials capable of ignition and subsequently supporting combustion under electrical fault conditions.

(m) The presence of foreign objects in vital parts of the electrical system.

(n) The impingement of quantities of hot air or gases on vital parts of the electrical system resulting from failures in Power-units or ducts.

(o) Common maintenance errors due to inadequate instruction or supervision.

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APPENDIX NO. 2 TO CHAPTER Q6–12

GROUND AND FLIGHT TESTS

1 **INTRODUCTION** This Appendix gives guidance on the tests which should be carried out to meet the requirements of **Q6–12**, 15.

2 **GENERAL** Sufficient tests should be made, on the ground or in flight as appropriate, to determine that the performance of the electrical supply system meets the declared characteristics of **Q6–12**, 3.3, under all the appropriate normal and emergency conditions required by **Q6–12**, 4. Due account should be taken in these tests of load switching and flight crew operation of the system.

3 **GROUND TESTS**

3.1 All tests should be carried out with equipment as representative as possible of the actual airship. In particular, the simulation should include the correct representation of airship cables in size, length and impedance, the correct ground (gondola structure) impedance where applicable and their correct relative location and location to other cables or systems that could influence performance. Customer loads and the generator drive system should also be correctly simulated.

3.2 The tests may be carried out on representative laboratory rigs or in an actual airship as appropriate.

3.3 Schedules should be prepared to cover the conditions of the tests.

4 **FLIGHT TESTS**

4.1 If not fully covered by ground testing, such flight tests should be carried out as are necessary to meet 2.

4.2 Temperature tests should be carried out on equipment where the operation of the cooling media is dependent upon the motion of the airship.

4.3 Measurements should be made to ensure that all equipment, particularly the airship battery, is operating within its specified environmental conditions.

4.4 Schedules should be prepared to cover the conditions of the test.

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APPENDIX NO. 3 TO CHAPTER Q6–12

ELECTRICAL LOAD ANALYSES

1 INTRODUCTION

1.1 This Appendix describes acceptable methods of preparing the electrical load analyses and summaries prescribed in **Q6–12**, 5. Other methods are acceptable as long as the equivalent information is provided.

1.2 The purpose of the load analysis is to demonstrate the system capacity needed to supply the most onerous combinations of electrical loads and it achieves this by evaluating the average and maximum demands under various conditions of flight. The purpose of the summary is to relate the load analyses to the system capacity and probable duration of the various normal and emergency conditions, and to draw attention to any limitations, with particular reference to future in-service use and possible modifications to, and additions of, equipment.

1.3 Guidance is given below upon the factors which should be taken into account when preparing the load analyses for both AC and DC systems under normal and emergency conditions. It is the responsibility of the designers concerned to ensure that the analyses take into account all variables covering the type of system used and the particular airship usage.

1.4 The analyses should indicate the conditions and periods of flight for which the equipment is required.

2 NORMAL CONDITIONS

2.1 The analyses should cover the electrical loading conditions appropriate to the various conditions of flight, e.g. take-off, cruise and landing for both day and night conditions, taking into account any additional loads, such as de-icing, when required.

2.2 The analyses should also identify permissible unserviceability recognised and likely to be authorised in the minimum equipment list during the certification of the airship and should include calculations appropriate to these cases.

2.3 For 3-phase AC systems the phase loads should be considered individually and in total.

2.4 The effect of paralleled and/or non-paralleled operation should be covered for generation systems as applicable.

2.5 The individual currents for each equipment or system, with phase values and power factors if appropriate, should be stated in the analyses with the number of such equipments and the time of operation to enable total loading to be assessed.

2.6 When considering short term loads RMS currents may be used to determine the heating effects upon generators which are capable of carrying overload currents for limited periods. However for generators which have no overload capacity and which may suffer voltage collapse if overloaded, due account should be taken of the total current possible at any time. (See also 1.4 of this Appendix No. 3.)

2.7 The analyses may be used to calculate and record the voltage drop to consumer equipment.

3 EMERGENCY CONDITIONS

3.1 The analyses should cover all possible combinations of power source failure, including complete loss of power from the normal generation sources and take into account any unserviceability likely to be authorised in the minimum equipment list.

3.2 The analyses should take into account both automatic and manual load shedding and in the latter case due account should be made for the time taken to initiate such load shedding (see **Q6–12**, 4.4).

3.3 For multi-engined airships using a battery to meet the requirements of **Q6–12**, 4 an analysis should be provided of the load required from the battery in order to determine the time available for supply of the required essential loads as defined in Appendix No. 1, 2 and those services which cannot readily be shed when carrying out the drills required under paragraph 3.6.

NOTE: For the purpose of calculations it will normally be accepted that intermittent use of a single VHF communication equipment satisfies the intent of paragraph 2.4(b) of Appendix 1. Utilisation on the basis of a total 15 minutes reception plus 3 minute transmission in the 30 minute period would be an acceptable interpretation.

3.4 In order to ensure that the essential services, will function adequately for the prescribed period, the calculation of the duration of battery supply should normally be based on the following assumptions:–

(a) Only 72% of the 'nameplate' rating of the battery is available. (It is assumed that at normal ambient conditions, a battery capacity of 80% of the nameplate rated capacity, at the 1 hour rate, and a 90% state of charge exists.)

(b) The voltage/time discharge characteristic of the battery, appropriate to the load of the listed services, is not extended beyond a battery terminal voltage of 21.5 volts on a 24 volt system, pro rata for 12 volt systems, (this is to ensure that the voltage available throughout the prescribed period is adequate for satisfactory operation of the services).

3.5 (a) Where all gyroscopic attitude reference instruments, i.e. bank and pitch indicator(s) and turn and slip indicator(s), are dependent on electrical power for their operation, at least one of these instruments shall continue to operate without crew action for the prescribed period.

NOTES: (1) For certain airship types a turn and slip indicator may not be acceptable as the sole remaining attitude reference instrument.

(2) Certain airships are equipped with both electrically operated and air driven attitude reference instruments. In such cases the air driven instrument(s) may be accepted as providing the emergency attitude information.

(b) The instrument(s) shall be clearly designated, and,

(i) shall be so located on the instrument panel that it will be visible to, and usable by, the pilot from his normal position;

(ii) shall be provided with means of indicating that the power supply to the instrument is operating correctly.

3.6 Precise drills covering crew action in the event of electrical generation system failures and malfunctions shall be included in the appropriate airship manual(s), together with a statement of the battery endurance under specified load conditions and list of services which are supplied.

4 **LOAD SUMMARIES**

4.1 Load summaries should be prepared, based upon the detailed load analyses, giving total loads upon the airship power sources and major sub systems under both normal and emergency conditions. For AC systems these summaries should include power factor and phase loadings.

4.2 These theoretical analyses may be verified by ground and/or flight tests.

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APPENDIX NO. 4 TO CHAPTER Q6–12

GENERATOR SWITCHGEAR AND BATTERY INSTALLATION

1 **INTRODUCTION** This Appendix describes acceptable methods of complying with the requirements of **Q6–12**, 9 and 10. Other methods are acceptable as long as an equivalent level of safety is achieved.

NOTE: There are requirements relating to flight crew operated controls and associated warning and indicating devices in **Q4–2**, **Q4–8** and **Q6–1**.

2 **SUPPLY SYSTEM CONTROL – EQUIPMENT AND CIRCUITS** (see **Q6–12**, 8)

2.1 **Isolation.** For each generator, means should be provided for its independent and rapid electrical disconnection from the system. When disconnected its voltage should be controlled to a safe value. The controls provided for disconnection should be grouped together for each section of the busbar system so that any busbar section can be rapidly selected for disconnection from power sources without confusion. The resetting requirements of **Q6–12**, 8.6 should also be met by this generator control system.

2.2 **Load Sharing.** Means should be provided to ensure the sharing of load between generators in parallel. The tolerances on load sharing will have to be taken into account in meeting the requirements of **Q6–12**, 4. Where generators are not normally connected in parallel, transfer arrangements may be made to ensure satisfactory operation following a failure.

2.3 **Provision of Protective Devices**

2.3.1 **Short-circuit Protection – Generators**

(a) Means should be provided to protect the generators and associated feeders.

(b) Individual protection should be provided for each generator circuit so that any dangerous short circuit which occurs on that circuit can be isolated without adverse effect upon the operation of other generator circuits.

(c) The protective devices should be so designed and installed that they will not operate under any acceptable overload conditions which are applied at the main busbar.

2.3.2 **Protection of Busbars**

(a) The main and distribution busbars should be arranged, and protected so that no likely failure or occurrence can cause a loss of electricity supply or of services which may lead to a dangerous situation.

NOTE: See also **Q6–12**, App. No. 1 and 3.

(b) Busbars should be limited in extent and only those devices essential for the protection of feeders and electrical supply system circuits should be connected to them. These protective devices should be free from any danger of short circuit in themselves. The busbar system should as far as practical have no externally exposed conducting surfaces.

2.3.3 **Protection against Excess Voltage**

(a) Where failure of voltage regulating equipment, or a fault in an associated circuit, may produce an over-voltage condition such as to disturb significantly the operation of the electrical generation system, provision should be made to limit this voltage to a safe value or to disconnect the generator circuit concerned. Where necessary the correct regulation of a generated voltage should be assessed prior to its connection to a busbar.

(b) Transient voltages which may have an adverse effect on the operation of equipment which is necessary for airship safety should be kept to an acceptable minimum and equipment should be so designed as to be capable of withstanding any such transient voltages which may be applied to them. (See **Q6–12**, 3.3.)

2.3.4 **Protection against Reverse Current.** Where a generator is so connected that reverse power conditions can occur, automatic means should be provided for opening the generator circuit under such conditions before a hazard can occur.

2.3.5 **Protection against Incorrect Phase Sequence.** Provision should be made to prevent a supply of incorrect phase sequence being connected to a busbar.

2.3.6 **Connection of Airships to Ground Power Supplies.** Where means are provided to enable a ground power source to be connected to the airship system, it is desirable that protection be provided in the airship, to prevent damage to the airship or its systems from incorrect polarity, incorrect phase sequence, open circuit line, incorrect frequency or over-voltage and under-voltage of the ground power source.

3 **WARNING AND INDICATING APPARATUS** (see **Q6–12**, 8)

3.1 **Supply Failure.** The supply failure warning may consist of a single warning for the whole system coupled with a series of devices which will indicate the state of each source of electrical power, and each secondary system conversion unit. For multiphase systems the warning should also sense or detect the loss of any phase. The warning should be automatically cancelled when corrective action is taken. The single warning may be cancelled by the flight crew.

3.2 **DC Systems.** It should be possible to measure, with the instruments normally provided in the airship, the voltage and current supplied by each generator and the voltage at the busbar, where this may be essential for safe operation.

3.3 **AC Systems**

3.3.1 **Paralleled Systems.** It should be possible to measure, with the instruments normally provided in the airship, the RMS voltage and the real and reactive power supplied by each source of electrical power in addition to the RMS voltage at the busbar.

3.3.2 **Non-paralleled Systems.** It should be possible to measure with the instruments normally provided in the airship the RMS voltage and RMS line current supplied by each source of electrical power.

3.3.3 **Frequency.** Where the control of frequency is important, means should be provided for measuring the frequency of the output of each generator.

3.4 **Self-regulated Systems.** In the case of self-regulated generators, an ammeter should be connected permanently in the battery circuit.

4 **BATTERIES** (see **Q6–12**, 9)

4.1 **General**

4.1.1 Battery terminal arrangements should be such as to obviate the possibility of incorrect connection.

4.1.2 Battery containers should be constructed of impervious and non-flammable materials. Where metal containers are employed these should be coated with an anti-corrosive, non-conducting material to minimise the risk of internal short circuits.

4.2 **Charging.** Precautions should be taken, in the arrangements for charging batteries in the airship, to prevent abnormal conditions of charging.

NOTE: Such conditions can cause loss of electrolyte, accumulation of gas and excessive temperature of plates or electrolyte, and thermal instability of the battery, with possible fire and smoke hazards.

4.3 **Installation**

4.3.1 **Location.** Batteries and their containers should be securely fixed in positions such that they are easily accessible for inspection, replacement and necessary tests.

4.3.2 **Temperature of Electrolyte.** The installation and method of cooling should ensure that, under operating conditions, the temperature of the electrolyte is maintained within the limits necessary for satisfactory operation.

4.3.3 **Ventilation.** Ventilation adequate for the prevention of dangerous concentrations of ignitable or toxic gases should be provided for the battery and the compartment in which batteries are installed. These arrangements should take account of the quantities of gas likely to be released under conditions of thermal instability of the battery, and of ground charging (where applicable).

4.3.4 **Corrosion.** Precautions should be taken to prevent corrosion of the airship gondola structure or other equipment by battery fluids and vapours.

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SUB-SECTION Q6 – EQUIPMENT INSTALLATIONS

CHAPTER Q6–13

UTILISATION AND INSTALLATION OF ELECTRICALLY OPERATED SYSTEMS AND EQUIPMENT

1 **INTRODUCTION** This Chapter states the requirements governing the following:–

(a) Circuit controls and devices for circuit protection.

(b) General design, installation and testing standards required for electrical circuits, systems and equipment.

(c) Installations where particular requirements are necessary (e.g. cables, domestic equipment).

2 ELECTRICAL SYSTEMS – RELIABILITY AND MALFUNCTIONING

2.1 Each electrical system and the equipment associated with it shall be so designed and installed that it will not jeopardise the safety of the airship or its occupants, under any operating conditions for which the airship is certificated,

(a) when subject to a single failure or combination of failures which are likely to occur,

(b) when subject to the conditions which could be imposed on it as a result of a Failure Condition in another system in the airship,

(c) when operating normally.

NOTES: (1) The failures required to be taken into account in this Chapter are those in electrically operated systems and equipment and in other associated systems and equipment. However, where relevant, requirements relating to failures elsewhere in the airship will also need to be taken into account (e.g. bird strikes).

(2) This requirement may entail the provision of duplicate or emergency systems depending on the type of hazard likely to result from malfunction or failure.

2.2 A fault analysis shall be prepared for each electrical system and the equipment associated with it for which it is not clear from examination or by simple test that the requirements of 2.1 have been met.

3 CIRCUIT FAULT CONTROL

3.1 Control and circuit arrangements shall be such that faults result in the condition of least danger to the airship and its occupants.

3.2 Manual or automatic means shall be provided for opening non-essential and other circuits where their continued operation in the event of fault conditions would be detrimental to the operation of circuits essential to airworthiness. Where manual means are employed suitable instructions shall be given to the flight crew.

3.3 It shall not be possible in flight to override the functioning of installed circuit breakers in cases where such overriding would enable an overload or circuit fault to persist (e.g. the circuit breakers should be of the ‘trip-free’ type).

4 CIRCUIT INTERLOCKING

4.1 The electrical position of switches in circuits shall be chosen in relation to the load and the supply so as to provide the maximum degree of safety.

4.2 For all electrical circuits, means shall be provided to minimise the possibility of inadvertent operation, if such operation would cause a dangerous condition.

4.3 If a circuit or group of circuits is switched off and then re-established the re-establishment shall not result in a dangerous condition.

NOTE: The means of switching should include those switches available to the crew and any automatic switches in the circuits including interlocks.

5 PROTECTION OF CIRCUITS AND EQUIPMENT

5.1 Circuit Protection

5.1.1 All electrical circuits shall be protected against excessive overloads and short circuits by means of suitable current-sensitive devices. Overcurrent protective devices shall be so arranged that when the current in any circuit exceeds the rated current to a dangerous extent, the current will be cut off automatically from that circuit.

5.1.2 For circuits where protection by a current-sensitive device is impracticable (e.g. engine or APU starter circuits) and where failure to open of the circuit control switch or contactor could result in overheating of electrical cables or components (e.g. starter motor) means shall be provided to enable the circuit involved, following such a failure, to be identified and isolated.

5.1.3 Every circuit or group of circuits shall be protected in such a way that a fault in the circuit(s) will not create a fire or smoke hazard. Where a single device protects more than one circuit the rating of the device and the circuit cables shall be such as to ensure freedom from fire or smoke hazard on all connected circuits (see also 6.6).

5.1.4 (a) The protective devices associated with circuits and equipment which may affect airworthiness and those associated with emergency systems, shall be so designed, located and identified that they are capable of being reset rapidly at least once, after automatic operation, when the airship is in flight.

(b) It shall not be possible to override the operation of the protective device when an overload or circuit fault exists.

5.2 Fault Protection Discrimination

5.2.1 Unless it occurs as a result of a multiple failure, the operation of any single protective device shall not produce a dangerous condition.

5.2.2 Circuit protective devices shall be arranged so that it is unlikely that any circuits which affect airworthiness will be disconnected in consequence of a fault in any other circuit. Additionally, they should be arranged so that the disconnection of circuits or groups of circuits not directly affecting airworthiness will not result in a dangerous condition.

5.2.3 **Graded Protection.** The performance of protective devices (including tolerances) shall be graded throughout the system so that under overload or fault conditions the protective device nearest to the fault and on the supply side of it, will operate first.

5.2.4 **Separately Protected Parallel Feeders.** Where, to improve integrity, separately protected parallel feeders are employed, the discrimination of the protective devices shall be such as to cause automatic isolation of only that feeder with which the fault is associated.

5.3 **Protection of Equipment.** Where overloading of equipment can present a danger because of overheating, the operating characteristics of the protective device shall be correctly related to the characteristics of the equipment it is protecting.

6 GENERAL REQUIREMENTS FOR THE INSTALLATION OF SYSTEMS AND EQUIPMENT

6.1 Design of Equipment

6.1.1 Parts and equipment essential to airworthiness shall conform to an agreed specification and shall be subject to the procedures of Section A Chapter **A4–8** or Section B Chapter **B4–8** as applicable. British Standard Specifications of the 'E' and 'G' (Aerospace) series are appropriate to airship electrical parts and equipment and may be used as guidance information.

6.1.2 Parts and equipment not essential to airworthiness shall be suitable for their intended use in the airship environment and those features of such parts and equipment which may affect airworthiness (e.g. risk of fire, smoke, electrical or magnetic interference) shall be controlled by the Applicant to a standard which ensures compliance with the relevant requirements of this Section.

6.2 **Segregation of Services** (see **Q6–13**, App. No. 1)

6.2.1 Wherever the equipment which is necessary for the fulfilment of an essential function is multiplicated in order to achieve the necessary standard of airworthiness, such multiplication shall be so electrically and mechanically discrete that the probability of any failure will not result in a dangerous condition.

6.2.2 Cables for different types of duty (e.g. general services DC, general services AC, radio navigation) shall be so installed as to meet the electrical and magnetic interference requirements of **Q6–12**, 13 and this Chapter. Such cables shall also be so installed as to avoid the risk of:–

confusion during maintenance or repair,

electrical contact, or

dangerous electro-magnetic coupling.

6.2.3 Electrical connections shall be so arranged as to limit the possibility of cross connections during servicing and maintenance. Where such cross connections could result in a dangerous condition means shall be provided to minimise such an occurrence.

6.2.4 Cables shall be so routed as to minimise the risk in the event of an over-current fault or local heating or arcing, combined with the failure to operate of the protecting device.

6.3 **Earthing Arrangements** (see also **Q6–12**, 6)

6.3.1 The earthing arrangements shall comply with the requirements of **Q4–6**, Electrical Bonding and Lightning Discharge Protection.

6.3.2 When an earthed system is used the earth path shall be electrically continuous and the resistance between any two points in the earth path shall remain substantially constant. The earth path shall be adequate for the conduction of any current, including possible fault currents, which it may be necessary to transmit.

6.3.3 The failure of any single earth connection shall not result in a dangerous condition.

6.3.4 The requirements of **Q6–12**, 6.3 shall apply insofar as they are appropriate to systems and equipment.

6.3.5 Hazardous damage to Primary Structure of the airship including the gondola shall be unlikely to result from the failure or corrosion of any earth connection.

6.3.6 Where a system using voltages of greater than 50v RMS is employed, all domestic equipment (e.g. cooking appliances, refrigerators) shall be provided with suitable earth terminals to which non-current-carrying metal parts of the appliances shall be effectively bonded and which shall themselves be effectively connected to the gondola structure or earth bonding system as appropriate.

6.4 **Precautions against Mechanical Damage** (see also 7.1)

6.4.1 Systems and equipment shall be installed so that, under normal conditions, they will not be exposed to the risk of mechanical damage.

6.4.2 Exposed live parts of systems and equipment shall be so mechanically protected that short circuits and earth faults are unlikely to occur.

6.5 **Precautions against Deterioration**

6.5.1 Precaution shall be taken to minimise deterioration and the possibility of failure of equipment as a result of conditions encountered in service. Equipment shall be suitable for the environmental conditions applied to them (which shall be specified by the airship constructor) and shall, so far as practicable, be installed in positions protected from the weather. Precautions shall be taken to ensure that any fluid in vapour, mist or liquid form likely to be encountered in the position in which the equipment is installed, has no dangerously adverse effect.

6.5.2 Particular attention shall be paid to the installation of electrical equipment relative to the position of the airship water system, galleys, toilets, doors and openable windows. Protection shall be applied against water ingress, leakage and spillage where necessary.

6.5.3 Equipment shall be so installed and located that it is not subject to dangerous deterioration due to heat effects including hot air, under both normal and fault conditions.

6.5.4 The specification referred to in 6.1 shall include requirements for all the environmental and installation conditions likely to be met on the airship.

6.5.5 Precautions taken against deterioration shall be consistent with **Q4–1**, 10.

6.5.6 All electrical connections liable to vibration or contamination by fluids shall be of such a nature that the vibration or contamination does not cause dangerous deterioration of the installation, assuming that regular inspections are made to an agreed maintenance schedule.

6.6 **Precautions against Fire Explosion**

6.6.1 Electrical equipment shall be so designed and installed that under the normal or emergency operating conditions for which the airship and its systems are certificated, they will not create a fire hazard.

6.6.2 Electrical equipment in regions immediately adjacent to firewalls shall be of such materials and at such a distance from the firewall, that they will not suffer damage that could hazard the airship if the surface of the firewall adjacent to the fire is heated to 1100°C for 15 minutes.

NOTE: The requirements of **Q5–8** may make it necessary for electrical equipment to be made Fire-resistant or Fireproof as appropriate and tests made to demonstrate these qualities.

6.6.3 All electrical equipment including cables and their accessories shall, as far as is practicable, be constructed of materials which do not support combustion and which meet the relevant requirements of CAA Specification No.8 'Flame Resistance Testing for Aircraft Interior Materials'. Other materials shall be so applied and/or protected that the risk of fire is not increased by their use. (See also **Q4–3**, 6.)

NOTE: In cases where air is blown through equipment the danger of fire may be increased because of the increased rate of combustion and the length of the flame. Particular care should be taken in the choice of materials for such applications.

6.6.4 Electrical equipment shall be so constructed and/or installed that in the event of failure, no hazardous quantities of toxic or noxious products (e.g. smoke) will be distributed in the airship gondola.

6.6.5 Precautions shall be taken to prevent any Flammable material from coming into contact with any portion of electrical equipment which may attain a temperature exceeding 200°C under either normal or fault conditions.

6.6.6 Electrical equipment, which may come into contact with Flammable vapours shall be so designed and installed as to minimise the risk of the vapours igniting and exploding under both normal and fault conditions.

NOTE: An acceptable method of meeting this requirement is to comply with the appropriate explosion proof categories given in British Standard 3G100, Part 2, Section 3, Sub-section 3.5, or RTCA D0 160A/EUROCAE ED-14B Section 9 as applicable to the various environments defined.

6.6.7 Electrical equipment and cables shall be installed so that the probability of fire, due to the presence of oxygen, under both normal and fault conditions in either the oxygen or the electrical equipment is Extremely Improbable.

6.7 **Precautions against Injury**

6.7.1 **Electric Shock.** The electrical system shall be so designed as to minimise the risk of electric shock to crew, passengers and servicing personnel, and also to maintenance personnel using normal precautions. In particular, the requirements of (a), (b) and (c) shall be met.

(a) All equipment likely to need attention during its operation shall be designed and installed so that attention can be given without risk of electric shock (e.g. the replacement of lighting equipment; the plugging in of galley and other equipment).

(b) At junction and distribution points adequate separation shall be made between connection of different (nominal) system voltages. In areas where there may be a hazard during maintenance, panels, etc, carrying voltages of above 100v DC or 50V AC RMS shall be marked with the voltage.

(c) Where socket outlets are provided for passenger use (e.g. for electric razors), these shall be labelled as to use and with the output voltage or voltages and where the output voltage exceeds 100v DC or 50v AC RMS, then the output shall be electrically isolated from the gondola structure.

6.7.2 **Burns**

(a) The temperature rise of any item which has to be handled during normal operation by the flight crew shall not be such as to cause injury to the crew member or dangerous inadvertent movement.

NOTE: A temperature rise in the order of 40°C for items made from a poor thermal conductor, or 30°C for items made of metal, should be the objective.

(b) For other equipment (excluding the heating surfaces of properly installed cooking apparatus) mounted in parts of the gondola normally accessible to passengers or crew, or which may come into contact with objects such as clothing or paper, the surface temperature shall not exceed 100°C, at the maximum ambient temperature.

NOTE: The provision of guards around hot surfaces is an acceptable method of complying with this requirement.

6.8 **Electrical and Magnetic Interference** (see also **Q6–12**, 13)

6.8.1 **General.** All electrical systems and equipment shall be so designed and installed as to avoid hazardous conducted or radiated interference with the operation of other systems and equipment, and so that they will not be susceptible to such electrical and magnetic interference as may exist in the airship.

6.8.2 **Avoidance of Interference with the Compass** (see **Q6–13**, App. No. 2)

(a) Electrical cables and equipment shall be so installed as to comply with the requirements of **Q6–1**, 6.

(b) To assist the airship designer in complying with 6.8.2(a) the designer of electrical equipment shall determine and declare the Compass Safe-Distance for each item of equipment when required by the airship constructor. The method of measurement of Compass Safe-Distance shall be defined in the specification required in 6.1.

6.8.3 **Avoidance of Interference with Radio Communication and Navigation Systems**

(a) Disturbances affecting radio communication and navigation, whether by radiation or conduction, shall be reduced to a safe level of interference.

(b) The airship constructor shall include in the specification required in 6.1, a definition of acceptable tolerances of radio interference including audio-interference, and where appropriate, electrical equipment shall be tested for compliance with this.

(c) The airship manufacturer shall make tests in the airship to determine whether radio interference is reduced to a level compatible with safety and ease of communication.

NOTE: Where the interference occurs in bursts, it may, under certain circumstances be acceptable. The acceptability of such bursts of interference will depend upon the equipment affected and the level, length and frequency of the interference.

6.8.4 **Avoidance of Interference with other Systems**

(a) Electrical or magnetic interference present in the airship shall not produce dangerous conditions under conditions likely to be foreseen.

(b) The types of interference to be considered shall include the following:–

(i) Conducted and radiated interference caused by noise generation by equipment connected to the busbar.

(ii) Coupling between electrical cables or between cables and aerials or aerial feeders.

(iii) The malfunctioning of electrical and radio equipment.

(iv) Parasitic currents and voltages in the electrical distribution system, including the effects of lightning currents or static discharges.

(v) Different frequencies between generating or other systems.

(vi) Transient spikes on electrical power supplies.

(vii) Interference from external transmitters on critical systems.

(c) The airship constructor shall ensure that the specification required in 6.1 contains a definition of interfering voltage characteristics and frequencies which equipment and systems shall be able to withstand without hazard. Where appropriate, equipment and systems shall be tested to ensure compliance with this specification.

(d) Tests shall be made to assess the interference likely to be present in the airship (see 6.10).

6.8.5 **Lightning and Static Electricity.** All practical steps shall be taken to minimise the hazardous effects of a lightning discharge through, or static discharges from, the airship envelope including the gondola (see **Q4–6**).

NOTE: Magnetic effects should be considered as well as electrical ones.

6.9 **Crash Fire Precautions**

6.9.1 Arrangements shall be made so that in the event of a crash, such electrical circuits as are likely to cause ignition of fuel, including that spilt because of the crash, can be isolated quickly. The arrangements shall be such as to preclude inadvertent operation.

6.9.2 Such circuits as are required during or after the crash shall be left connected and shall be so protected that the risk of their causing a fire under these conditions is minimised.

6.9.3 Main power cables (including generator cables) in the gondola shall be designed to allow a reasonable degree of deformation and stretching without failure and shall either be isolated from Flammable fluids or be shrouded by electrically insulated flexible conduit or equivalent, which is in addition to the normal cable insulation.

6.10 **Tests on Electrical Systems and Equipment** (see also **Q6–12**, 15). Tests shall be carried out as appropriate, on systems and equipment to determine compliance with this Chapter. These tests shall include the following:–

6.10.1 Bench tests on systems shall be carried out, as appropriate:–

(a) to establish compliance with the specification for the system and to confirm that the characteristics of the individual items forming the systems are correctly related to each other and the duty which the system has to perform,

(b) to provide information for checking the safety of the system,

(c) to complete sufficient endurance testing to establish confidence in the airworthiness of the system,

(d) to provide proof of the effectiveness of fault protection systems.

6.10.2 Group tests on the airship or a representative ground rig shall be carried out, as appropriate:–

(a) to establish as far as is practicable the satisfactory performance of all electrical systems and circuits having airworthiness significance when operating together as they would in flight, and to confirm that the characteristics of the individual systems are correctly related to other systems interconnected with them,

(b) to assess the likelihood and extent of electrical and magnetic interference between systems,

(c) to provide information for checking the safety of the system,

(d) to assess crew drills including emergency procedures,

(e) to investigate difficulties revealed by flight testing.

6.10.3 The test rig shall be representative as far as is practicable of the electrical system in the airship.

NOTE: The wiring should be made to airship drawings and the equipment used should be to the same specification as that fitted to the airship. The cable, looms and ducting should be representative of those in the airship.

6.10.4 Where the conditions of flight have not been adequately simulated in the preceding tests, tests under prescribed conditions of flight shall be made on test airships, to confirm the suitability of systems.

6.10.5 Such tests shall be carried out on series airships as are necessary to confirm the correct functioning of electrical systems and equipment.

(a) These tests shall be in accordance with schedules prepared by the airship constructor.

(b) Suitable instrumentation shall be provided to record the parameters required by the test schedule.

(c) The test schedule shall include the checking of emergency procedures.

7 PARTICULAR REQUIREMENTS FOR THE INSTALLATION OF SYSTEMS AND EQUIPMENT

7.1 Cables and Associated Fittings and Equipment (see also **Q6–13** App. No. 3)

7.1.1 **Types of Cable.** The conductor(s), insulation and protective coverings, if any, of electrical cables shall be so designed and constructed that the cables can perform their respective functions satisfactorily under the conditions to which they will be subjected in service. These shall include the following:–

(a) Cables shall be suitable for the voltages which will be applied to them under all the conditions of operation in flight and on the ground.

(b) The current rating of the cables shall be such that when the cables are installed and carrying the most onerous loads in the most adverse ambient temperatures probable, the temperatures attained by the conductors will not cause damage to, or deterioration of, the cables or the airship or injury to the occupants of the airship. Due account shall be taken of the maximum current ratings for the cables under the appropriate installational conditions including any heat generated by the adjacent equipment or systems.

NOTE: Information on the ratings of standard cables for general services wiring is given in the appropriate cable specification.

(c) Cables shall be sufficiently robust to withstand, without risk of failure, all movement, flexing, vibration, abrasion and other mechanical hazards to which they may be reasonably subjected when installed in the airship and shall be so supported as to prevent mechanical damage.

(d) The circuit protection system and the cables used shall be such that the cables meet **Q6–13**, 5.1 under both continuous and temporary over-load conditions.

(e) Cables shall be so designed or installed as to be Fire-resistant or Fireproof where compliance with the requirements of **Q5–8** makes this necessary.

NOTE: The requirements of (c), (d) and (e) may be met by providing suitable mechanical protection for the cables. For example, cables not in themselves completely Fire-resistant may be enclosed in conduits or installed in protected places provided such procedure can be shown to be adequate.

7.1.2 **Identification.** In order to facilitate the checking of cable runs and the testing of equipment and circuits, adequate means of identification shall be provided for cable runs, connectors and terminals. The means employed shall be such as to ensure that the identification is preserved in service.

7.1.3 **Accessibility of Cables and Connections.** The disposition of cables and connections shall be such, so far as is practicable as to enable scheduled inspections and/or tests to be made without undue disturbance to the installation.

7.1.4 **Damage to Cables.** The risk of mechanical damage, and of damage by fluids and vapours to cables, shall be minimised. Where practicable, cables shall be so routed as to avoid such risks; otherwise adequate protection shall be provided for the cables.

7.2 Switch Indication and Warning Lights

7.2.1 Manually-operated switches shall be so installed and labelled that no dangerous ambiguity can arise regarding the state of a circuit.

7.2.2 The use of red warning lights on the flight deck shall be confined to the indication of conditions demanding immediate attention unless otherwise required elsewhere in this Section. The dimming of red warning lights shall not be provided for unless specific approval has been obtained, and in any such cases all practical precautions shall be taken to ensure that these are not left in the dimmed condition.

7.2.3 Where light signals are used as continuous indicators they shall not interfere with the vision of the flight crew.

7.3 **Galleys and Domestic Equipment** (see also **Q6–13** App. No. 4)

7.3.1 Domestic appliances shall be so designed and installed that, in the event of failures of the electrical supply or control system or faults in the equipment itself, no hazard shall occur to either the airship or to passengers or crew.

NOTE: When considering failure cases, the effect of the loss of water supply to a water heater with the electrical supply maintained should be taken into account.

7.3.2 The installation of galleys and cooking appliances shall be such as to minimize the risk of a fire.

NOTE: The design of the installation should be such as to facilitate cleaning and to limit the accumulation of extraneous substances which may constitute a fire risk.

7.3.3 Live heating elements shall be protected against contact with cooking utensils or equipment, except where it can be demonstrated that such contact will not constitute a danger.

7.3.4 Adequately insulated means of operating switches and switchgear shall be provided, particularly where such switches may be operated by crew or passengers with wet hands.

7.3.5 The main galley structure shall be bonded to the gondola structure or earth return system as appropriate.

7.3.6 Where electric toilet flush motors are installed, they must be fitted with a suitable thermal protection device to prevent them overheating such as to create a fire or smoke hazard due to the failure of the control circuit, control circuit components, motor, or pump unless it can be shown that:–

(a) Any failure of the control circuit or its associated components which causes the motor to run continuously will not create an overheat condition such as to create a fire or smoke hazard or,

(b) Failures within the motor or pump which could result in such an overheat condition will cause the supply circuit protective device to operate.

APPENDIX NO. 1 TO CHAPTER Q6–13

INSTALLATION

1 **INTRODUCTION** This appendix amplifies the requirements of **Q6–13**, 6.2 which deals with the segregation of services and the prevention of inadvertent operation.

2 **SEGREGATION OF SERVICES AND PREVENTION OF INADVERTENT OPERATION** (see **Q6–13**, 6.2)

2.1 **Power-unit Controls.** The implications of **Q6–13**, 6.2, together with **Q5–1**, entail careful attention to detail in the installation of electrical wiring and equipment.

2.1.1 **Cases to be Considered.** The following cases which have occurred in the past are typical of the possible faults to be borne in mind in new designs from the point of view of double failures and of inadvertent operation.

(a) Cables rubbing together in loose looms.

(b) Broken connections falling on other terminal blocks, and faults between adjacent connections on terminal blocks, or in plugs and sockets.

(c) The shearing of a shaft in one rotary machine in a synchronising system causing feathering of all propellers.

(d) The failure of one pitch control circuit affecting pitch control on all other propellers.

(e) A fire in one Power-unit affecting the controls to another.

(f) Feedback from a faulty earth connection affecting more than one Power-unit.

(g) A bird strike on the leading edge, inboard of an inner Power-unit affecting controls to more than one Power-unit.

(h) Damage to components, systems and cables caused by uncontained debris following a Power-unit failure.

2.1.2 **Loss or Malfunctioning of More than One Power-unit**

(a) It is not acceptable that the failure of one item of equipment should cause the loss of more than one Power-unit (e.g. an electrically operated tank cock which could fail to open during flight would constitute such a hazard), nor that loss or malfunctioning of more than one Power-unit should result from a single failure. (See **Q5–1**.) The most likely causes of the latter occurrences would be:–

(i) Cross connections where equipment and connections for more than one Power-unit are housed in a common compartment or taken through the same plugs and sockets and cable looms, or

(ii) where it is possible to make cross connections during servicing (e.g. by inter-changing plugs and sockets), or

(iii) where common earth connections are used (see **Q6–13**, 6.3).

(b) In general, therefore, equipment controlling separate Power-units should be housed in separate compartments and any cross connections between compartments should be kept to a minimum and arranged so that no possible single failure to any of them can dangerously affect more than one Power-unit.

NOTE: In the case of controls for an airship having two Power-units a control box for each Power-unit or a single control box divided mechanically by a barrier of earthed metal or insulating material would be acceptable.

(c) The arrangement of external connections to the control boxes are such that there is no danger of confusion between services to different Power-units.

(d) Major controls to more than one Power-unit should not be taken through the same plug and socket.

(e) Cables to individual Power-units should be so grouped and routed that failures or accidental damage producing inter-connection between circuits of Power-units, or failures producing loss of vital controls to more than one Power-unit are not possible.

2.2 **Other Controls and Systems Affecting Airworthiness.** In general, the same principles can be applied as for Power-unit controls, that is:–

(a) Precautions should be taken to prevent confusion during repair or maintenance between circuits for different controls or systems.

(b) Where a control or system is duplicated for airworthiness reasons the two circuits should be so mechanically and electrically separated that the probability of a single failure causing both controls or systems to fail is minimised.

(c) No single failure should cause operation of any control or system in such a manner as to endanger the airship.

APPENDIX NO. 2 TO CHAPTER Q6–13

INTERFERENCE

1 **INTRODUCTION** This Appendix amplifies the requirements of **Q6–13**, 6.8.2, which refer to magnetic interference with compasses which are actuated by the horizontal component of the earth's magnetic field.

2 **AVOIDANCE OF MAGNETIC INTERFERENCE WITH THE COMPASS**

2.1 It is possible for interfering magnetic fields to be set up in the airship gondola by electrical apparatus, by electric currents in the wiring or gondola structure, and by magnetic material.

2.2 In the case of electric currents, it is the steady or continuous component which produces the field interfering most with compasses. Interrupted DC should be regarded as continuous current in this respect. Magnetic fields due to alternating currents do not generally interfere with compasses unless of a frequency below 10 H_Z or of a magnitude sufficient to modify the magnetic characteristics of adjacent material.

2.3 Magnetic interference with the compass may be avoided by reducing the magnitude of the interfering fields at the compass. This may be done by:–

(a) The removal of each source of magnetic interference to or beyond the safe-distance from the compass;

(b) The reduction, at source, of the interfering field.

2.4 **Cases to be Considered.** The following cases (some of which have occurred a number of times) are typical examples of possible interference sources:–

(a) Local earthing of navigation lights with a single feeder cable being run in close proximity to a remote compass detector unit.

(b) Installation of DC rotating machines in the nose of an aeroplane with local earthing for the negative lines.

(c) Single pole wiring for instrument lights.

(d) Segregation of supply and return wiring to equipment in cockpit area.

(e) Installation of busbars and routing of heavy duty feeders adjacent to the cockpit in such a manner as to form an electrical loop.

(f) Electrically heated windscreens, and associated power supplies.

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APPENDIX NO. 3 TO CHAPTER Q6–13

CABLES AND CABLE INSTALLATIONS

1 **INTRODUCTION** This Appendix provides guidance material on the installation and termination of cables to meet the requirements of Chapter **Q6–13**, 7.1.

2 **INSTALLATION**

2.1 Cables should not be so sharply bent as to cause risk of damage or deterioration.

2.2 **Preparation of Conduits, etc.** The end of all conduits, tubes and ducts which carry electrical cables should be so prepared or bushed with insulating materials at the points of entry or possible contact, as to reduce to a minimum the risk of damage in service and when drawing in the cable.

2.3 Wherever possible and to assist drainage, cables connected to equipment should be arranged to run downward from the equipment.

NOTE: This may necessitate the incorporation of a loop immediately before entering the equipment.

2.4 Where conduits, tubes or ducts are used, they should be so installed that any moisture accumulating in them will drain safely away; in addition, the cables used in them should be capable of withstanding such moisture as may nevertheless be encountered.

2.5 The methods used for the connection of cables to equipment or to each other should ensure that the mechanical strength, electrical insulation and protection from damage are adequate. The methods should be of a type established to be reliable under the appropriate conditions, by test and/or experience.

2.6 The installation should be such that it is not necessary to make soldered joints within the gondola, except where a control specification is agreed which adequately controls both the effectiveness and safety of the operation.

3 **TERMINATIONS** Where aluminium conductors are used, particular care should be taken in the choice and quality control of the cable terminations. Rigorous attention to these aspects should be made to limit the possibilities of in-service deterioration.

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APPENDIX NO. 4 TO CHAPTER Q6–13

DESIGN AND INSTALLATION OF GALLEYS AND DOMESTIC EQUIPMENT

1 **INTRODUCTION** This Appendix provides guidance material on the installation of galleys and other domestic equipment to meet the requirements of **Q6–13**, 7.3.

2 OVENS AND HEATING DEVICES

2.1 The design and installation of heated domestic appliances should be such that no single failure (e.g. welded thermostat or contactor) can result in dangerous uncontrolled heating and consequent risk of fire or smoke or injury to cabin staff or passengers.

2.1.1 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 power cannot be re-set in flight.

2.1.2 The design and installation of microwave ovens should be such that no hazard could be caused to the occupants or the equipment or the airship under either normal operation or single failure conditions. (See British Standard 5175 paragraph 32 for guidance on microwave leakage.)

3 HEATED LIQUID CONTAINERS

3.1 Heated liquid containers, e.g. water boilers, coffee makers, should, in addition to overheat protection, be provided with an effective means to relieve overpressure.

3.2 Where pressure vessels are utilised in such equipment the design of the unit and its installation should be such that there is no possibility of any fault or combination of faults which will result in explosion.

NOTE: Due account should be taken of the possible effects of lime scale deposit both in the design and maintenance procedures of water heating equipment.

4 **CONTAMINATION FIRE AND SMOKE** In addition to the requirements of **Q6–13**, 6.6.5 and 7.3.2, the following precautions should be taken:–

(a) Electrical/electronic components should be so located as to minimise their exposure to cooking steam or vapour, cooking or waste residues and water system leakage.

(b) Measures should be taken to limit the possibility of use of heated areas for storage of, or contact with, potentially flammable or smoke producing articles.

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SUB-SECTION Q7 – OPERATING LIMITATIONS AND INFORMATION

CHAPTER Q7–1

GENERAL

1 **INTRODUCTION** A certain amount of Information* is derived in the course of showing compliance with the Requirements. The establishment of this and other information and its presentation to the flight crew in the form of markings, placards and the Flight Manual is the subject of this Sub-section Q7.

NOTES: (1) The operating limitations prescribed in **Q7–2** are those which are within the competence of the flight crew to observe and there is a legal obligation on the flight crew to observe them.

(2) There are operating limitations, however, which are not within the competence of the flight crew to observe, the observance of which is the responsibility of the operator of the Airship. Such limitations are usually those relating to the maintenance of the Airship (e.g. a limitation, in terms of total flying hours, placed on the life of a component for fatigue reasons) and are either contained in the Approved Maintenance Schedule for the Airship or are promulgated by the CAA as Mandatory Modifications or Inspections.

2 **GENERAL** In addition to the Information prescribed in this Sub-section, the Applicant shall provide such additional information as is considered necessary; in particular that associated with unusual design, operating or handling features.

NOTES: (1) Details of Information which has to be established are contained in **Q7–2**.

(2) General requirements applicable to markings and placards (e.g. warning notices) are prescribed in **Q7–3**. **Q7–3** also prescribes markings not necessarily covered elsewhere in the requirements, and for convenience, lists and cross references all mandatory Airship markings other than those necessary for compliance with the Air Navigation Order.

(3) Details of the Information which normally has to be included in the Flight Manual or appropriate document are contained in **Q7–5**.

(4) Administrative procedures for the publication of Flight Manuals are prescribed in Section A/B, Chapter **A7–2/B7–2**.

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*For the purposes of this Sub-section 'Information' includes such things as data, technique, procedures, limitations, instructions, warning notices and the like.

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SUB-SECTION Q7 – OPERATING LIMITATIONS AND INFORMATION

CHAPTER Q7–2

OPERATING INFORMATION

1 **INTRODUCTION** This Chapter contains requirements for the establishment of Information*, mostly in the form of operating limitations and procedures.

NOTE: The method of presentation of this Information is the subject of the requirements of **Q7–3** and **Q7–5**.

2 **AIR SPEED**

2.1 **General.** The air-speeds detailed in this paragraph 2 shall be established, and the values shall be so chosen as to comply with 2.2. Any other air-speeds which are necessary shall also be considered.

2.1.1 The Applicant shall ensure that the value of each airspeed declared is consistent with compliance with all airworthiness limitations established for the Airship. Air-speeds shall be stated in terms of Indicated Air Speed (IAS); the values being chosen so that in no case, assuming each instrument to have zero instrument error, will the Design Equivalent Air Speed (EAS) be exceeded.

2.2 **Demonstrated Flight Diving Speed, V_{DF}.** V_{DF} is the maximum speed which can be achieved when the airship is dived, in the condition of Maximum Static Heaviness, with Maximum Take-off Power on all engines at a nose-down angle of pitch such that the maximum rate of descent, established in accordance with **Q2–6**, 3.1 is attained.

2.3 **Maximum Operating Speed, V_{MO}.** The Maximum Operating Speed, V_{MO} shall not exceed the lesser of V_{DF} minus 5 knots or the Design Cruising Speed, V_C minus 5 knots.

2.4 **Rough Air Speed, V_{RA}.** The recommended speed for flight in rough air shall be not less than V_{Bmin} (see **Q3–2**, 2.3) and shall not exceed V_B.

3 **WEIGHT AND BALANCE** The weight and balance limitations prescribed in this paragraph 3 shall be established and shall be so chosen as to comply with 3.1 to 3.3 as appropriate. Any other weight and balance limitations which are necessary shall also be established.

3.1 **Maximum Weight.** The Maximum Weight shall be the weight established in accordance with **Q1–2**, 2.2.

3.2 **Cargo and Baggage Compartment Loading.** The maximum total load and the maximum load per unit area of cargo and baggage compartments shall not exceed those at which compliance with **Q4–3**, 2 has been established.

3.3 **Centre-of-Gravity Range.** The centre-of-gravity range shall be a range no greater than that at which compliance with the Requirements has been established.

*'Information' includes such things as data, technique procedures, limitations, instructions, warning notices and the like.

4 **POWERPLANT** The Powerplant limitations and data prescribed in this paragraph 4 shall be established. Any other Powerplant limitations which are necessary shall also be established. The Powerplant limitations shall be such that any limitations declared as a condition of the type certification of the engine, propeller or Powerplant accessories will not be exceeded.

4.1 **Fuel and Oil.** The established information shall include the following:–

(a) The minimum fuel grades, together with any associated temperature limitations.

(b) The approved oil specifications, brands or types, together with any associated temperature limitations.

4.2 **Engine Starting.** The established information shall include the following:–

(a) Limitations (e.g. minimum temperature, oil pressure) concerning the starting of an engine on the ground or restarting an engine in flight.

(b) Limitations to be observed following an unsuccessful attempt to start an engine on the ground or to restart an engine in flight.

4.3 **Oil System.** The established information shall include the following limitations:–

(a) The maximum permissible oil temperatures.

(b) The minimum permissible oil pressure and the conditions of engine rotational speed and oil temperature with which it is associated.

(c) The maximum rate of oil consumption.

4.4 **Engine Power**

4.4.1 The established information shall include the following which shall be expressed in the appropriate terms of 4.4.2:–

(a) Maximum Take-off Power limitations together with any restricted period for use.

(b) Maximum Continuous Power limitations.

4.4.2 (a) Engine rotational speeds.

(b) Induction manifold pressure.

(c) Cylinder head temperature.

(d) Oil temperature.

(e) Oil pressure.

4.5 **Miscellaneous Powerplant Limitations.** The established information shall include the following:–

(a) Limitations on the use of thrust vectoring.

(b) Limitations associated with weak mixture operation.

(c) Limitations on the use of a propeller at a pitch less than that permitted for flight.

(d) Limitations on the use of Powerplant ice protection systems.

5 **ENVELOPE** The envelope limitations prescribed in this paragraph 5 shall be established. Any other envelope limitations that are necessary shall also be established.

5.1 **Envelope and Ballonet Pressures.** The established information shall include the following:–

(a) The maximum permissible pressure in the envelope and Ballonets.

(b) The maximum operating pressures in the envelope and Ballonets.

(c) The minimum operating pressure in the envelope.

5.2 **Maximum Rates of Climb and Descent.** The maximum rates of climb and descent established in accordance with **Q2–6**, 3 where these are limited by the maximum or minimum operating pressure in the envelope or Ballonets.

5.3 A statement of the type of gas approved for filling the envelope.

6 **MISCELLANEOUS** The information prescribed in this paragraph 6 shall be established. Any other information which is necessary shall also be established, in particular that associated with unusual design, operating or handling features:–

(a) Whether or not the Airship can be used for the types of operation described in (i) to (iii).

(i) IFR by day or by night.

(ii) At a Flight Level* greater than 100.

(iii) In icing conditions.

(b) The maximum operating altitude, which shall be not greater than the maximum altitude at which compliance with the Requirements has been established.

(c) The maximum and, if appropriate, the minimum air temperature in which operation is permissible, together with information on any special features necessary for operation at any particular temperature level.

(d) The maximum crosswind component established in compliance with **Q2–3**, 4.

(e) The minimum flight crew for safe operation under VFR taking into account the fields of view obtained, and the accessibility and ease of operation of the essential controls, by the appropriate member of the flight crew.

(f) The maximum permissible surface wind speed for operation of the Airship established in accordance with **Q2–6**, 5.

(g) **Mooring.** The established information shall include the recommended maximum wind speed in which the Airship may be moored, to a mast or to any alternative mooring point.

(h) The maximum permissible angles of nose-up and nose-down pitch.

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*Defined in the ANO as one of a series of levels of equal atmospheric pressure, separated by notified intervals and each expressed as the number of hundreds of feet which would be indicated at the level on a pressure altimeter calibrated in accordance with the International Standards Atmosphere an set to 1013·2 millibars.

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SUB-SECTION Q7 – OPERATING LIMITATIONS AND INFORMATION

CHAPTER Q7–3

MARKINGS AND PLACARDS

1 GENERAL

1.1 The markings and placards prescribed in this Chapter shall be provided, together with any other markings and placards which are necessary; in particular those associated with unusual design, operating or handling features.

1.2 Markings and placards shall be such that they are not easily removed, disfigured or erased.

NOTE: It is recommended that, wherever possible, markings and placards should be in the form of engraved metal or plastics labels.

1.3 Markings and placards shall be displayed in a conspicuous place, as close to the related feature as is practical. Placards which are not related to a particular feature or which are not required by this Chapter shall be positioned such that they will not reduce the ability of the pilot to read instruments.

1.4 Information conveyed by markings and placards shall be presented as briefly as possible and with maximum clarity. Terminology shall, as far as is possible, be standardised.

2 INSTRUMENT MARKINGS

2.1 General

2.1.1 Where markings are placed on the transparent cover of the dial of an instrument, provision shall be made to maintain the correct alignment of the markings with the instrument dial.

2.1.2 Each marking shall be of sufficient boldness to be clearly visible to the flight crew.

2.1.3 When the limitations to be presented are of such complexity that the significance of markings is unlikely to be quickly apparent to the flight crew, the limitations may, with the agreement of the CAA, be presented in the form of placards.

2.2 **Air Speed Indicators.** Each air speed indicator shall be marked with a red radial line at V_{MO} in terms of IAS. If this limiting speed varies with altitude, the marking shall correspond to the value appropriate to sea-level.

2.3 Powerplant Instruments

2.3.1 Each mandatory Powerplant instrument shall be marked in accordance with this paragraph 2.3.1. The markings to be applied are:–

(a) A red radial line at the maximum, and if applicable, the minimum limitation.

(b) A yellow arc for each cautionary or take-off range, which shall not extend beyond any radial line provided in accordance with (a).

(c) A green arc for each normal operating range, which shall not extend beyond any radial line provided in accordance with (a) nor overlap any arc provided in accordance with (b).

(d) A red arc for each engine speed range that is critical (e.g. as a result of excessive vibration).

2.3.2 **Fuel Quantity Indicators.** If the unusable fuel quantity, established in accordance with **Q5–2**, 8, for the tank to which an indicator relates is greater than 5% of the tank capacity and not less than 4·5 litres (1 gal), a red arc shall be marked on the indicator, extending from the calibrated zero reading to the lowest reading obtainable in level flight.

2.4 **Envelope and Ballonet Pressure Indicators.** Each envelope and Ballonet pressure indicator shall be marked in accordance with this paragraph 2.4. The markings to be applied are:–

(a) A red line at the maximum permissible envelope and Ballonet pressures.

(b) A yellow band between the maximum permissible and the maximum operating envelope and Ballonet pressures.

(c) A green band between the minimum and maximum operating envelope and Ballonet pressures.

(d) A red line at the minimum operating envelope pressure.

2.5 **Pitch Attitude Indicator.** Each pitch attitude indicator shall be marked with red lines at the maximum permissible angles of nose-up and nose-down pitch.

3 CONTROL MARKINGS

3.1 **General.** Except for primary flight controls, a marking shall be provided for each normal and emergency operating control which is intended for use by the flight crew so as to indicate its function and, except for simple push-button switches, its method of operation. Emergency operating controls shall be coloured red.

3.2 **Powerplant Fuel Controls**

3.2.1 A marking shall be provided for operating controls for fuel tank selection to indicate the position corresponding with each tank and any cross-feed positions.

3.2.2 Where more than one fuel tank is provided, and if safe operation depends upon the use of tanks in a specific sequence, a marking shall be provided for the operating controls for fuel tank selection to indicate to the flight crew the order in which the tanks are to be used.

3.2.3 A marking shall be provided for operating controls for engine selection to indicate the position corresponding to each engine.

3.2.4 The usable capacity of each fuel tank shall be indicated adjacent to the operating control for fuel tank selection.

3.3 **Emergency Deflation Control.** A placard shall be provided adjacent to the emergency deflation control to prohibit operation of the control in flight.

4 MISCELLANEOUS MARKINGS

4.1 A marking shall be provided to identify the datum to which the centre-of-gravity range, established in accordance with **Q7–2**, 3.3, is related, unless some well-defined feature of the Airship is used.

4.2 Markings shall be provided to enable the Airship to be levelled on the ground.

4.3 Operating controls for normal and emergency exits shall be marked to indicate their function. The markings for emergency exits shall be in red. (See also 5.3.)

4.4 The word 'fuel' the usable fuel capacity and the minimum fuel grade shall be marked on or near each fuel filler cap.

4.5 The word 'oil' and the total oil capacity shall be marked on or near each oil filler cap.

4.6 The type of gas approved for filling the envelope shall be marked adjacent to the gas filling point.

4.7 Safety equipment shall be marked as to its method of operation and suitable markings, visible to the occupants of the Airship, shall indicate the places where any such equipment is stowed.

5 PLACARDS

5.1 Loading

5.1.1 Placards shall be provided for each baggage and cargo compartment stating the loading limitations established in accordance with **Q7–2**, 3.2.

5.1.2 Placards shall be provided stating the loading limitations for each ballast location.

5.1.3 Where the weight which may be carried in a seat is less than 77 kg (170 lb), a placard stating this lesser weight shall be attached to the seat structure.

5.2 Operation of the Airship

5.2.1 A placard shall be provided stating the Airship shall be operated in accordance with the Approved Flight Manual.

5.2.2 A placard shall be provided stating:–

(a) the type of operation (e.g. VFR, IFR Day or Night) for which the Airship is approved to be used, drawing attention, where necessary, to the need for the required equipment to be installed for such operations, and

(b) the type of operation (e.g. flight in icing conditions) for which the Airship may not be used.

5.3 **Emergency Exits.** A placard shall be provided near each emergency exit indicating its purpose and method of operation. The lettering of the placard shall be red. (See also 4.3.)

5.4 **Magnetic Compass.** The card required in accordance with **Q6–1**, 6 shall be installed on or near the magnetic compass.

5.5 **Airspeed Indicator.** The placard required in accordance with **Q6–1**, 2.10 shall be installed adjacent to the airspeed indicator.

5.6 **Automatic-pilot Operation.** A placard shall be provided stating all the limitations regarding the use of the automatic-pilot established in accordance with **Q7–2**, 6.

5.7 **Smoking**

(a) If required by **Q4–3**, 6.1.3 a placard stating that smoking in the compartment is not permitted.

(b) A notice in each toilet stating that smoking is prohibited.

SUB-SECTION Q7 – OPERATING LIMITATIONS AND INFORMATION

CHAPTER Q7–5

FLIGHT MANUALS

1 **INTRODUCTION** This Chapter prescribes requirements for the layout and contents of Flight Manuals.

NOTE: Administrative procedures covering submission of data for approval are prescribed in Section A/B Chapter **A7–2/B7–2**.

2 **GENERAL** (see **Q7–5** App. No. 1, 1)

2.1 A Flight Manual, hereinafter referred to in this Chapter as 'the Manual', shall be supplied with each Airship and shall comply with the requirements of this Chapter. Where unusual design features, operating procedures or handling characteristics so warrant, the CAA may require data, additional to that prescribed by this Chapter, to be included in the Manual.

2.2 The Flight Manual shall be Approved by the CAA, and each page of the Manual shall indicate this, together with the date and issue of the page.

2.3 No material shall be included in the Manual if, beyond reasonable doubt, it can be assumed to be knowledge common to the flight crew who will be entitled by their licences to operate the Airship.

2.4 The Manual shall be provided with a protective cover. The binding shall be such that pages are unlikely to be inadvertently detached, and such that amended pages can be inserted (but see 2.7).

2.5 The method of reproduction adopted shall be such as to provide good quality text and graphs, with minimum distortion of graphs and minimum variability in legibility and contrast between pages.

2.6 **Contents.** The Manual shall be divided into Sections as follows:–

Section 1 – General
Section 2 – Limitations
Section 3 – Emergency Procedures
Section 4 – Normal Procedures
Section 5 – Performances
Section 6 – Supplements

2.7 **Amendments.** Provision shall be made for the incorporation of amendments. Amendments shall be effected by the provision of revised or additional approved pages. The amendment number shall be shown on each page affected by the amendment. Where the Manual consists of less than ten pages amendment may be made by a complete re-issue of the Manual.

2.8 **Units**

2.8.1 The following units shall be used in the Manual:–

(a) Horizontal distance – large . . . . n miles.
(b) Horizontal distance – small . . . . metres (m).

(c) Speed . . . . knots.
(d) Temperature . . . . degrees Celsius (°C).
(e) Vertical distance . . . . feet (ft).
(f) Weight . . . . kilograms (kg).

NOTES: (1) It is acceptable for additional units to be given (e.g. 100 m (328 ft) (see also 3(f)).

(2) See also **Q7–5** App. No. 1, 1.3.4.

2.8.2 In the cases of all parameters, including any additional to those detailed in 2.8.1, the units referred to in the Manual shall be the same as those marked on the appropriate instruments.

3 **SECTION 1 – GENERAL** This Section shall contain the items prescribed in (a) to (f).

(a) A front page which includes, or incorporates provision for, the following:–

(i) The official designation of the Airship.

NOTE: A type name will only be acceptable if this has also been used consistently in other official documents such as the Certificate of Airworthiness and Certificate of Registration.

(ii) Registration marks.

(iii) The constructor's serial number.

(iv) The name of the designing company, and (if different) the name of the constructor.

(v) The number and date of issue of the associated Certificate of Airworthiness.

(vi) The date of the initial approval of the Manual and the name of the Authority which approved it.

(vii) A statement as follows:–

'This Airship shall be operated in accordance with the limitations in Section 2 and any additional limitations in the Supplements contained in Section 6.'

(b) A Table of Contents.

(c) A description of the amendment system, together with amendment record sheets.

(d) A drawing giving three views of the general arrangement outline of the Airship, together with the principal dimensions, including height, length, envelope volume and the scale of the drawing.

(e) A graph showing the relationship of air temperature to pressure altitude in the ICAO International Standard Atmosphere, if reference is made in the Manual to this atmosphere.

(f) Conversion graphs or tables where additional units are given in accordance with 2.8.

4 **SECTION 2 – LIMITATIONS** (see **Q7–5** App. No. 2) This Section shall contain those items prescribed in (a) to (j) in the order given together with any other item which has been established as being a limitation in accordance with **Q7–2**. Quantitative limitations shall be expressed in such terms as can be checked by the flight crew during flight when using the available instrumentation,

and shall only cover situations over which the flight crew has control. If any unusual limitation is imposed, the reason for it shall be concisely stated.

NOTE: Legislation places a legal obligation on the flight crew to observe the limitations in the Manual.

(a) **Weights.** A statement of the following:

(i) Maximum Weight.

(ii) The maximum permissible Static Heaviness and Static Lightness.

(iii) Any additional restrictions on weight and/or buoyancy necessary in particular conditions to ensure compliance with the rate-of-climb requirements of **Q2–4**, 2.

(b) **Baggage and Freight Loading.** A statement of the maximum loads and intensity of load of all cargo and baggage compartments. If necessary the limitations may be shown on a diagram or graph.

NOTE: For these limitations only structural considerations need be taken into account. Balance considerations will be the subject of loading instructions provided in accordance with Section A Chapter **A5–1**.

(c) **Fuel System.** A statement of any limitations on the loading of fuel tanks, and on their use in flight.

(d) **Centre of Gravity.** A statement of the centre-of-gravity limits in terms of distance from a datum, together with a definition of that datum.

(e) **Powerplant**

(i) A statement of the engines and propellers to which the Manual relates.

(ii) A statement of the limitations for the Powerplant which have been established in accordance with **Q7–2**.

(iii) An explanation of the significance of any instrument colour markings provided in accordance with **Q7–3**.

(iv) Where the unusable fuel supply in any tank exceeds 5% of the tank capacity or 4·5 litres (1 gal), whichever is the greater, a statement to the effect that the fuel remaining in the tank, when the quantity indicator reads zero, cannot safely be used in flight.

(v) A statement of the effect on the unusable fuel quantity resulting from the failure of any booster pump.

(vi) A statement giving the conditions (configuration and flight attitudes) under which the full amount of usable fuel can be used.

(f) A statement of the Maximum Operating Speed limitation established in accordance with **Q7–2**.

(g) **Envelope.** A statement of the following:–

(i) The permissible envelope and Ballonet pressures established in accordance with **Q7–2**.

(ii) Any limitations relating to mooring established in accordance with **Q7–2**.

(h) **Miscellaneous**

(i) A statement of the Category or Categories in which the Airship is certificated.

(ii) A statement of the type of operation (e.g. VFR, IFR Day or Night) for which the Airship may be used, when suitably equipped, and for which it may not in any circumstances be used.

(iii) A statement of the number and composition of the minimum flight crew.

NOTE: Usually the minimum flight crew stated will be one pilot. When additional crew members are prescribed, these should be stated in terms of the flight crew licences which are available in the United Kingdom. All permissible combinations of licences should be given, e.g. 'the minimum crew is two pilots, or one pilot and one flight engineer'.

(iv) (See **Q7–5** App. No. 2, 1.) A statement of the maximum permissible number of occupants, together with a statement that children under the age of three years when carried in the arms of an adult need not be taken into account.

(v) A statement of any restrictions on smoking in the Airship.

(vi) A statement of the maximum air temperature in which operation is permissible;

a statement of any minimum air temperature limitation which has been established;

where the fitting of any device (such as a radiator blanking piece) is necessary for operation below certain air temperatures, a statement to that effect.

NOTE: The maximum air temperature cannot be greater than the maximum for which any performance information is scheduled.

(vii) A statement of the minimum height above terrain for the operation of the automatic-pilot together with any other limitation on its use.

(viii) A statement of the maximum permissible operating altitude.

(ix) A statement of the maximum cross-wind component for take-off and landing established in compliance with **Q2–3**, 5.

(x) A statement of the inscription on, and location of, each placard which is required to be displayed, together with an explanation of the significance of any instrument colour markings not covered by 4(e)(iii).

(xi) A statement of any limitations on the use of the systems in the Airship with particular reference to the electrical system and equipment.

(xii) A statement of the minimum ground handling crew established in compliance with **Q2–3**, 1.4.

(xiii) A statement of the maximum permissible angles of nose-up or nose-down pitch.

(xiv) A statement of the maximum permissible rates of climb and descent established in compliance with **Q2–6**, 3.

(xv) A statement of the maximum surface wind speed established in compliance with **Q2–6**, 5.

(xvi) A statement of the minimum quantity of ballast established in compliance with **Q6–3**, 2.

5 **SECTION 3 – EMERGENCY PROCEDURES** This Section shall contain those operating procedures for flight and system emergency conditions which are essential for the continued safe operation of the Airship. An emergency in this context is defined as a foreseeable but unusual situation in which the risk of a disaster can be substantially reduced by crew action. The procedures shall be presented as briefly as possible and with maximum clarity. References to air speed shall be made in terms of IAS. At least the items prescribed in (a) to (c) shall be included.

(a) For all Airships, the procedure for re-starting an engine in flight established in accordance with **Q5–1**, 2.4 or 2.5.

(b) Procedures for precautionary and emergency alighting, established in compliance with **Q2–6**, 7, including procedures for releasing ballast and valving gas, as necessary.

(c) Procedures, established in compliance with **Q4–3**, 4.5, for emergency evacuation.

6 **SECTION 4 – NORMAL PROCEDURES** (see **Q7–5** App. No. 3, 2)**.** This Section shall contain recommended procedures and information which are necessary for safety in relation to the handling of the Airship, its engines and its equipment. References to air speed shall be made in terms of IAS. At least the items prescribed in (a) to (c) shall be included.

(a) The procedures for determining the amount of Static Heaviness or Lightness, both on the ground prior to take-off and in flight.

(b) The procedures for ground handling and mooring, including information on the recommended maximum wind speed in which the Airship should be moored.

(c) A statement of the recommended Rough Air Speed, V_{RA}, established in accordance with **Q7–2**.

7 **SECTION 5 – PERFORMANCE**

7.1 **General**

7.1.1 The Performance Section of the Manual shall be presented in accordance with the requirements of this paragraph 7.

7.1.2 Reference to airspeeds shall, unless otherwise stated, be made in terms of IAS.

7.2 **Method of Scheduling Data.** The information shall be presented either in graphical or in tabular form with supporting text which should include an explanation of the use of the data and examples of typical calculations.

7.3 **Sub-division of the Section.** The information shall be presented in the following sequence:

General
Take-off Procedures and Speeds
Take-off Distances
Climb Performance and Flight Path
Landing Procedures and Speeds
Landing Distances

7.4 **General.** The general items prescribed in (a) to (e) shall be included.

(a) The type of engines and the type of propellers for which the performance is valid.

(b) A graph to enable winds of known speed and direction to be converted into components along the direction of the intended flight path.

(c) A diagram which shows the position of each source of static and dynamic air pressure to which an air-speed indicator is connected.

(d) Graphs or tables to enable speeds when expressed in IAS to be corrected to EAS. These shall take into account the effect of configuration and, if significant, power.

(e) A statement of the maximum value of the static error correction to be applied to the altimeter reading.

7.5 **Take-off and Landing Procedures.** The recommended procedures established in compliance with **Q2–3**, 1, which will enable the take-off and landing performance to be achieved.

7.6 **Minimum Space Required for Take-off.** The minimum space required for take-off, established in compliance with **Q2–3**, 3, shall be scheduled for each approved take-off procedure.

7.7 **Maximum Take-off Heaviness – Climb Limits.** The maximum heaviness at which compliance with the take-off climb requirements of **Q2–4**, 2 has been established shall be scheduled for each approved take-off procedure.

7.8 **Climb Performance and Flight Path.** The en-route climb performance data determined in compliance with **Q2–4**, 3 shall be scheduled. Data presenting the minimum radius of turn as a function of airspeed, determined in compliance with **Q2–6**, 4, shall also be included.

7.9 **Pressure Ceiling.** The Pressure Ceiling, and its variation with initial Ballonet inflation, shall be established and scheduled.

NOTE: This data, together with en-route climb performance data scheduled in compliance with 7.8 may be used, in conjunction with operational requirements for en-route obstacle clearance, for the purpose of flight planning.

7.10 **Minimum Space Required for Landing.** The minimum space required for landing, established in compliance with **Q2–3**, 4, shall be scheduled for each approved landing procedure.

7.11 **Variation of Weight.** The variation of Maximum Weight with initial Ballonet inflation lifting gas purity and differential pressure between the gas and outside air shall be established and scheduled.

8 **SECTION 6 – SUPPLEMENTS** (see **Q7–5** App. No. 4, 1) This Section shall contain, in the form of Supplements, information applicable to any particular feature or use of the Airship which is not covered by the information and data included in the Manual.

NOTES: (1) It is the intention that the Flight Manual of each particular Airship should include only those supplements which apply to it.

(2) When weight and balance data is required to be included in the Flight Manual (see Section A, Chapter **A5–1**) it shall be included in Section 6 as a Supplement.

8.1 Each Supplement shall describe the specific feature or use of the Airship to which it is related and shall list any additions to, or revision of, the scheduled information and data which have to be observed in the particular circumstances.

8.2 The material contained in a Supplement shall comply with the relevant requirements of this Chapter **Q7–5**.

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APPENDIX NO. 1 TO CHAPTER Q7–5

FLIGHT MANUALS – GENERAL

1 **GENERAL** (see **Q7–5**, 2)

1.1 **Size.** For standardisation with other manuals, 'American quarto' size paper should be used (8½ ins × 11 ins). For small Airships in which stowage space for documents is limited, a size more convenient to the pocket may be selected.

1.2 **Reproduction.** Graphs should be printed on a right hand page; text associated with a graph should, where practical, appear on the left hand facing page. Where a number of graphs form a series and are likely to be used successively in a calculation, the same scales should be used.

NOTE: It is recommended that an offset-lithographic process be used.

1.3 **Contents**

1.3.1 When the contents of the Manual consists of more than ten pages, each Section of the Manual should commence on a right hand page, and Sections should be separated from one another by divider cards. These cards should each be identified by a tab with the name of the Section printed on it. The card and tab for the Emergency Procedures should be coloured red.

1.3.2 When the Manual forms part of another manual or when it includes unapproved portions not prescribed by this Chapter, other Sections may be included in any suitable order but the following is recommended:–

Section 1 – General
Section 2 – Design Features
Section 3 – Limitations
Section 4 – Emergency Procedures
Section 5 – Normal Procedures
Section 6 – Performance
Section 7 – Cruise Control
Section 8 – Supplements

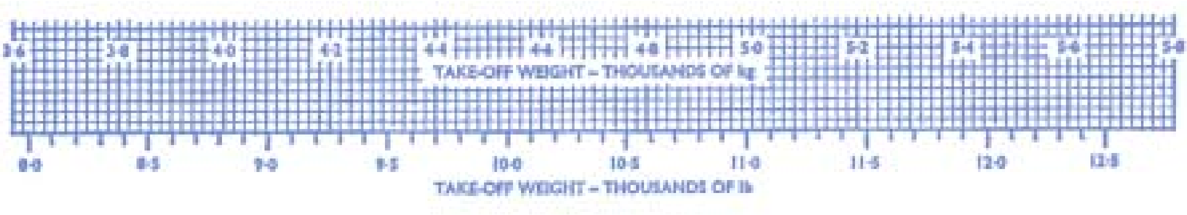
1.3.3 **Amendments.** When it is likely that the Manual will require frequent amendment an explanation should be given of the system that will be used e.g. temporary revisions or advance amendment bulletins. Divider Cards etc, should also be included.

1.3.4 **Conversion Graphs and Tables**

(a) In addition to the system of units prescribed in **Q7–5**, 2.8.1 it is recommended that unless dual scales are used throughout, the following conversions be supplied either in graphical or in tabular form:–

kilograms	to pounds
knots	to miles per hour, to kilometres per hour
degrees Celsius	to degrees Fahrenheit
feet	to metres
nautical miles	to kilometres.

(b) The method in Fig. 1 (**Q7–5** App. No. 1) should be used for showing more than one scale on a graph.



METHOD OF SHOWING MORE THAN ONE SCALE ON A GRAPH

Fig. 1 (Q7–5 App. No. 1)

APPENDIX NO. 2 TO CHAPTER Q7–5

FLIGHT MANUALS – LIMITATIONS

1 **MAXIMUM NUMBER OF OCCUPANTS** (see **Q7–5**, 4(h)(iv)) This limitation should be expressed as follows:–

'The total number of persons carried including crew shall not exceed X or the number of seats which are approved for use during take-off and landing. Children under the age of three years carried in the arms of passengers need not be included in the total.'

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APPENDIX NO. 3 TO CHAPTER Q7–5

FLIGHT MANUALS – PROCEDURES

1 **GENERAL** In order to assist the flight crew to follow the procedures contained in the Manual, capital letters should be used to correspond with the marked position of the switch or control in question. The names by which switches or controls are identified should be the same as the marking in the Airship. For example the procedure:– 'HP fuel valve: START' means that the control marked 'HP' should be moved to the position marked 'START'.

2 **NORMAL PROCEDURES** (see **Q7–5**, 6) In addition to the procedures described in 2.1 and 2.2 this Section of the Manual should include any procedure which is recommended in the event of malfunctioning of any part of the Airship which is not considered to be serious enough to be classified as an Emergency as defined in **Q7–5**, 5.

2.1 The procedures should cover all systems in the Airship and, in general, should be presented in the normal order of flight. The following order should be used as a guide:–

(a) External inspection.

(b) Internal inspection.

(c) Before starting engines.

(d) After starting engines.

(e) Engine run-up.

(f) Ground manoeuvring.

(g) Before take-off.

(h) Take-off.

(i) Climb.

(j) Cruise.

(k) Descent.

(l) Approach.

(m) Landing.

(n) Mooring.

(i) Ground.

(ii) Mast.

(o) Engine shut-down.

(p) Leaving the Airship.

2.2 Any procedures which cannot readily be included in the items detailed in 2.1 should be given separately under a separate heading marked 'Systems Control'. Typical examples are:–

Environmental control systems (e.g. air conditioning, temperature).
Flight in icing conditions.
Oxygen system.
Electrical system.

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APPENDIX NO. 4 TO CHAPTER Q7–5

FLIGHT MANUALS – SUPPLEMENTS

1 **GENERAL** (see **Q7–5**, 8) An illustration of an acceptable method of complying with the requirements of **Q7–5**, 8 is shown in this Appendix.

NOTE: It is recommended that amendments to Supplements be usually effected by a re-issue of the complete Supplement.

SPECIMEN SUPPLEMENT

Flight Manual Ref. No. 1234 **CAA approved 1.4.72**

HYPO MANUFACTURING CO.

Supplement No. 3

PROPELLER DE-ICING

SYSTEM TO MODIFICATION AL/1345

INTRODUCTION

When HMC modification AL/1345 is installed on Bordair Model 215 Airships, this Supplement must be included in the Flight Manual.

The propeller de-icing consists of a neoprene ice guard which is bonded to each propeller blade. An electrical heating element is embodied in the guard; when the propeller de-ice switch is in the ON position, an electronic timer alternately directs 28 volts dc supply to the heating elements to give a 30 second heating period, followed by a 30 second off period between the left and right propellers.

The following additions or changes are made to the limitations procedures and information in Flight Manual Ref. No. 1234. Unless otherwise stated the contents of this Manual are unchanged.

SECTION 2 LIMITATIONS

Type of Operation

When the required equipment to modification AL/1345 is installed and operative, the airship may be flown when icing conditions are known or forecast.

PLACARDS

The placards which prohibit flight into icing conditions may be removed and the following substituted.

FLIGHTS INTO KNOWN OR FORECAST ICING ARE PERMISSIBLE WHEN PROPELLER DE-ICE TO MOD. AL/1345 IS FITTED AND OPERATIVE. SYSTEM MUST BE OFF FOR TAKE-OFF.

SECTION 3 EMERGENCIES

No change.

SECTION 4 NORMAL PROCEDURES

Before take-off

1. Propeller de-ice switch . . . . . . ON for not more than 60 seconds
2. Ammeters . . . . . . check each reading at least 14 amperes
3. Regulator pressure . . . . . . check in GREEN arc

When icing conditions are suspected or encountered

1. Propeller de-ice switch . . . . . . ON
2. Ammeters . . . . . . check readings increase by at least 14 amperes

After leaving icing conditions

The systems may be switched OFF as required.

SECTION 5 PERFORMANCE

No change.